Independent Scientific Review Panel
for the Northwest Power & Conservation Council
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Memorandum (2018-4) May 11, 2018

To: James Yost, Chair, Northwest Power and Conservation Council

From: Steve Schroder, ISRP Chair

Subject: Review of Klickitat River Spring Chinook Master Plan – Response Requested

Background

In response to the Northwest Power and Conservation Council's request, the ISRP reviewed the Yakama Nation's *Klickitat River Spring Chinook Master Plan* (2018 Master Plan) for project #1988-115-35, *Klickitat River Design and Construction-Yakima/Klickitat Fisheries Project (YKFP)*. This Step review is a follow-up to the ISRP's *Step Two Response Review of the Yakama Nation's Klickitat River Anadromous Fisheries Master Plan* (ISRP 2013-1). That ISRP review and the Yakama Nation's cover letter for this 2018 review provide a summary of the numerous master plan revisions and responses to the ISRP dating back to 2004. Please refer to those documents for a full background on the review process for this project (also see ISRP 2012-12, ISRP 2008-6, and ISRP 2005-7).

The current 2018 Master Plan focuses on spring Chinook production, which differs from earlier master plan drafts (2004, 2008, 2012) that proposed multispecies hatchery reform initiatives for fall Chinook, coho, and steelhead, as well as spring Chinook. As described in Yakama Nation's cover letter, the overall goals of the 2018 Master Plan are to:

a) Implement a phased-in integrated broodstock spring Chinook production program at the Klickitat Fish Hatchery to replace the current segregated spring Chinook program and thereby increase the biological performance of the spring Chinook produced;
b) Ensure that returning adults are locally adapted and compatible with restoration goals for the Klickitat Subbasin;
c) Improve the overall ecology of the Klickitat River system; and
d) Support harvestable populations of spring Chinook consistent with regional mitigation obligations and U.S. v Oregon agreements.

After the ISRP's 2013 review (ISRP 2013-1), the remaining issues with the spring Chinook focused on details of adaptive management (the decision tree) for achieving local adaptation targets and smolt-to-adult survival rates, and for monitoring and evaluation of minijack production at the integrated hatchery facilities. Our review below is organized around these two primary issues.

The following documents were submitted for the ISRP's review:

- Cover letter, with request and history
- Klickitat River Spring Chinook Master Plan
- Appendix A: Hatchery and Genetic Management Plan (HGMP); Klickitat Spring Chinook Production Program - Klickitat Hatchery Complex
- Appendix B: Klickitat spring Chinook: Integrated program description, analysis, and implementation schedule

ISRP Recommendation

Response Requested

The 2018 Master Plan for an integrated hatchery program to rebuild the Klickitat spring Chinook salmon population is well conceived and presented. The rationale for shifting from the current segregated hatchery program to an integrated program is well justified. Four phases are carefully defined and each phase has explicit quantitative objectives for natural production and harvest. However, to complete this portion of the Step Review, the ISRP requests a detailed response to the following five items, which are largely repeated from our 2013 review:

1. The Master Plan should explicitly describe an adaptive management process with "decision tree" contingency planning. Adaptive management requires quantitative objectives with explicit timelines that serve as predetermined triggers to reconsider options or apply previously established contingency plans. Although the Master Plan includes appropriate quantitative and time-specific objectives for the Program's overall natural production and harvest goals, more detailed performance standards are needed for the Program's in-hatchery operations. The decision-tree process for triggering contingency plans seems insufficiently developed overall – a shortcoming noted in our 2013 review and still not adequately addressed.

2. The Master Plan should identify performance standards for early maturation of males (i.e., acceptable proportions of "minijacks"), describe procedures for evaluating the proportion of minijacks, and discuss actions that will be taken if the performance standards are not being achieved. Historically, the Klickitat Hatchery has produced a high proportion of minijacks (about 0.75), and it seems this level must be reduced significantly to achieve program objectives. The Master Plan does not mention how efforts to reduce the size of smolts at release since 2004 have affected minijack proportions. As in our 2013 review, we urge the proponents to adopt more accurate methods (i.e., beyond just visual or behavioral

observations) to evaluate the proportion of minijacks in their hatchery lines, and we suggest two alternatives below. Being able to estimate the proportion of smolts that will become minijacks is essential for accurate interpretation of statistics based on smolt survival (e.g., SAR, SAS, and R/S).

