Independent Scientific Review Panel
for the Northwest Power and Conservation Council
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2020 Response Review of the Hood River Production Program

Review of the Confederated Tribes of Warm Springs (CTWS) and Oregon Department of Fisheries and Wildlife (ODFW) response to the ISRP's review of the 2019 *Addendum to the 2008 Revised Master Plan for the Hood River Production Program (HRPP)*

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Note on ISRP Membership

This review occurred during a significant transition of ISRP membership. Dave Heller, Robert Naiman, Greg Ruggerone, Steve Schroder, Carl Schwarz, and Chris Wood have completed their terms but participated in this review to ensure continuity and understanding of this complex program. Their positions were recently filled by Richard Carmichael, Patrick Connolly, Kurt Fresh, Josh Korman, Tom Quinn, and James Seeb. Four of the new members were able to participate and add to the review discussion.

Steve Schroder and Greg Ruggerone were recently appointed as unaffiliated members of the Hatchery Scientific Review Group (HSRG), for which their role is to provide impartial, independent advice. They have not yet completed any reviews for the HSRG and were not involved in creating the HSRG guidelines or applying the guidelines to the Hood River Production Program.

ISRP 2020 Response Review of the Hood River Production Program

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Background

At the December 3, 2019 request of the Northwest Power and Conservation Council, the Independent Scientific Review Panel (ISRP) reviewed a response from the Oregon Department of Fish and Wildlife (ODFW) and Confederated Tribes of Warm Springs (CTWS), regarding the ISRP's review of the 2019 *Addendum to the 2008 Revised Master Plan for the Hood River Production Program (HRPP)*. The HRPP consists of improvements to supplementation, research, monitoring, evaluation, and habitat in the Hood River subbasin. For this review, the CTWS and ODFW are requesting to increase spring Chinook production from 150,000 to 250,000 yearling smolts, but no changes are being proposed to the winter steelhead hatchery program.

The proponents' response is intended to address qualifications from the ISRP's recent review (ISRP 2019-3, September 6, 2019). The 2019 ISRP review contains a summary of past reviews and background on the project, which provide useful context for this review. In the 2019 review, the ISRP recommended "Meets Scientific Review Criteria (Qualified)" and provided the following general comments:

> The Addendum to the Hood River Production Master Plan is well written and adequately addresses many of the qualifications from the 2008 ISRP review. It includes revised objectives for both the winter steelhead and spring Chinook integrated hatchery programs, All-H Analyzer (AHA) model simulations to justify proposed levels of release and harvest, and a broodstock management plan for winter steelhead. The proponents are making good progress in developing alternative approaches to enumerate smolts and adults following the removal of the Powerdale Dam and its associated infrastructure. They are addressing genetic and ecological risks associated with precocious maturation and residualization of hatchery fish. We commend them for their prudent application of the HSRG guidelines and their thorough responses to our questions.

The ISRP's 2019 qualifications asked the proponents to address a set of issues specific to the winter steelhead program (six issues) and the spring Chinook program (five issues) in the next Step iteration. The ISRP also provided some specific comments, queries, and editorial suggestions to be considered as the program proceeds. In their December 2, 2019 response, the proponents address the ISRP's issues point-by-point, and our review below follows their point-by-point response. We begin with our overall recommendation.

ISRP Recommendation

Meets Scientific Review Criteria in Part (Qualified)

Spring Chinook salmon

The spring Chinook component of the HRPP Master Plan program meets scientific review criteria (qualified). The spring Chinook salmon hatchery program was developed following extirpation of spring Chinook salmon in the 1970s. It has shown progress in providing harvest opportunities and recolonizing spawning habitat with hatchery and natural origin spring Chinook. A key change in this program is the proposal to increase the release of hatchery origin spring Chinook from 150,000 (identified in the 2008 Master Plan) to 250,000 smolts (identified in the 2019 amendment). The 2019 response substantively addresses ISRP concerns, although several qualifications should be addressed more completely in the next phase of the review.

Qualification 1: Develop quantitative harvest objectives for hatchery origin spring Chinook salmon returning to the Hood River. The response to the first of previous qualifications for the spring Chinook program (i.e., SCP 1) does not adequately explain or justify the harvest targets for the terminal fishery in terms of the average number of hatchery origin returns (HOR) to be harvested or the proportion of years in which the terminal fishery will be opened. Quantitative objectives should also specify how the target harvest rate would change with adult abundance (e.g., a "sliding scale" decision rule). Quantitative harvest objectives are needed to provide a basis for evaluating the program and for informing stakeholders about the level of harvests that might be expected from the program.

Qualification 2: Develop a plan for monitoring and reducing the proportion of hatchery origin adults that spawn naturally (pHOS) **prior to** demonstrating success in re-introducing spring Chinook (see previous qualification SCP 3). The ISRP remains concerned that hatchery supplementation efforts are proceeding and expanding without adequate monitoring to detect and respond adaptively to unexpected outcomes (e.g., HOR exceeding harvest demand, excessive straying, poor spawner distribution, or low natural productivity), and without decision rules to change the scale or objectives of the program. Monitoring density effects on productivity (previous qualification SCP 2) is likely the most expedient way to determine if total spawner abundance is exceeding the capacity of the watershed. We refer the project managers to the ISAB report on density dependence for additional information (ISAB 2015-1).

Additional comments in the point-by-point responses section below should also be considered during subsequent revisions to the HRPP Master Plan.

Winter Steelhead Trout

The winter steelhead component of the HRPP Master Plan does not currently meet scientific review criteria. The ISRP commends the proponents for providing detailed and analytical responses to many of our questions. Some of the previous qualifications have been adequately addressed, but we remain concerned about the scale of supplementation of this natural ESA-listed population and the adequacy of the adaptive management process (see the first of our previous qualifications for the winter steelhead program (i.e., WSP 1a-e). A further response to the following major concerns is needed for the ISRP to make a final recommendation on the winter steelhead component.

Major Concern 1: Address previous qualification WSP 1 with a view to achieving a self-sustainable natural winter steelhead population consistent with requirements of the Fish and Wildlife Program and the ESA. The ISRP remains concerned that augmenting the harvest of hatchery returns by scaling hatchery supplementation to reach a natural origin escapement target of 1,100 spawners conflicts with the objective of maximizing long-term fitness of this ESA-listed winter steelhead population. The new stock-recruitment analysis appears to confirm that the best estimate of the current maximum self-sustainable spawning population does not exceed 500 spawners given current watershed conditions. The ISRP acknowledges that the Beverton-Holt (BH) estimate of capacity (R_p) is highly uncertain, and that habitat restoration may be increasing this capacity. We agree there may be merit in probing habitat capacity by setting a provisional target higher than 500 natural origin spawners (NOS) but only if the program has adequate monitoring and adaptive management protocols (see Major Concern 2).

Habitat restoration projects should have quantitative objectives to indicate how much salmonid abundance and productivity are expected to increase given the extent and assumed effectiveness of restoration actions. Lessons from monitoring activities over the last 10 to 20 years should make it feasible for the proponents to specify approximate ranges for quantitative expectations, at least to within an order of magnitude. For example, if the physical habitat is restored as planned, are productivity and capacity expected to increase by <10, 10-50, 50-100, or >100%?

The quantitative target for NOS in the 2008 Master Plan (page 8) was to "*achieve and maintain an average wild/natural-origin spawning population of 1,100 adult winter steelhead returning to the Hood River by 2019.*" We commend the proponents for having formulated this quantitative objective in 2008 and note that the target has not been achieved (Figure 1). The proponents should take this opportunity to re-evaluate assumptions behind the 2008 objective, to investigate why it has not been achieved, and to determine the likelihood of achieving it given current or future conditions.

Major Concern 2: Develop a plan to prevent the number of hatchery origin spawners (HOS) and the proportion of HOS on the spawning grounds (pHOS) from exceeding acceptable limits. Setting acceptable limit reference points for HOS and pHOS, as well as proportionate natural influence (PNI), is essential for avoiding short-term ecological (i.e., density) effects on productivity, as well as long-term genetic (i.e., interbreeding) effects on fitness of this ESA-listed population (Araki et al. 2007). Achieving these targets will help to ensure that the integrated population can remain adapted to natural conditions in the Hood River subbasin.

