Independent Scientific Review Panel
for the Northwest Power & Conservation Council
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Memorandum (2017-4) **April 10, 2017**

To: Henry Lorenzen, Chair, Northwest Power and Conservation Council

From: Steve Schroder, ISRP Chair

Subject: Follow-up Review of Mid-Columbia Coho Restoration Program - Response Requested

Background

In response to the Northwest Power and Conservation Council's February 15, 2017 request, the ISRP reviewed a revised Mid-Columbia Coho Restoration Program Master Plan which included responses to issues raised in the ISRP's most recent review of this project (ISRP 2009-47, November 2009).

The Master Plan is designed to achieve the Yakama Nation's (YN) long-term vision to re-establish naturally spawning coho populations in mid-Columbia tributaries to biologically sustainable levels that will provide significant harvest in most years.

This is a long-running project, and the ISRP has participated in numerous reviews of the project over the years including annual reviews of proposals for funding through the Fish and Wildlife Program for fiscal years 1998, 1999, and 2000; a partial Step Review in 2000 (ISRP 2000-5); a provincial review for funding in fiscal years 2003-2005; a concurrent Master Plan review and FY 2007-09 proposal review in 2006 (ISRP 2006-5); and two iterative Step Reviews in 2009 (ISRP 2009-6 and 2009-47). Since 1998, the project has received generally favorable reviews that included constructive comments on future direction and provided scientific support for the effort. For the most recent review in November 2009, the ISRP recommended "Response Requested - the Master Plan does not currently meet scientific review criteria" and commented:

> The ISRP raised three primary concerns in its March 2009 review of the Master Plan and concludes that at this time the concerns have not been sufficiently addressed in the revision. In addition to these three, the updated contingency plan and decision process … need a clearer description of the performance objectives for each phase that will trigger contingency actions and especially the analysis of monitoring data that will be used to decide on the causes of not achieving production objectives.

In March 2010, the Council recommended:

> Based on the ISRP reviews and the Yakama Nation's corrective response, and in the context of the current conceptual phase of the project's development, Council recommends that the project proceed with Step 2 and 3 activities (i.e., preliminary and final design). This recommendation is based on the understanding that the concerns raised by the ISRP regarding appropriate metrics (i.e., ISRP concern #1), the status of feasibility studies (i.e., ISRP concern #2), and contingency plans (i.e., ISRP concern #3) have been met at an appropriate level for a Step 1 review. This recommendation is conditioned on the YN addressing the three issues raised by the ISRP in a revised master plan that includes updating the issues where appropriate and providing additional details of the approach the YN is taking regarding the plan for Broodstock Development Phase 2. The final design and revised master plan will be submitted in late 2011 after the NEPA Record of Decision is complete. It is also expected that the Environmental Impact Statement prepared under the National Environmental Policy Act will address ISRP concerns about alternative approaches and strategies.

ISRP Recommendation

A response is requested.

The revised Master Plan shows that substantial progress has occurred since the last ISRP review. Quantitative objectives and time periods for when project milestones should be reached have been established. A contingency plan that presents a series of alternative actions that the project may take if circumstances prevent it from achieving expected goals is also in place. What needs some further thought, however, is how to create a coho broodstock that is suited for the upper Wenatchee River.

The proponents are testing whether out-of-basin broodstock from Lower Columbia River hatcheries can be used to reintroduce coho salmon into two mid-Columbia River tributaries. A five-phased approach to create self-sustaining populations of coho in the Wenatchee and Methow Rivers is being evaluated.

The greatest uncertainty lies in the timelines that are established for each of the project's phases. Durations for each phase are expressed in coho generations and are based on the assumption that natural selection will lead to adaptations that improve fitness in the new environment. Empirical assessments, however, are needed to test these expectations. Coho originating from Lower Columbia River hatcheries are adapted to very different conditions than those existing in mid-Columbia subbasins. Whether Lower Columbia River coho possess enough genetic diversity and adaptability to produce self-sustaining populations in their new environments, and how long this might take, remain open questions.