3. The proponents should reexamine the pHOS and pNOB values presented in Appendix B of the Master Plan and check their PNI calculations to eliminate the errors or inconsistencies noted below (under ISRP comments) and previously in our 2013 review. For the project to reach its PNI goals, it is essential that pNOB and pHOS targets be established and calculated correctly.

4. The ISRP would like to see further consideration of how annual variability in survival (SARs) might affect Program outcomes based on stochastic modeling or a greater range of deterministic scenarios. Tables 4-6 in Appendix B provide a timeline for the transitions from Phase I to the final Phase IV stage based on a single (perhaps optimistic) survival scenario. How long might the Program take to succeed in the face of a plausible random sequence of low SARs, even if the biological assumptions are correct? Such scenarios are needed to inform contingency plans within the adaptive management process.

5. The ISRP also requests additional brief responses to specific questions on the following topics; details are provided in the last section of this review ("Other ISRP Questions"):

    - Measuring adult-to-smolt productivity and juvenile capacity in the Klickitat subbasin above Castile Falls
    - Release locations of N1 line smolts
    - Broodstock selection protocols
        - Use of hand-held ultrasound scanners for sex determination
        - Selection of adults for the H2 line
        - Identification of H1 and H2 adults
    - In-hatchery operations
        - Potential use of "isobuckets"
    - Monitoring and Evaluation
        - Detecting changes in allele changes in Klickitat spring Chinook
        - Estimating the abundance and survival of naturally produced spring Chinook smolts

The ISRP would be pleased to have direct conversations with the proponents, if necessary, to clarify any questions they may have about our requests for additional information.

ISRP Comments on Qualifications from 2013

1. ***Adaptive management (the decision tree) for achieving local adaptation targets and smolt-to-adult survival rates***

Objectives and contingency planning: This Master Plan appropriately includes conservation objectives with explicit standards for productivity, capacity, abundance, spatial structure, SARs, and PNI values for naturally reproducing spring Chinook in the Klickitat subbasin. Similarly, explicit and measurable objectives are presented for harvest rates and harvest numbers for the mainstem Columbia and Klickitat River for both Tribal and non-treaty fisheries.

The Master Plan should also include objectives for in-hatchery performance. The success of the Program will depend in part on the quality and survival of adult fish collected as broodstock and held at the Klickitat hatchery, and of juveniles released from the hatchery. The HGMP (Section 9.1.1) contains a table that summarizes the number of green eggs taken, green egg-to-eyed egg survival, eyed egg-to-ponding, fry-to-fingerling survival and fingerling-to-smolt survival that has occurred at the Klickitat Hatchery from 1995 up to 2016. The values in this table indicate that the hatchery is well run, achieving survival rates at each stage that typically fall within ranges established for other spring Chinook hatchery programs throughout the basin (e.g., LSRCP spring Chinook hatcheries; ISRP 2014-6). Additional performance standards should be included for metrics related to fish health assessments, the number and size of smolts released, the proportion tagged, the tag retention rate, and the proportion of smolts that subsequently mature as minijacks.

An adaptive management plan should specify the decision-tree process by which failure to achieve quantitative objectives would trigger previously established contingency plans. Both the contingency plans and the decision process should be described in greater detail in the Master Plan.

Timeline for transitions from Phase I to Phase IV: The Master Plan describes four discrete phases of transition from the current segregated spring Chinook hatchery Program to an integrated one. Conservation and harvest objectives have been developed for each phase. As these objectives are reached, the Program progresses from one phase to the next and a new set of objectives. To illustrate the number of years that might be required to progress from Phase I to the final Phase IV stage, the proponents predict adult returns for a plausible, but perhaps optimistic, set of assumptions (Tables 4-6 in Appendix B). The proponents acknowledge that the actual timeline is uncertain because of year-to-year variability in smolt survival.