The plan should include a decision-making process that indicates the proponents' commitment to increase selective harvests of hatchery steelhead by fishers and to cull excess hatchery origin returns at traps and ladders in the subbasin. The response to previous qualification WSP 4 did not inform or reassure the ISRP about the number of hatchery steelhead that will be removed in relation to the estimated number of hatchery spawners. The proponents should also inspect and re-calculate (or explain) PNI values in the Master Plan that appear to be incorrect. Furthermore, we note that NMFS states that PNI should be calculated using actual (i.e., "census") pHOS rather than "effective" pHOS, as done in the Master Plan, unless there is strong evidence that the hatchery fish are not interbreeding with natural fish.

Major Concern 3: Develop a plan for monitoring, evaluation, and decision making that will allow the program to proceed cautiously given uncertainties about the appropriate scale for supplementation of winter steelhead. Besides habitat restoration and careful management of pHOS, the program must have adequate monitoring and adaptive management protocols to evaluate the consequences of probing habitat capacity with escapement targets higher than 500 NOS. It is also imperative that the Master Plan includes an *a priori* decision-making process for reducing, suspending, or terminating hatchery supplementation if outcomes (e.g., harvest, natural origin spawning population, or PNI) are less than expected and appear to compromise the long-term viability of the natural population (see previous qualification WSP 2).

The ISRP strongly recommends that the HRPP reinstate monitoring to identify and enumerate natural winter steelhead smolt production. We believe this monitoring is critical to demonstrating the scientific merit of the winter steelhead supplementation program. The ISRP now understands that funding rather than technological limitations has prevented enumeration of winter steelhead smolts after 2014. The proponents should develop a plan that reallocates funds (or requests additional funding) to support enumeration activities that will provide annual estimates of smolts-per-natural spawner. This metric of productivity is needed to implement adaptive management and to evaluate program success.

ISRP Comments on Proponents' Point-by-Point Responses

Winter Steelhead Program (WSP)

WSP 1.a: Revise (or justify) the escapement target of 1,100 natural origin winter steelhead by providing statistical analyses or statistical models based on all available data related to current productivity and carrying capacity (i.e., density dependence). The AHA analysis presented in Table 13 suggests that the self-sustaining population under current conditions is < 400 natural origin spawners.

Despite its length and detail, the response does not adequately address ISRP concerns about the escapement target for natural origin winter steelhead. The proponents provide a new analysis in which parameters for a Beverton-Holt (BH) model are estimated from stock-recruitment data collected over the last 22 years (Figure 1). Strong density effects are evident during this time series with recruits-per-spawner falling below replacement (i.e., R/S < 1) in years with more than 700 fish spawning naturally in the subbasin (Figure 2). It is also evident in Figure 1 that the abundance of natural origin spawners (NOS) has not increased substantially since supplementation began in 2008. The quantitative target for NOS in the 2008 Master Plan (page 8) was to "*achieve and maintain an average wild/natural-origin spawning population of 1,100 adult winter steelhead returning to the Hood River by 2019.*" We commend the proponents for having formulated this quantitative objective in 2008, but the target has not been achieved. It now behooves them to re-evaluate the initial assumptions and the reasons for this lack of success, and to revise their initial objective accordingly.

The proponents estimated "peak recruitment" (R_p) to be 504 spawners (95% CI 403-854). This terminology is a bit misleading because recruitment in some years clearly exceeded 505 adults. The parameter R_p is actually a measure of "average capacity" denoted by the asymptote representing maximum average recruitment. The proponents did not calculate the number of natural origin spawners (NOS) needed for replacement (i.e., sustainable spawning abundance). Based on the BH parameters provided (R_p = 504, a = 7.85), the replacement spawning population would be 440 spawners (calculated as R_p (1 - 1/a)). Thus, the new stock-recruitment analysis seems to confirm that the best point estimate of sustainable spawning population is <500 spawners, as noted in our 2019 review based on data previously available.

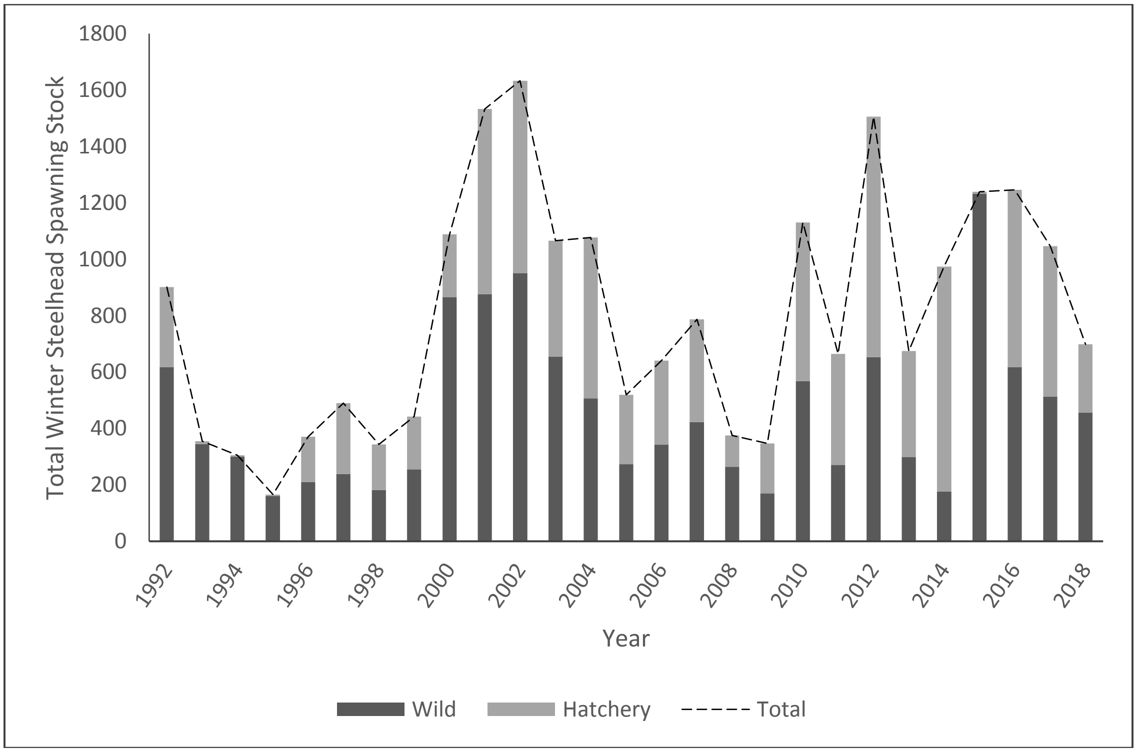

Figure 1 (from the proponents' response). Total number of winter steelhead spawners in the Hood River (1992 – 2018).