Our response request has two parts and is designed to help the proponents answer the questions raised above. Part One is a request for the proponents to consult with CRITFC or other regional geneticists to evaluate the benefits and costs of a breeding program that would selectively use coho capable of ascending Tumwater Canyon. The current breeding program combines gametes from coho recovered at Dryden Dam (a lower river location) with those obtained from fish captured at Tumwater Dam (the trapping location above Tumwater Canyon). This protocol maximizes genetic diversity in the overall population returning to the Wenatchee. However, by including gametes from fish that failed to migrate through Tumwater Canyon, the strength of selection for upstream migration is reduced. Utilizing broodstock made up of fish collected at Tumwater Dam, on the other hand, would simulate the assortative mating that would occur during natural recolonization. Progeny produced from these matings are expected to be more adapted to upstream conditions than those produced by the current mating system. The ISRP acknowledges that a trade-off exists between the strength of directional natural selection (increased by assortative mating of fish collected at Tumwater Dam) versus the random effects of genetic drift (decreased by including a larger number of broodstock). This trade-off between broodstock composition and the number of parental fish needed to prevent losses in genetic diversity will determine how coho returning to Tumwater Dam ought to be inserted into the Program's mating procedures. This decision should be guided by geneticists. By maintaining two separate broodstocks, one made up of coho collected at Tumwater and the other comprised of individuals obtained at Dryden Dam, it may be possible for the project to take advantage of assortative mating without sacrificing the overall number of fish used as parents.

Part Two of our response request is for the proponents, with assistance from geneticists, to determine if existing genetic samples can be used to track the ability of progeny produced from four different types of crosses to ascend Tumwater Canyon. The goal of such an analysis would be to determine how successful fish produced from Tumwater Dam x Tumwater Dam parents, Dryden x Dryden parents, and their reciprocal crosses were at reaching Tumwater Dam. This approach would be facilitated by existing parentage-based tagging (PBT) that is being used to identify project fish. Perhaps, PIT tag data along with PBT data could be used to decipher the role of smolt release locations on the homing locations of adults.

Such *ad hoc* analyses may not be possible with the samples presently on hand. If this is the case, the proponents may wish to consult with geneticists to develop a study that examines the effects of parental origins (i.e. Tumwater and Dryden adults) and release locations on the ability of their progeny to successfully navigate through Tumwater Canyon. Results from such a study would provide the proponents with data they can use when developing future breeding and smolt release programs. More generally, such information will help to improve the design of recolonization projects elsewhere in the Columbia Basin.

A report describing the results of these consultations should be submitted to the ISRP to determine if the project fully meets scientific review criteria.

ISRP Comments

March 2009 ISRP Issue 1. The performance metrics at each stage of the project are insufficient

The revised Master Plan now contains explicit numerical goals for returning adults and smolt release numbers for each of the program's five phases. Clearly defined time periods to transition from one project phase to the next are presented in numbers of fish generations for each phase. The project's first phase was conducted to determine whether coho from Lower Columbia River hatcheries could return to two mid-Columbia tributaries, the Wenatchee, and Methow rivers. Adult coho originating from releases of Lower Columbia River hatchery coho smolts returned in great enough numbers to achieve Phase One broodstock goals for both the Wenatchee and Methow rivers. During Phase Two, hatchery smolts produced from adult hatchery origin returns (HOR) to the Wenatchee and Methow rivers were released at sites in the Wenatchee and Methow rivers. Numerical targets for adult returns from Phase Two smolt releases were established along with an expected timeline to achieve these targets in three generations.

The Master Plan states that the goal of this second phase has been reached for the Methow River but not for the Wenatchee River. However, additional data need to be included in the Master Plan to verify that the goal for the Methow River was reached. It is likely that the goal was attained during return years 2011-2013, but data for 2013 need to be added to the Master Plan to confirm this was the case. For completeness, adult return numbers to the Methow and Wenatchee rivers for 2014-2016 should also be included in the Plan.

The second phase of broodstock development for the Wenatchee River has not yet been achieved. Overall target adult abundance levels have been exceeded, but an additional condition that at least 50% of the total female broodstock be collected above Tumwater Canyon (at Tumwater Dam) has not been met. This requirement was included after it was found that many returning females were unable to ascend the Tumwater Canyon to reach the dam. In the Wenatchee River, much of the suitable habitat for naturally reproducing coho exists above Tumwater Canyon. Thus, it was hypothesized that successful recolonization depends on producing coho that have the capacity to negotiate this portion of the Wenatchee River. The YN conducted a study (Murdoch and Jefferies 2015) that examined how an array of factors influenced the ability of females and males to successfully pass through this portion of the Wenatchee River. Females that arrived early and in the beginning stages of maturation had the greatest success. So far, the findings of the YN study have not been incorporated into the Program's broodstock and mating protocols.