The ISRP agrees that numerical predictions are essential for testing if the biological assumptions for increased natural production are correct. However, the ISRP also emphasizes that such deterministic predictions are highly uncertain, and we would like to see further consideration (e.g., stochastic modeling or a range of additional scenarios) of how expected levels of annual variability in survival could affect the timeline for transitions from Phase I to Phase IV. For example, what range of SARs would be needed to transition from one phase to the next? How long might the Program take to succeed in the face of a plausible random sequence of low SARs, even if the biological assumptions are correct? How and when would the proponents conclude that the biological assumptions were incorrect?

Calculation of Proportionate Natural Influence (PNI)[1]: The proponents show how PNI is expected to change from one Program phase to the next in Figure 1 of Appendix B. These PNI values seem unchanged from corresponding figures in Appendix C of the 2013 Master Plan, even though the ISRP's 2013 review pointed out that the PNI values were inconsistent with the pNOB and pHOS values presented. Here we repeat our 2013 concerns about the PNI calculation: if pHOS is 0.27 and pNOB is 0.33, PNI would be approximately 0.55, not 0.67 as claimed. If pHOS is 0.27, the target PNI of 0.67 could be achieved only by increasing pNOB from 0.33 to 0.55. Alternatively, if pNOB is 0.33, the target PNI of 0.67 could be achieved by reducing pHOS from 0.27 to 0.16.

Adding to this confusion, values for NOB and pNOB appear inconsistent between Tables 3 and 7 in Appendix B. Discrepancies in run sizes of NOR spring Chinook shown in Appendix A (p.13) and Appendix B (Table 1) should also be explained or corrected. This failure to correct errors in PNI calculation (or explain the inconsistencies) is particularly disappointing, as it detracts from the credibility of Appendix B, and our confidence that a PNI of 0.67 can be achieved in Phase IV.

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[1] PNI is estimated approximately by using the following formula:

$$PNI = pNOB/(pNOB + pHOS)$$

Where:

> PNI = Proportionate Natural Influence; a value that approximates how closely a population made up of hatchery and natural origin fish maintains the natural population's genetic properties. The higher the PNI percentage the more closely it is expected to resemble the natural population.
>
> pNOB = the proportion of the broodstock made up of natural origin fish
>
> pHOS = the proportion of the natural population made up of hatchery origin fish

If any two values in the above formula are known the third can be calculated. For example, pNOB values can be determined when PNI and pHOS are known by using the following formula:

$$pNOB = - (PNI) \times (pHOS)/(PNI – 1)$$

And similarly, if pNOB and PNI are known then pHOS can be estimated by:

$$pHOS = -(pNOB) + (pNOB)/(PNI)$$

Because achieving a PNI exceeding 0.50 is an important Program goal for the integrated population, we request that the proponents reexamine the pHOS and pNOB values presented and check their PNI calculations. For the project to reach its PNI goals, it is essential that pNOB and pHOS targets be established and measured correctly.

2. *Monitoring and evaluation of minijack production*

In the Columbia Basin, male spring Chinook salmon can mature at ages 1 (microjacks), 2 (minijacks), 3 (jacks), 4, 5 or 6 (adults). Microjacks and minijacks, collectively called precocious parr, typically remain in fresh water and occur at a fairly low proportion ($\leq$0.04) in natural spawning populations (Pearsons et al. 2009, Larsen et al. 2013). Nonetheless, they are potentially important sources of gene flow, helping to retain genetic diversity and increase effective population size (Saura et al. 2008, Schroder et al. 2011). Exposure to favorable growing conditions (e.g., optimal water temperatures and high feeding rates in a hatchery) is known to substantially increase the occurrence of precocious parr in spring Chinook populations. For instance, Larsen et al. (2013) found that 41% of male spring Chinook released from the Cle Elum Supplementation Research Facility over a 7-yr period showed initial signs of maturation as minijacks. This proportion is an order of magnitude greater than those observed in naturally rearing fish.