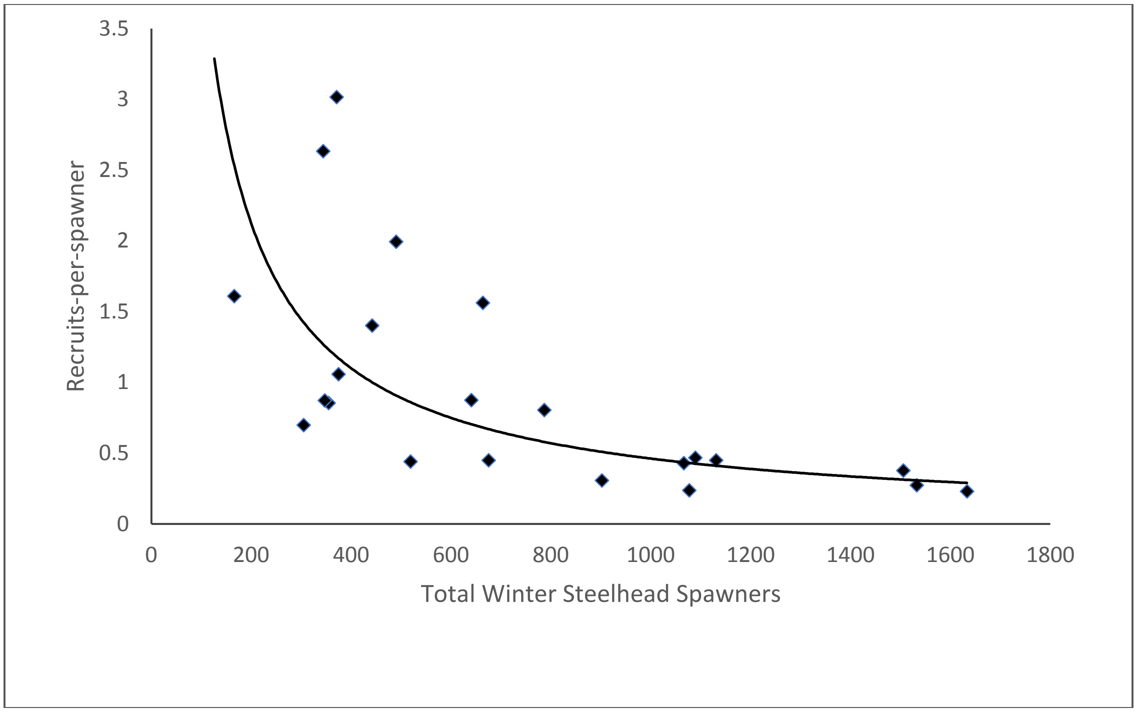

Figure 2 (from the proponents' response). Hood River winter steelhead (1992 – 2013) recruits-per-spawner as a function of total available spawners.

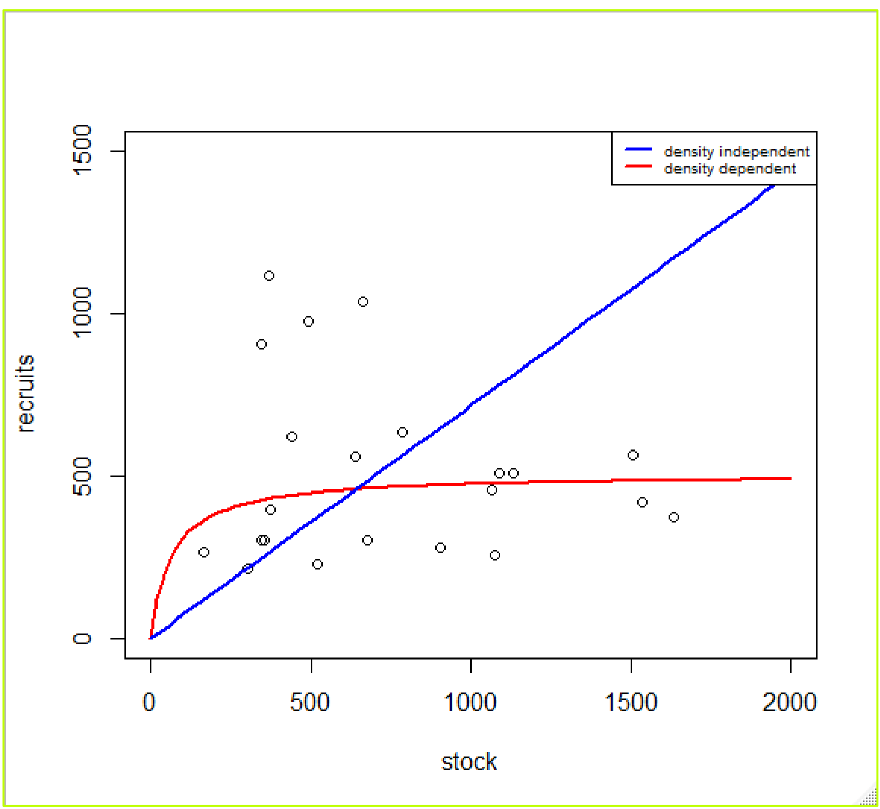

Figure 3 (from the proponents' response). Density-dependent (Beverton-Holt) and density-independent stock-recruit models for Hood River winter steelhead (spawn years 1992 – 2013). Note the low number of steelhead recruits when the spawning stock exceeds ~800 fish.

The proponents assert that a spawning target of 1,100 natural origin spawners is appropriate, even though this target is higher than the estimated upper 95% CI for R_p for the 22-year time series. They make this assumption by pointing to uncertainty in the BH analysis, to observations that spawning habitat is greater in years of high flow, and to commentary by Quinn (2005). However, the proponents do not provide reasons to expect improvements in flow or other habitat conditions (see responses to qualifications WSP 1c and 1d). Quinn's commentary describes mechanisms causing density dependence and supports choosing a population model like the BH model that can capture the effects of density dependence. His commentary does not justify choosing a target beyond levels determined by a BH model. The ISRP agrees that increased flow and ongoing habitat restoration efforts could lead to greater capacity to support winter steelhead in the future than is indicated by the recent data series. However, the BH estimate already accounts for historical fluctuations in survival from flow and other factors.

The ISRP notes that the BH model could be extended to account for flow or other factors influencing the stock-recruitment relationship, as follows:

$$R=(a*S)/(1+a/R_p*S)*exp(g*X)$$

Variables R (adult recruitment) and S (spawners) and parameters a (productivity) and R_p (capacity) are the same as those in the version of the BH function used by the proponents. The new factor exp(g*X) predicts brood-year specific deviations based on the annual values of covariate X and the estimated parameter g. (See p. 285 of Hilborn and Walters 1992 for an example applied to the Ricker model.) This model will predict vertical deviations extending upward and downward from the main curve (red line in Figure 3) based on the annual values of the covariates and the estimated value of g. For example, if X is smolt-to-adult survival rate (SAR), we would expect years with higher SAR to produce higher-than-average recruitment at the observed escapements and vice versa for broods that experienced lower SAR.

An advantage of using the extended BH model is that including the covariate allows the escapement target to be estimated for typical or expected values of the covariate. For example, if the majority of high recruitment events at low stock abundance were from broods that experienced high SAR, the fitted stock-recruit curve will not increase as steeply at low escapements and the escapement target would increase. X could also include some aspect of flow, allowing investigators to predict how much recruitment will be improved by a particular change in flow, and how much higher the target has to be for this to occur. By including both X_{SAR} and X_{flow} in the model, it becomes possible to predict the relative importance of, and expected improvements from changes in SAR versus flow enhancements. An escapement target could then be determined based on the expected improvement with and without flow restoration measures and the expected SAR value.

In our 2019 review, the ISRP stated, "*Continuing hatchery supplementation above the existing self-sustaining level is likely to reduce long-term fitness in the natural environment, unless habitat restoration efforts succeed in creating conditions that will support a larger self-sustaining population in the future.*" We remain concerned that augmenting the harvest of hatchery returns by scaling hatchery supplementation to reach a natural origin escapement target of 1,100 spawners conflicts with the objective of maximizing long-term fitness of this ESA-listed winter steelhead population. That said, the ISRP acknowledges that the BH estimate of capacity (R_p) is highly uncertain and that habitat restoration may increase capacity in the future.

We agree there may be merit in probing habitat capacity by setting a provisional target higher than 500 NOS, but only if the program has adequate monitoring and adaptive management protocols. It is essential that the Master Plan includes an *a priori* decision process for reducing or terminating hatchery supplementation should outcomes (e.g., harvest, natural origin spawning population, PNI) be less than expected, which would likely reduce the long-term viability of the natural population. In particular, setting and achieving pHOS and PNI targets will help ensure that the integrated population remains adapted to natural conditions in the Hood River subbasin.

The ISRP has two specific concerns for how the provisional target of 1,100 NOS might be used inappropriately when managing returns of HOR. First, the goal of 1,100 NOS must not encourage managers to achieve a total escapement of 1,100 spawners by allowing a large escapement of HOS in the Hood River. The proponents note in their response that the ultimate goal is to exclude hatchery steelhead from the spawning grounds (i.e., pHOS = 0). It is important that fishery managers also recognize this goal and seek to limit pHOS via selective harvests, selective removal at weirs and ladders, and if need be, reduced hatchery production. The selective harvest target has not been achieved to date, even though sufficient HOR have been available for harvest. The inability to harvest HOR or remove them at traps and ladders has resulted in large total escapements (i.e., 698 to 1246) and highly variable pHOS (i.e., 1 to 82%) over the past 5 years (Addendum Table 10). This continuing high abundance of HOS is almost certainly reducing the productivity of NOS given the analysis shown in Figures 2 and 3.