Once the broodstocks meet Phase Two targets, the reintroduction program transitions into its final three phases (Phases Three-Five) to establish naturally reproducing and self-sustaining populations of coho in both the Methow and Wenatchee basins. These final three phases represent a stepwise progression that increases natural origin returns (NOR) in each basin. Objectives with quantitative metrics have been established for each phase. They include

broodstock numbers, Proportionate Natural Influence (PNI) values, and the NOR escapement needed to shift to the next phase. Although this phased approach is logical and now has some key trigger points, the Master Plan should specify clearly the number of years of NOR escapement needed at a specific level before hatchery releases would be reduced.

As the program progresses from Phases Three to Five, the proponents plan to limit the proportion of hatchery fish (pHOS) present on spawning grounds. It was not clear, however, how the proponents propose to control pHOS or how effectively pHOS can be limited in the various spawning habitats. More explanation is also needed on how the distribution patterns of HORs and NORs will be ascertained. The Master Plan indicates that PIT tags may be utilized for this purpose, but additional information on how these tags might be employed is not provided; only a small percentage of the fish will have PIT tags. Similar confusion exists around the proponent's selective terminal harvest of hatchery fish during Phases Three through Five. Some clarification on how this might be accomplished is needed as HORs and NORs are not externally marked and are thus visually indistinguishable from one another. All hatchery fish receive CWTs, so it is possible that CWT wands could be used to identify hatchery fish at weirs for selective harvest. Whatever approach is being planned should be indicated in the Master Plan.

March 2009 ISRP Issue 2. The reporting of the feasibility studies does not provide explicit status of the appropriate metrics at this time

Chapters 3 and 4 in the Master Plan provide an adequate overview for the five-phase coho reintroduction plan being proposed. However, not all the information requested by the ISRP in 2009 has been added to the revised Master Plan. Missing are tables showing: (a) the number of hatchery coho released by location and date, (b) smolt-to-smolt survival rates from program release locations to McNary Dam, (c) estimated contribution rates of project fish to ocean and in-river harvests, and (d) returns of adult coho to the Columbia River. Some of this information is scheduled to be collected once the project's Monitoring and Evaluation (M&E) Plan is implemented. In other instances, requested information is shown in figures, but it is difficult to evaluate. For example, the distributions of project coho allowed to spawn naturally in the Wenatchee and Methow rivers are presented in multiple figures. Clarity and utility would be improved by including the numerical data used to produce these figures in two tables, one for the Wenatchee River and one for the Methow River. Additionally, SAR data for hatchery and naturally produced coho originating from the project are included but scattered among various tables and figures. It would be more useful to consolidate the SAR data in two tables, one for hatchery-origin and another for natural-origin fish. The proponents are encouraged to add information contained in their HGMP (Table 27) to the table containing SAR data on hatchery origin fish. The table with this combined information would then show SARs by smolt origin (Lower or Mid-Columbia River) and allow comparisons between the SARs achieved by coho smolts released from the Wenatchee and Methow subbasins.

The program's proposed M&E plan states that pre-smolt to smolt survival in acclimation sites will be monitored. The proponents may find it useful to incorporate additional in-hatchery

metrics in their M&E Plan. Lower Snake River Compensation Plan (LSRCP) cooperators developed a set of in-hatchery performance metrics that have proved to be useful (ISRP 2014-6). Data from the LSRCP M&E efforts were used to change broodstock sources, mating protocols, rearing and release procedures as well as to make informed changes to hatchery infrastructure. It can be challenging, for instance, to hold maturing salmon. Establishing a survival standard would help determine if adult fish handling and holding procedures need to be modified. Similarly, a standard for survival from fertilization to the eyed-egg stage could be established by the proponents. Quite a bit of variation in this metric appears to exist, as reported values ranged from 58.6% to 91.6% (HGMP Table 28). Understanding the source of this variation could lead to alterations on how newly fertilized eggs are incubated and treated.

In general, the M&E plan presented in Chapter 7 of the Master Plan is a good beginning. In particular, we commend the use of explicit null hypotheses associated with parts of the proposed monitoring plan. However, some of the null hypotheses in section 7.2.1.3 seem inconsistent with one another. Perhaps the subscripts for "treated" and "reference" are incorrect (reversed) or the inequality signs are in error. Presumably the goal in each case is to test whether a null hypothesis of no effect can be rejected. Consequently, we suggest that the proponents consult with a statistician to refine future hypothesis testing and sampling efforts.