Both genetic and environmental conditions drive early maturation in male spring Chinook salmon. It appears that precocious maturation is initiated when a metric related to growth rate (e.g., body size or energy stores) exceeds a genetically determined threshold at a particular age (Larsen pers. comm., Meyers and Hutchings 1986, Aubin-Horth and Dodson 2004). This relationship between body size and early maturation in salmonids is also influenced by the number of generations that a population has been cultured artificially. In Atlantic salmon, Debes and Hutchings (2014) observed that the occurrence of early male maturation decreased by over 70% after three generations of hatchery exposure. This finding suggests that salmonid populations with little previous exposure to hatchery conditions will be especially susceptible to high rates of precocious development when raised under favorable water temperatures and plentiful food, as is likely to occur during hatchery rearing (Harstad et al. 2014). In other words, minijack production can be expected to increase during the initial transition from a segregated to an integrated hatchery program.

The ISRP believes it will be important to carefully monitor the proportion of early maturing males produced by the N1 line (NOR x NOR crosses) because these fish may be especially susceptible to early maturation (Harstad et al. 2014). Currently, the Master Plan calls for visual inspections to detect early maturation in smolts at release from the N1, H1, and H2 lines (p. 52), as well as for visual inspections to determine the proportion of minijacks among maturing salmon collected at the hatchery. Visual and behavioral differences such as color changes or lack of migratory behavior can indicate early maturation, but these cues are subject to errors of interpretation. Additionally, counts of minijacks returning to the hatchery would underestimate their actual abundance in the population as not all of them will return (Beckman and Larsen 2005). Because of the inherent variability of the methods being proposed, we urge the proponents to adopt a more accurate method for assessing the proportion of smolts likely to become minijacks.

In our 2013 review, we state that the most sensitive test for detecting smolts destined to become minijacks involves measuring plasma levels of the reproductive steroid ketotestosterone (Larsen et al. 2004). If this test is deemed too expensive, a cheaper alternative (described by Campbell et al. 2003) is to determine the gonadosomatic index (GSI) of sampled males. Both methods can be used to estimate the proportion of males that will become minijacks based on smolt samples. The GSI method is not as accurate as the plasma assay, but it requires only simple dissection and weighing. Perhaps smolts that will be sacrificed for disease testing under the protocol described in the Master Plan could serve "double duty" by being used to detect signs of early maturity either through plasma assays or GSI measurements.

Reducing minijack production is a key opportunity for achieving higher adult returns and earlier progression to the next phase of the Program. About 75% of male salmon matured as minijacks prior to 2004 when large smolts were released from the Klickitat Hatchery. The proponents quite reasonably assumed that releasing smolts at a smaller size would reduce the proportion of minijacks, but no data are presented in the Master Plan to test this assumption. Knowing the proportion of males that will mature as minijacks is critical to understanding the extent to which apparent SAR, SAS, and R/S values are influenced by "losses" of adults due to early maturation. This knowledge will also allow the proponents to evaluate the effectiveness of the fish culture techniques being implemented to avoid amplified levels of precocious maturation and its undesired consequences, including reduced numbers of adult salmon for harvest or broodstock (Zimmerman et al. 2003; Beckman and Larsen 2005) and increased ecological interactions among precocious hatchery parr and native fishes (Beckman and Larsen 2005).

The effort to evaluate and reduce minijack proportions should be a key component of the adaptive management process. As mentioned above in our comment on adaptive management, the Master Plan should include performance standards for the proportion of smolts that will become minijacks. Reduced minijack production should also be considered as a separate but key part of the strategy to improve SARs.

Other Specific Questions

The ISRP also requests additional brief responses to the specific questions listed below (and corresponding revision to information presented in the Master Plan):

- Measuring Adult-to-Smolt Productivity and Juvenile Capacity:

The Plan indicates that the first F1 adults produced from the N1 line will be released into the Klickitat subbasin above Castile Falls. How will juvenile productivity and capacity in this area be assessed? For example, will a rotary screw trap be installed above the falls to measure juvenile abundance and condition at smolting? This evaluation is important because productivity and capacity were initially estimated by EDT modeling based on habitat conditions in 2005, prior to substantial efforts at habitat restoration. Smolt monitoring would be needed to verify the initial estimates of capacity and productivity, and to test assumptions about increased capacity and productivity following continuing habitat restoration.