Second, the plot of recruitment data in Figure 3 suggests "overcompensation" in that a spawning stock between 300 and 800 spawners produced the 6 highest recruitments and higher average recruitment than spawning stocks exceeding 800 spawners. The ISRP is not aware of any reports of overcompensation occurring in other steelhead populations, and the apparent relationship may be a statistical artifact of this 22-year time series. However, overcompensation has been reported in some Columbia River Chinook salmon (see ISAB 2015-1 and addendum). The main concern arising from overcompensation is that recruitment is expected to decline (rather than just level off) at high spawning abundance. HOS will exacerbate any overcompensation effects on NOS, so selective removal of hatchery steelhead in the fishery and at traps and ladders is needed to prevent the HOS escapement from causing the total escapement (i.e., HOS +NOS) to exceed the putative overcompensation threshold (i.e., ~800 spawners).

Understanding the effect of pHOS on natural production is essential for making decisions on harvest and hatchery production. The stock-recruitment covariate model described above could be helpful in this regard. By setting X to the annual value of pHOS, one could evaluate if years with higher pHOS produce fewer recruits than years with low pHOS. The lower (i.e., the more negative) the estimated value of g, the greater the impact of high pHOS on the natural production. The greater the impact of pHOS on natural production, the greater the need to either reduce hatchery smolt releases or increase removals of HOR.

WSP 1.b: Monitor the abundance of natural origin smolts and total smolts to estimate freshwater productivity (i.e., smolts-per-natural spawner). Is it feasible to restart the smolt enumeration program that was terminated after 2014? If the program was terminated because of uncertainty distinguishing summer and winter

steelhead smolts, consider contacting the CRITFC Hagerman Lab about the feasibility of using genetic analysis (see qualification 6).

The response clarifies why estimates of natural origin winter steelhead smolts are not available after 2014. It also summarizes progress in using genetic methods to distinguish smolts from winter steelhead versus summer steelhead populations. The ISRP now understands that funding rather than technological limitations has prevented enumeration of winter steelhead smolts after 2014.

The ISRP asks the proponents to estimate the budget that would be required to annually enumerate natural origin winter steelhead smolts. We think this cost would be small compared with the overall cost of the program, and we believe that annual estimates of natural winter steelhead smolts are important for evaluating program success and implementing adaptive management. In the meantime, if not already being done, we encourage the proponents to collect and archive DNA from representative annual samples of steelhead smolts emigrating from the Hood River. This would allow the project to recover valuable data once funding and staffing issues have been resolved.

The need for enumeration of winter steelhead smolt production was clearly specified in Strategy 3 of the 2008 Master Plan and the 2008 HGMP for winter steelhead. Strategy 3 states "*Purpose: One objective of the HRPP is 'to increase production of wild summer and winter steelhead (*Oncorhynchus mykiss*) commensurate with the subbasins current carrying capacity' (Coccoli 2004). … The HRPP's defined smolt production and spawner escapement objectives for summer and winter steelhead are implicitly based on two general hypotheses: 1) that the Hood River subbasin is under seeded in terms of both smolt and spawner carrying capacities and 2) habitat improvement work will significantly increase the subbasins carrying capacity relative to both smolts and spawners…Downstream migrant traps will be used to estimate numbers of wild rainbow- steelhead moving past selected areas of the Hood River subbasin. Estimates will be used to determine the number of smolts produced in the Hood River subbasin; in the West, Middle, and East forks of the Hood River subbasin; and in Neal Creek, Lake Branch, and Green Point Creek. Data will be used to determine if the HRPP is successfully achieving its defined goal of restoring depressed populations of wild summer and winter steelhead in the Hood River subbasin to levels commensurate with the subbasins current carrying capacity.*" The ISRP notes that this strategy appears to have been dropped or significantly de-emphasized in the 2019 Addendum and the 2017 HGMP for winter steelhead.

The ISRP strongly recommends that the HRPP reinstate monitoring to identify and enumerate winter steelhead smolt production. These data are needed to evaluate progress towards program goals. The "smolts-per-spawner" metric measures productivity within the Hood River during the life stages targeted by hatchery supplementation and habitat restoration. Consequently, it provides a more direct evaluation of habitat capacity and project effectiveness than metrics based on full life cycle productivity, which are also necessary for the overall evaluation, but potentially influenced by factors outside the Hood River subbasin.

WSP 1.c: Estimate the maximum self-sustaining population under planned future conditions based on evidence of successful habitat restoration efforts in the Hood River subbasin.

The response is only partially adequate. It suggests that the proponents cannot yet provide evidence or analyses to support the assumption that habitat capacity will improve in the near future, which might otherwise justify a target of 1,100 NOS to probe expected capacity (see WSP 1a).

The proponents indicate that estimating the maximum self-sustaining population of winter steelhead under planned future conditions is difficult because of the dynamic nature of environmental conditions in the Hood River subbasin. For example, they mention that ongoing glacial recession may cause debris flows that block fish passage and influence the suitability of riverine habitats. At the same time, however, they suggest that restoring the physical habitat, flow regime, and stream structure may buffer the population against some of this environmental stochasticity.

The ISRP understands that estimates of benefits from habitat restoration will be highly uncertain, and that year-to-year fluctuations in salmonid abundance will be strongly influenced by variability in flow, temperature, and other factors. Even so, each suite of habitat restoration projects should have quantitative objectives for how much salmonid abundance and productivity are expected to increase given the level of effort and assumed effectiveness of restoration actions. It is important to convey this type of information to decision makers and to track progress so that goals and objectives can be evaluated. Given monitoring activities over the last 10 to 20 years, it should be feasible for the proponents to develop some rough quantitative expectations for the outcome of habitat restoration actions. For example, if the physical habitat is restored as planned, are productivity and capacity expected to increase by <10, 10-50, 50-100, or >100%? The proponents should support these expectations with information from other sources (e.g., AEM, life cycle models, or published reports from monitoring in other subbasins). They should be cautious about expanding smaller reach-level responses to the entire network or subbasin. They should also consider the size of the streams, the proportion of the basin that could be restored within the timeframe of the management plan, and the time required for functional changes to occur after restoration. For example, riparian planting will not instantly increase shade, reduce stream warming, and contribute large wood.

WSP 1.d: Describe how habitat restoration efforts in the Hood River subbasin are being evaluated and indicate if reference streams are being used. Evaluation of fish responses to habitat restoration actions typically requires reference streams for use in Multiple Before After Control Impact (MBACI) designs (when habitat improvements are large and sudden) or Stair Case Designs (when habitat improvements are added incrementally over time).

The response is partially adequate. The ISRP understands that determining the ecological effectiveness of small habitat restoration projects is difficult. However, we note that Strategy 6 in the 2008 Master Plan (repeated in the 2008 HGMP for winter steelhead) states "*Habitat will be monitored throughout the Hood River subbasin to evaluate changes in subbasin carrying capacity*." This commitment appears to have been dropped in the 2019 Addendum and 2017 HGMP for winter steelhead.

The ISRP agrees with the proponents that adult spawning escapements, harvests, and smolt production should be monitored annually. Counting "adults in" and "smolts out" provides data to evaluate annual productivity (i.e., the number of smolts produced per female) and the effects of spawner density and environmental conditions. We strongly recommend that some funds be used to measure smolt abundance and productivity separately for natural origin winter versus summer steelhead. The genetic tools described by the proponents appear to be adequate to distinguish smolts from these populations when the migrations overlap. Data on environmental covariates (e.g., daily flow and temperature data) should also be collected during the period from spawning to smolt migration for each brood year.

Counts of "adults in" and "smolts out" must be reliable and consistent enough to allow statistical comparisons of productivity among treatment and reference areas. Reference areas need not be pristine or located within the same subbasin. Recently, the ISAB (ISAB-2018-1) reviewed the selection of reference streams being used by managers and researchers in the upper Columbia River basin. That report contains suggestions for selecting reference streams and for incorporating the reference data into statistical designs (e.g., BACI). For example, the report states *"…the purpose of the reference stream is to simply show the change in the mean response over time between the before and after periods. This difference is compared to the change in the MEAN response in the supplemental [restored] stream between the before and after periods… If this differential change in the MEAN (the BACI effect) is not zero, then there is evidence that supplementation [restoration] has an effect*." We recommend that the proponents examine the ISAB report for advice on incorporating reference streams into their monitoring and evaluation efforts.

WSP 1.e: Revise the AHA modeling tables as appropriate if values change as a result of new analyses of capacity and productivity, including the winter steelhead escapement target.

The response does not provide new data or analyses that would substantially change values in the existing AHA modeling tables. However, the ISRP's key concern is that hatchery steelhead should be selectively removed through fishing or culling with traps when overall spawning abundance begins to exceed capacity. Therefore, we encourage the proponents to use the extended recruitment curve approach discussed above (e.g., inclusion of influential variables such as flow and SAR) and re-estimate capacity that supports maximum recruitment. This new decision should be conveyed to the managers, so that actions can be taken now rather than waiting until after the next review. If the total spawning escapement is near or above the estimated spawning capacity, natural spawning by hatchery origin steelhead will decrease the productivity of the natural origin component of the integrated population, contrary to program goals and objectives. Controlling pHOS could minimize this density effect on productivity as well as increase PNI to help maintain long-term fitness.

WSP 2: Provide quantitative decision rules that specify the conditions and time frames that would trigger changes to hatchery supplementation of winter steelhead (including reduction or termination). Examples might be a continuing decline in natural origin returns that reduces pNOB to below a specified threshold or a continuing increase in natural spawners (both HOS and NOS) to densities that cannot be sustained by existing habitat.

The response is not adequate. No quantitative decision rules for increasing, reducing, or terminating hatchery supplementation are provided. The ISRP remains concerned that the scale of the hatchery program appears too large and has not been adequately justified. The Master Plan still lacks an adequate process for adaptive management with provision for an "exit ramp". For example, the proponents state that "*supplementation may be needed to ensure the persistence of steelhead in this basin given environmental stochasticity...*", which implies that supplementation might continue despite consistently large returns of natural origin steelhead.

The ISRP asks that a quantitative decision tree be developed based on the ideas presented in the response before observations call for such decisions. The key goals of the winter steelhead program are to provide in-river harvests (i.e., 876 hatchery steelhead), and to increase the number of NOS (i.e., 1,100 spawners) while maintaining the fitness of this primary ESA population. The harvest goal is not being met because fishing and trapping are inefficient—not because of insufficient HOR. Methods to increase harvest and trapping efficiency should be developed, evaluated, and implemented because increasing efficiency is the key to success. Meanwhile, the number of NOS has remained well below the target with no obvious upward trend (Figure 2).

The proponents suggest that substantial changes in hatchery operations (e.g., egg take goals, broodstock numbers and composition, and smolt release numbers) are challenging given the lack of monitoring infrastructure to reduce uncertainties in the number of adult returns and the composition of spawners. The proponents also state that the current program is designed to protect natural fish and meet HSRG guidelines in the absence of suitable fish trapping infrastructure, and that a sliding scale for incorporating NOR broodstock will be developed once improvements in infrastructure have been made. However, it is not clear how the program will protect natural fish and meet the HSRG goals for primary populations. Rules stipulating the proportion of NOR to be used as brood stock (i.e., pNOB) are not presented in the response or the Master Plan. These rules should be developed even before the infrastructure is improved. Clearly, some form of multi-year enumeration capability is essential to support evaluations that can inform decisions and actions.

The ISRP notes that the proponents may be using "effective pHOS" inappropriately when calculating PNI scores (e.g., in Table 10). NMFS cautions that "effective pHOS" should not be used unless there is good evidence (e.g., from parentage-based tagging (PBT) analyses) that hatchery fish are NOT interbreeding with natural salmon or steelhead. If hatchery fish are interbreeding with natural salmon, then the Ford model from which the PNI formula is derived already accounts for lower reproductive fitness of hatchery salmon. Below is a quote written by NMFS scientists in recent Biological Opinions involving hatcheries (text provided by Craig Busack, NOAA Fisheries):

> *NMFS feels that adjustment of census pHOS by RRS should be done very cautiously, not nearly as freely as the HSRG document would suggest. The basic reason is quite simple: the Ford (2002) model, the foundation of the HSRG gene flow guidelines, implicitly includes a genetic component of Relative Reproductive Success (RRS). In that model, hatchery fish are expected to have RRS < 1 (compared to natural fish) due to selection in the hatchery. A component of reduced RRS of hatchery fish is therefore already incorporated in the model and by extension the calculation of PNI. Therefore reducing pHOS values by multiplying by RRS will result in underestimating the relevant pHOS and therefore overestimating PNI. Such adjustments would be particularly inappropriate for hatchery programs with low pNOB, as these programs may well have a substantial reduction in RRS due to genetic factors already incorporated in the model.*
>
> *In some cases, adjusting pHOS downward may be appropriate, however, particularly if there is strong evidence of a non-genetic component to RRS. An example of a case in which an adjustment*

by RRS might be justified is that of Wenatchee spring Chinook salmon (Williamson et al. 2010) where, the spatial distribution of natural-origin and hatchery-origin spawners differs, and the hatchery-origin fish tend to spawn in poorer habitat. However, even in a situation like this it is unclear how much of an adjustment would be appropriate. By the same logic, it might also be appropriate to adjust pNOB in some circumstances. For example, if hatchery juveniles produced from natural-origin broodstock tend to mature early and residualize (due to non-genetic effects of rearing), as has been documented in some spring Chinook salmon and steelhead programs, the "effective" pNOB might be much lower than the census pNOB.

WSP 3: Improve monitoring and evaluation methods to meet NOAA criteria for the precision of escapement estimates (i.e., CV < 15%) for natural and hatchery origin winter steelhead.

The response provides a clear assessment of challenges to improving the precision of escapement estimates to meet NOAA criteria. The proponents used models to test if increasing the number of smolts tagged, improving adult detection at the mouth of the Hood River, or doing both would adequately increase precision. They found that doing both would decrease the CVs of the abundance estimates for both wild and hatchery adults. However, the required improvements are probably not feasible in practice. The proponents argue that their estimates of adult abundance appear to be accurate despite the relatively high CVs.

A key issue identified by the proponents is that variability in river conditions affects the date of weir installation. High flows or a high likelihood of subsequent flooding events can delay decisions to put the weirs in place. PIT-tag detection data obtained at the Bonneville Dam and observations by anglers suggest that some winter steelhead are likely ascending into spawning areas prior to the installation of trapping facilities. Thus, delays in trap installation could decrease adult detection rates and lead to underestimation of escapement, which would bias estimates of productivity based on smolts-per-spawner or adult returns-per-spawner. As mentioned in our original review, the proponents may wish to consult with NOAA Fisheries to determine if installing newly developed PIT-tag detection devices in the Hood River could solve some of these monitoring difficulties.

We encourage the proponents to include the response to WSP 3 (as well as detailed responses to other qualifications) in the Master Plan, perhaps as an appendix. We appreciate the comment that the proponents want to remove surplus hatchery steelhead at traps and ladders. However, we emphasize that the overall effectiveness of removal will be determined by the efficiency of both traps and fishers in the lower river.

WSP 4: Provide estimates of all hatchery steelhead removed each year including those harvested by anglers and those removed in all traps, ladders, and weirs in the subbasin. This information is critical to documenting program success and evaluating the overall harvest goals. Describe how the harvest of winter steelhead will be monitored in the future given the lack of funding to support the harvest survey in 2019. Will the East Fork Irrigation District ladder and adult trap be operated every year as

a means to remove hatchery fish (in addition to obtaining hatchery broodstock)?