Will all smolts produced from the N1 crosses be released from the hatchery location at rkm 68? Please clarify or correct an apparent discrepancy in Section 9.2.3 of Appendix A, which indicates that these fish will initially be reared at the Klickitat Hatchery and then transferred to acclimation sites in the upper Klickitat for eventual release. In contrast, Section 10 of the HGMP, the Master Plan, and Appendix B state that all the juvenile spring Chinook produced by the hatchery will be released from the hatchery location (rkm 68).

- Broodstock Collection:

Early detection of sex in brood fish is valuable for guiding broodstock collection efforts. Ultrasound scanners are successfully being used to determine the sex of spring Chinook broodstock in the Upper Columbia and Yakima subbasins. Will handheld ultrasound scanners be used to sex the fish collected at Lyle Falls, the Klickitat Hatchery, and Castile Falls?

The Master Plan indicates that F1 adults produced from the N1 line will be preferred as brood stock for the H2 line. Will any effort be made to limit the inclusion of subsequent generations (F2, F3, etc. produced by the H2 line) as future brood stock? If so, how might this be done?

For several years, HORs produced from the H1 and H2 lines will arrive at the hatchery during the same return years. How will adults from each of these lines be differentiated from one another?

The Master Plan indicates that excess brood stock will be distributed to Tribal members for ceremonial and subsistence reasons. Is it a concern that fish collected for brood stock will have been anesthetized in MS222 and injected with antibiotics? A brief explanation of the steps that will be used to ensure that distributed fish are safe for human consumption would be an important addition to the Master Plan.

- In-Hatchery Operations

  The Master Plan states that the eggs obtained from each female will be isolated from one another until results from ELISA (Enzyme-Linked Immunosorbent Assay) tests become available. Kidney material from each female will be analyzed to detect antigen levels for *Renibacterium salmoninarum* (Bacterial Kidney Disease or BKD). Eggs originating from females with high antigen levels will be culled to prevent BKD outbreaks during the rearing period. However, the FAL vertical stack incubation system (the only incubator design mentioned in the Master Plan) is not suitable for isolating discrete batches of eggs. Horizontal transmission of pathogens could occur because water moves from upper to lower trays. Will “isobuckets,” similar to those used at the Cle Elum Supplementation Research Facility be built, installed, and used at the Klickitat Hatchery? If so, the Master Plan should include a description of the isobuckets, the infrastructure needed for their operation (e.g., header boxes, water distribution lines, individual valving, alarm systems, raceways to hold the buckets, etc.), and where the isobuckets would be located. If isobuckets are not going to be used, the Plan should indicate how eggs from each female would be sequestered until ELISA results are obtained.

- Monitoring and evaluation

  How many DNA samples will be collected from both natural and hatchery salmon as a means to track and detect changes in allele frequency (Section 8.5 of Appendix A)? How (briefly) will genetic results be evaluated to look for the influence of hatchery practices on genetic composition and reproductive success (as mentioned on p. 59 of the Master Plan)?

  The Master Plan indicates that a high proportion of smolts disappear during the short migration from the release site to Bonneville Dam even though they do not have to pass other dams. Might these losses reflect a high proportion of minijacks that go undetected rather than mortality during migration? If in fact, these smolts are dying, the daily rate of mortality is remarkably high compared to that sustained during the rest of the life cycle below Bonneville Dam until their return as adults. In either case, further efforts to identify and rectify the causes of these losses are warranted to improve the Program’s chances of success.

  If all hatchery-origin smolts are visually marked and enumerated prior to volitional release, could these marked fish be used to estimate the total abundance of natural-origin smolts? Annual estimates of natural-origin smolt abundance would be useful for partitioning overall estimates of survival of natural-origin salmon between the spawnerto-smolt phase and the smolt-to-adult phase, which in turn, could help to identify key factors affecting survival in the respective phases.

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