The response is helpful but insufficient. ISRP asked for estimates of hatchery steelhead removals in fisheries, traps, ladders, and for hatchery broodstock. Recreational harvests of hatchery steelhead are provided in Table 6, and hatchery steelhead collected for broodstock are shown in Table 14, but collection and removal of additional hatchery steelhead at traps and weirs are not apparent. Data on the escapement of hatchery and natural origin steelhead are readily available (Table 10). The response notes that the requested data are compiled in "annual reports" but no links or specific references were provided. The ISRP does not have easy access the specific annual reports. We are not yet able to assess the level of commitment to removing hatchery steelhead at traps and ladders. The ISRP wants to be confident that we understand the number of hatchery steelhead that will be removed in relation to the estimated number of hatchery spawners. This is a significant issue that needs resolution in the near future.

The proponents mention that it is now possible for the project to construct a permanent adult weir at the former Dee Lumber Mill site to provide a safe and reliable way to manage steelhead and bull trout in the East Fork of the Hood River. Data and fish collected or sampled at this site would aid in monitoring the effectiveness of the project's supplementation and conservation efforts. The ISRP judges this to be an important component of monitoring and evaluation. We ask that the proponents provide more details on how many hatchery steelhead, and what proportion of total steelhead, could be removed with this proposed trap, and at what cost.

The proponents indicated that creel surveys to estimate HOR harvest will no longer be carried out because of budget constraints. Instead, the proponents plan to rely on the ϕ parameter of a CJS model to estimate HOR harvest. Harvest numbers estimated from the CJS ϕ parameter versus creel surveys were found to be similar in the two years compared (i.e., 2016 and 2018). The proponents mention that ODFW harvest card data could also be used to estimate the HOR harvest. We feel it would be useful to compare harvest data estimated from harvest cards, the ϕ parameter, and creel surveys for 2016 and 2018 as another possible check on the adequacy of the CJS ϕ parameter method. However, the proponents should be aware of, and if possible evaluate, possible bias in the harvest card data.

WSP 5: Reconsider the decision not to release some hatchery steelhead smolts in the lower river. Releasing a portion of the smolts in the lower river would make it easier to achieve the harvest goal (i.e., average annual harvest of 876 adults), which requires selectively catching 67% of hatchery origin fish in the terminal fishery. Describe what steps will be taken to increase the terminal harvest rate by improving angler access and how these actions will be evaluated.

The response is adequate. The proponents acknowledge the potential benefit of releasing hatchery smolts in the lower Hood River subbasin and describe the operational challenges they face. Because the program's success depends, in part, on increasing the capability to harvest and cull HOR, we encourage the proponents to continue to evaluate potential approaches to do this, including test releases of hatchery smolts in the lower river (e.g., at Neal Creek). The ISRP hopes that progress can be made on acquiring the Neal Creek property. Releases into the lower river could be useful as a means to increase harvests while also reducing pHOS in the upper river where natural origin steelhead spawn. If this site is acquired, would it also be necessary to construct an acclimation pond and a more permanent adult weir?

WSP 6: Examine the feasibility of conducting genetic analyses of tissue samples from smolts collected in the rotary screw traps (RST) to:

a: distinguish summer and winter steelhead smolts to determine their relative abundance (see qualification 1b); and

b: monitor the extent of hybridization between residual steelhead and cutthroat trout (see Christie et al. 2011).

The response is adequate. It appears that the proponents have developed genetic tools that can be used to address important management issues. We encourage them to continue their work with CRITFC geneticists in developing genetic methods to help determine the relative abundance of summer and winter steelhead smolts and to monitor the extent of hybridization between residual steelhead and cutthroat trout. A description of these activities should be included in the next iteration of the Master Plan.

Spring Chinook Program (SCP)

SCP 1: Develop a quantitative objective for harvests associated with the proposed increase in hatchery production of spring Chinook salmon, and provide background information and decision criteria to justify the increase.

The ISRP appreciates the detailed response. It clearly explains why the proponents believe releasing more hatchery smolts (i.e., 250K rather than 150K) is needed to continue to meet requirements for broodstock and current expectations for terminal fisheries in most years, given the anticipated impact of the Pacific Decadal Oscillation (PDO) on marine climate and SARs. The ISRP agrees that this strategy may help to meet broodstock requirements for the HRPP despite low SARs. However, if the PDO effect on SARs is density dependent (i.e., mediated by competition for food), then adopting this strategy generally throughout the Columbia River Basin would exacerbate rather than ameliorate the underlying problem of poor marine survival. The ISAB has examined this policy issue in its reports on food webs and density dependence (ISAB 2011-1, 2015-1).

The response does not adequately explain or justify the harvest objectives for the terminal fishery, either in terms of a target harvest rate averaged over all years or the proportion of years in which the terminal fishery can be opened. Nor is there any discussion of how adult abundance may alter fishing opportunities. Quantitative harvest objectives are needed to provide a basis for evaluating the program and for informing stakeholders about the level of harvests that might be expected from the program. Multiple harvest objectives could be identified depending on the anticipated production regimes, as discussed by the proponents. If not already being done, we suggest that in-season counts of Hood River spring Chinook at the Bonneville Dam be used to help forecast adult return numbers to the Hood River. These annual estimates could be used to set a preliminary level of harvest compatible with the management goals for spring Chinook.

SCP 2: Evaluate options and propose a plan to estimate the annual smolt production and parental spawning abundance of natural origin spring Chinook in the Hood River subbasin. To date, natural origin spawning abundance has been estimated in only one year (2016). A primary objective should be to analyze density effects on productivity (e.g., the decline in smolts-per-spawner with increasing spawning abundance) to develop more explicit goals for terminal harvests and escapements. We urge the proponents to determine the relationship between river conditions (e.g., discharge and water height) and trapping efficiency for each RST, and to use that relationship to refine estimates of smolt production from trap catch data.

The response acknowledges but does not discuss the ISRP's recommendation to propose a plan to evaluate density effects on productivity. Instead, the response indicates that estimating the annual smolt production and parental spawning abundance of natural origin spring Chinook in the Hood River subbasin is not feasible financially due to the following operational challenges: (1) abundance of natural origin spring Chinook is typically low (e.g., < 100 adults were counted past Powerdale Dam in most years); (2) juvenile fall and spring Chinook cannot be differentiated morphologically; and (3) capture rates in rotary screw traps (RST) during the spring are currently insufficient to generate reliable mark-recapture estimates of abundance.

The ISRP commends the proponents for providing their analysis of mark-recapture estimates of natural spring Chinook smolt production during 2015-2017. The analysis shows that a trapping efficiency model with fork length as a covariate performs better than an alternative model with flow as a covariate. However, the tabulated abundance estimates with 95% confidence intervals suggest that the proponents have made two statistical errors in this analysis. First, it appears they incorrectly used mean fork length instead of using a Horvitz-Thompson estimator for each observed fork length. Second, it appears they incorrectly estimated the lower and upper confidence limits for abundance (i.e., it is not correct to simply recalculate abundance using the estimated lower and upper bounds of the parameter values).

The proponents may wish to try a different approach to mark-recapture estimation that has been used successfully throughout the Northwest (e.g., USFWS Arcata Fisheries Technical Report and Rotary Screw Trap Protocol). The alternative approach involves temporarily marking (e.g., with Bismarck Brown) batches of fish recently caught in the RST. The marked fish are released upstream of the trap to determine the recapture rate. The marking and release operation is repeated routinely at intervals throughout the trapping season under varying flow conditions. The seasonal relationship between measured efficiency rate and stream gauge height is then used to determine an appropriate efficiency rate for estimating daily counts of emigrants given the daily stream gauge reading. The USGS operates a stream gauging station in the subbasin and discharge values from the USGS station could be correlated to data from stream gauges placed at trapping sites. As the proponents point out, flow and trapping efficiency can vary substantially over a short period of time (i.e., hours), but such variation can be accounted for in this alternative approach. In combination with genetic identification methods, this approach may ease some of the proponents' operational challenges.

The proponents also conclude that juvenile abundances (i.e., ranging from 78 to 1,828, 95% C.I. 48 to 2,238) and SAR values are typically too low for any model to characterize density effects. However, a low SAR value would not preclude a model from detecting density effects. Perhaps the proponents are simply pointing out that low levels of smolt production combined with low SAR values lead to "low" spawning escapements, but that conclusion begs the question of whether escapements are currently well below capacity. The ISRP's request to evaluate possible density effects on the productivity of spring Chinook is motivated by clear evidence of density effects on the productivity of the winter steelhead population. Data from the subbasin illustrate that recruits-per-spawner generally decreases when adult steelhead abundance exceeds ~400 fish (Figure 2).

The Addendum indicates that returns of spring Chinook to the Hood River have averaged 285 NOR and 1,641 HOR over the last 5 years (Table 20). On average, 837 (51%) of the HOR were harvested. If the NOR are sport caught at the same rate as HOR, then 7 NOR are expected to die after release due to hooking mortality (i.e, 5% of 51%). To produce 150K smolts with pNOB = 10%, 144 HOB and 16 NOB must be removed from the run as broodstock. Thus, under average conditions, a total of 922 spring Chinook are expected to spawn naturally (i.e., 660 HOS + 262 NOS). When the smolt goal is increased to 250 K this number becomes 802 adults (i.e., 552 HOS + 250 NOS). These total spawning escapements are similar to the spawning escapements that produce detectable density effects in steelhead.

Spring Chinook and winter steelhead occupy different freshwater niches and steelhead typically spend an additional year in freshwater. Consequently, spring Chinook might not experience a similar reduction in productivity under current abundance levels. Still, hatchery supplementation of spring Chinook has been taking place in the subbasin since 1990, and a self-sustaining population has not yet been established. It is therefore important to understand the factors constraining their productivity and abundance. Such knowledge would help to guide future decisions about habitat actions and harvest rates.

SCP 3: Develop a plan to monitor hatchery origin Chinook returns and to reduce pHOS when total spawner abundance approaches the capacity of the watershed to support both natural origin and hatchery origin Chinook.

The proponents seek to defer development of a plan to monitor and reduce pHOS until after success in the re-introduction program has been demonstrated. The ISRP remains concerned that hatchery supplementation efforts are proceeding and expanding without adequate monitoring to detect changes and respond adaptively to unexpected outcomes, and without decision rules to reduce the size of the program. Monitoring density effects on productivity (i.e., SCP 2) is likely the most expedient way to detect whether total spawner abundance is exceeding the capacity of the watershed. Monitoring and, when necessary, culling HOS could be essential for reducing pHOS and density effects on the natural origin component of the integrated population.

The Master Plan already calls for annual estimates of sport and tribal harvests and harvest rates of hatchery spring Chinook, total hatchery returns at the river mouth, and SAR estimates. Is it not feasible to estimate the spawning escapement of NOS and the total spawning escapement (i.e., HOS +NOS) by monitoring and expanding the number of NOR released from in-river sport and tribal fisheries relative to HOR Chinook at the river mouth and captured in the mark-selective fisheries? Estimates of NOS are needed to calculate pHOS, PNI scores, and to track the status of the NO population.

SCP 4: ***Compare straying rates of adult spring Chinook with different rearing histories. Some fish are incubated, reared, and released entirely within the Hood River subbasin, whereas others are incubated and reared in the Deschutes River subbasin prior to being acclimated and released back into the Hood River subbasin. The ISRP is concerned that in years of low harvest rate, straying of Hood River hatchery origin Chinook may adversely affect other natural populations in neighboring watersheds.***

The proponents provide a commendable analysis of the fate of 974 PIT-tagged Hood River Chinook that had been reared, acclimated, or released in several different locations and were subsequently detected ascending Bonneville Dam between 2008 and 2013. Their analysis indicates that fewer than 5% of spring Chinook released by the program stray to areas outside the Hood River. If adequate baseline samples have been collected to support genetic and parentage-based tag analyses, it might be feasible, and worthwhile, to undertake an independent assessment by sampling spawners and spawner carcasses in adjacent watersheds. In any case, the ISRP recommends continued routine monitoring of straying rates, both out of and into the Hood River, as part of a long-term evaluation of potential straying effects and appropriate smolt release targets. We also suggest comparing observed straying rates to those reported by Westley et al. (2013).

SCP 5: ***Review existing studies and/or conduct new research to evaluate the risk that the productivity of natural origin winter steelhead or other non-target native fishes might be adversely affected by increasing hatchery releases of spring Chinook smolts from 150,000 to 250,000 annually. Previous work in the Yakima River by McMichael and Pearsons (1998), Temple and Pearsons (2012), and Fast et al. (2015) suggests that hatchery supplementation of spring Chinook generally had no detectable effects on resident rainbow trout and other native fish species. However, Pearsons and Temple (2010) did find reductions in rainbow trout abundance and biomass in one Yakima River tributary that might have been linked to the continuing annual release of hatchery spring Chinook juveniles. Consequently, we suggest that the proponents consider assessing possible impacts of continuing annual releases of hatchery origin spring Chinook on the abundance and growth of Hood River steelhead.***

The proponents cite evidence from a nearby subbasin to indicate that a hatchery program for spring Chinook is not likely to impact native fishes or wild steelhead. We agree that if spring Chinook smolts leave the subbasin rapidly and soon after release, their interactions with juvenile steelhead would be limited, and consequently, potential impacts on steelhead would be minimal. Even so, we recommend monitoring to test for significant changes in the density-dependent relationship between steelhead smolt size and juvenile steelhead density (or total steelhead smolt migration) associated with the transition from current conditions (i.e., 150K Chinook smolts released) to proposed conditions (i.e., 250K Chinook smolts released). Empirical evidence that the size of steelhead smolts (after correcting for steelhead density) is not affected by increased releases of Chinook smolts would provide reassurance that ecological impacts on winter steelhead productivity are minimal and acceptable.

Specific Comments and Suggestions

- ***Correct (or explain) apparent errors in the PNI calculations in Tables 11, 13 and 15.***

The short response does not adequately explain how the "new Busack PNI values" are calculated. The footnote in Table 11 indicates that PNI values are calculated assuming that the natural reproductive success of HOS is effectively only 80% that of NOS. Even so, using values shown in Table 11 in the equation PNI = pNOB/(pNOB + effective pHOS), we calculate PNI to be 0.59 and 0.77 rather than 0.73 and 0.89 for the current versus doubled terminal harvest rate scenarios, respectively. Please re-check the PNI calculations in Tables, 11, 13, and 15, and elsewhere, and provide a more detailed explanation of PNI calculations in the next iteration of the Master Plan.

Additionally, please see our comment above (based on our discussion with Craig Busack) regarding the inappropriate use of "effective pHOS." NMFS recommends use of actual (i.e., "census") pHOS unless there is strong evidence that the hatchery fish are not interbreeding with natural fish.

- ***Provide more detail (or a reference) to justify the decision rule that allows no more than 25% of the natural population to be removed for hatchery broodstock. The ISRP remains unconvinced that the 25% threshold is optimal for protecting the natural population if it decreases PNI by triggering the use of hatchery origin or out-of-basin broodstock. It is unclear if this decision rule is specified in ODFW and/or NOAA policy or was developed by the proponents and approved by these agencies. In any case, the decision rule highlights a conflict between the conservation and harvest goals for the program. An alternative approach would be to focus on maintaining a high PNI value by reducing the total number of broodstock used and smolts produced as circumstances dictate.***

The response partially addresses the ISRP's concerns but does not justify or explain the origin of the "<25% broodstock mining rule." The proponents acknowledge that they are unaware of any authoritative publication that specifies a maximum limit on the proportion of a wild salmonid population that should be captured as hatchery broodstock. This threshold can vary depending on a population's status and local circumstances. Some conservation efforts have incorporated 100% of a population into a hatchery captive breeding program; others (e.g., the Yakima spring Chinook program) set the maximum mining threshold at 50%. Thus, the 25% threshold proposed in this program seems relatively low, but the proponents point out that it is unlikely to constrain broodstock collection given current abundance and the small size of the hatchery program.

Decision rules based on a quantitative "sliding scale" for retaining natural origin fish as broodstock are typically required components of a hatchery Master Plan. The sliding scale is clearly described for winter steelhead in Table 16 of the Addendum. However, we were confused by the brief description (on page 40 of the Addendum) of the broodstock collection plan for spring Chinook. Moreover, Table 23 does not provide separate values for HOB and NOB; Table 24 does, but only for three years (i.e., 2013 to 2015). We request that the proponents clarify the sliding scale decision rules for spring Chinook by including more detail in the next iteration of their Master Plan.

- ***How long are juvenile winter steelhead held prior to volitional release under the new acclimation protocol? Have straying rates increased or decreased following changes to the protocol? Would it be advantageous to create more natural settings for smolt rearing and acclimation? The Yakama Nation and Nez Perce Tribe are currently rearing Chinook in quasi-natural hatchery environments featuring underwater feeders, floating covers, painted walls, and in some cases natural substrates and in-water structures. The proponents may wish to consider two relevant publications (Maynard et al. 2001, Fast et al. 2008) and consult Charlie Strom (Yakama Nation, Cle Elum Hatchery manager) and Billy Arnsberg (Nez Perce Tribe) for more details regarding this possibility.***

The proponents point out that rearing and release protocols recently adopted for winter steelhead have already increased smolt-to-adult survival rates. They speculate that further physical alterations to rearing vessels would not result in substantial improvements in survival. They may be right, but losses of hatchery salmonid smolts soon after release can be substantial. Two unintended consequences of feeding and rearing in artificial environments are hypothesized to affect predation rates on hatchery fish shortly after their release. First, surface feeding may orient hatchery fish towards the surface and habituate them to above surface movements. Second, the light coloration of raceways can reduce melanosome development in smolts making them initially more vulnerable to predators (Maynard et al. 2001). Installation of underwater feeders, placement of floating covers to provide shade, and the use of paint (or other materials) to darken raceways can alter juvenile behavior and coloration possibly making them less susceptible to predation immediately after release (Maynard et al. 2001). Accordingly, the proponents may wish to work with OSU researchers (e.g., Michael Blouin) who are currently examining the possible benefits of such amendments for hatchery steelhead. The proponents may discover an opportunity to test the effects of raceway alterations as a pilot project.

- ***Are the proponents removing fish that remain in the acclimation pond after most fish have emigrated? Is it feasible to recapture and remove steelhead that residualize in the river following volitional release in order to reduce their potential interactions with native salmonids?***

The response is adequate. The proponents no longer collect or transport fish remaining at the Sandtrap steelhead acclimation site. They conclude that attempts to recapture residuals would not be advantageous. They cite multiple studies to indicate that the prevalence of residualism is not high enough to be a concern and that efforts to separate migratory from non-migratory fish are typically incomplete and impose significant additional stress on both hatchery and wild fish.

- ***Population estimates from mark-recapture analysis involving the CJS model benefit from sequential detections of the same marked fish through the migration corridor. We recommend that the proponents contact researchers involved with BPA projects 1982-013-01 (New Marking and Monitoring Technologies) and 1993-029-00 (Survival estimate for passage through Snake and Columbia River Dams and reservoirs) who are developing, implementing, and evaluating new methods to detect PIT-tagged fish in large rivers. The experience and equipment they have developed may be useful for improving detections at the mouth of the Hood River and elsewhere in the subbasin.***

The response indicates that the proponents are already coordinating with other BPA projects in ways the ISRP has suggested. Continued coordination is encouraged.

- ***The proponents have made reasonable assumptions about the abundance, harvest rates, and apparent survival of the program's winter steelhead in the ocean, the estuary, and Zone 6. However, they should consider possible opportunities to validate or refine these initial assumptions using additional data from three continuing BPA projects. CRITFC staff use genetic analyses of tissue samples to estimate the abundance of salmonid stocks passing Bonneville Dam and stock-specific harvest rates in Zone 6 and elsewhere (Project 2008-907-00 Genetic Assessment of Columbia River Stocks). They also estimate stray rates and provide mortality estimates on adult salmonids as they move upstream in the mainstem (Project 2008-518-00 Upstream Migration Timing). Finally, project 2008-502-00 (Expanded Tribal Catch Sampling) documents tribal harvest by species using PIT-tag recoveries of fish caught in Zone 6.***

The response is adequate. The proponents indicate that they will explore the utility of additional data from the three projects identified above. The ISRP looks forward to reading updates in future reports.

- ***The adaptive management process should include quantitative objectives with timelines, robust monitoring of performance metrics, and regular evaluation to assess progress toward achieving the objectives. The proponents should explain how the adaptive management process will enable review and refinement of specific monitoring methods, for example, how smolt and adult abundances are estimated, or how in-hatchery performance is measured. Will the adaptive management process address the challenge of meeting NMFS monitoring criteria for the precision of spawner abundance estimates?***

The current response does not fully address the ISRP's concerns. The proponents note these concerns, and presumably, plan to address them in the next iteration of the Master Plan. We repeat that the revised plan should address topics listed in the adaptive management section of the Addendum

(Section 4.4) and the 2019 ISRP response request. The Plan should also address ways to monitor and reduce inefficiencies in the harvest of hatchery steelhead with a view to reducing pHOS.

- ***Why were SAR estimates for wild winter steelhead consistently and substantially lower for the method based on tag detections at Bonneville Dam than for the method based on total smolt and adult return enumerations for the three years when both methods were used (smolt migration years 2005-2007, Table 2.2.2 in Appendix D)?***

The response mostly answers the ISRP's question. The proponents attribute the consistent discrepancy in SAR estimates to systematic biases in both methods of estimation. PIT-tag loss and tag-induced mortality are known to cause underestimation of SARs based on PIT-tag detections. Underestimation of smolts due to high flows and other operational challenges during enumeration is known to cause overestimation of SARs from run reconstruction of total smolt and adult numbers. Even so, the average discrepancy is so large (i.e., 19%) that the ISRP wonders about the extent of undocumented mortality of PIT-tagged steelhead captured in fisheries that are not being monitored for PIT tags. This concern potentially applies to all PIT-tagged salmon populations in the basin.

- ***The proponents provide a good summary of habitat restoration activities, but more analysis is needed to support the conclusion that "the distinct increase in wild winter steelhead smolt production in recent years (Table 4) clearly corresponds to the removal of Powerdale Dam in 2010" and to support the interesting discussion that "However, the mechanisms are somewhat in question as Powerdale dam was not generating or diverting water for several years before its actual removal, and thus was not expected to have a large impact on downstream juvenile survival (it was a low head dam with negligible reservoir). Eliminating adult migration delay, and handling and sorting at the Powerdale trap, may have provided the largest benefit for steelhead production." Evaluation of the extent to which the productivity of natural steelhead has been or can be improved by habitat restoration is critical to justifying targets for the supplementation program.***

The proponents identify some plausible mechanisms to account for the increased survival of winter steelhead after Powerdale Dam was removed. However, they do not evaluate (or acknowledge the need to evaluate) the extent to which habitat capacity might be increased through further habitat restoration. Quantitative analysis is needed to justify the current target of 1,100 natural origin winter steelhead spawners. A principle of the 2014 Fish and Wildlife Program (page 78) is that "*agencies and tribes and operators will tailor hatchery program goals … in consideration of several local factors, including but not limited to, … the quantity and quality of fish habitat, …*" In short, it is important that hatchery efforts to rebuild natural populations are tailored to habitat capacity and coordinated with habitat restoration actions.

- ***Describe how decommissioning Powerdale Dam has affected the Hood River ecosystem beyond the direct effects on steelhead and Chinook populations.***

The response partially addresses the ISRP's request by noting rapid recolonization of the Hood River by Pacific lamprey. We appreciate that some ecological changes associated with the removal of Powerdale Dam may take years to recognize. However, because the proponents are undertaking extensive fieldwork in the subbasin, they are in a good position to document any ecological changes they observe. We urge them to include an expanded narrative of effects of dam removal in the background section of the Master Plan during its next revision.

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