March 2009 ISRP Issue 3. The rationale for the design of Broodstock Development Phase 2, Natural Production Implementation Phase, and Natural Production Support Phase I and II are not scientifically supported by the results from the feasibility studies or modeling

The pivotal question this reintroduction program is poised to answer is whether out-of-basin transplants can be used to repopulate areas previously occupied by coho. Given time and opportunity, salmonids are remarkable colonizers. In the recent geologic past they recolonized areas vacated by retreating glaciers and established populations that became adapted to their new environments. In most cases, colonizers were likely strays from adjacent populations that were preadapted to some extent for the new conditions they were facing. In the present study, a composite population of coho from lower Columbia River hatcheries is being used to recolonize an area that is geographically remote from the donor population. Additionally, the fish being transplanted have been exposed to hatchery conditions for multiple generations and are at least partially domesticated. Despite these difficulties, the project has successfully developed local broodstocks of coho capable of returning to the Wenatchee and Methow rivers.

What remains unknown is how long it will take coho runs arising from these local broodstocks to adapt to natural conditions in their new natal streams. The ISRP suggested a study designed to determine how environmental and genetic effects influenced the ability of coho to return to release locations upstream of Tumwater Canyon in the Wenatchee River. It was proposed that data derived from that study could be used to estimate selection coefficients for simulation

modeling to estimate the number of generations needed to produce fish capable of establishing self-sustaining populations.

The suggested study was not implemented. The Master Plan states that the study proposed by the ISRP in 2009 was not worthwhile: "it delays practical results in favor of a scientific exercise that develops alternative program designs in order to model their potential differing outcomes in advance." Yet, the study was designed to assess the relative benefits of selecting returns to upstream locations as broodstock. It could also facilitate more rapid adaptation of coho to the Wenatchee watershed upstream of Tumwater Canyon. Furthermore, the study offers practical advantages in program design that could be generalized to other Columbia Basin tributaries. Coho returning to the Wenatchee River initially originated from the lower Columbia River where migration was short and not as difficult as in Tumwater Canyon. Appendix 1 clearly shows that ascending Tumwater Canyon poses a serious challenge to female coho salmon. Most early arriving females were able to survive the canyon whereas the majority of late arriving females were not (100% in mid-September versus less than 10% in mid-October). A breeding program that favored the incorporation of coho salmon that successfully negotiated Tumwater Canyon may provide genetic characteristics (e.g., migration timing) that would facilitate the creation of a coho stock capable of recolonizing upper portions of the Wenatchee Subbasin.

Deliberate efforts to change migration and maturation timing in salmonids have been successful in the past. One example would be alterations in the arrival and maturation timing of hatchery steelhead in Puget Sound. In this case, hatchery steelhead were bred to have earlier timing than natural counterparts. Such a program is not without some risk. The potential downside for the Mid-Columbia River coho project is that numbers in the upstream group may be so small that random effects of genetic drift could overwhelm directional effects of natural selection for local adaptation. The trade-off between the positive effects of increasing natural selection versus the negative effects of decreasing effective population size (and thereby increasing random genetic drift) could be examined in simulations as originally proposed by the ISRP.

Currently, adult coho are returning to the Wenatchee River and some coho return to Tumwater Dam. Thus, we recommend that the proponents consult with CRITFC or other regional population geneticists to develop a breeding scheme that could be used to develop a coho broodstock that is suited for upper portions of the Wenatchee River. The current practice of mating coho obtained from Dryden and Tumwater dams together is maintaining genetic diversity. However, it may also constrain the selection of traits suitable for the upper Wenatchee River.

Presently, coho are transported to lower Columbia River hatcheries to complete the final stages of incubation and most of the subsequent rearing period. This situation is not ideal as transportation stress may increase straying and decrease smolt quality. It is clear that the proponents recognize these difficulties. We encourage them to continue to seek out

infrastructural solutions that would allow them to incubate and rear their hatchery fish in the Wenatchee and Methow Subbasins.

November 2009 ISRP Issue 4. An unambiguous course of action to be taken if performance goals are not met within a defined period of time (that time to be specified in the Mid-Columbia Coho Master Plan)

As indicated above, the revised Master Plan now contains set time periods, as measured in fish generations, to transition from one project phase to the next. The Master Plan also presents contingency actions for each of the five phases. What remains unclear is the rationale for the number of fish generations needed to progress from one phase to the next. The proponents conducted AHA analyses and these were useful in demonstrating that the time frame and actions being proposed (i.e., release numbers, pNOB, pHOS and PNI at each phase) are plausible given assumptions from Ecosystem Diagnosis and Treatment (EDT) analyses about productivity and habitat capacity. The AHA results address the feasibility of a stepwise plan for specified increments of PNI to avoid an expected loss of fitness due to exposure to hatchery conditions. They are not designed to predict how rapidly a hatchery stock may adapt to natural conditions. In that regard, we ask the proponents to be patient. A key assumption of the project is that the Lower Columbia River founder population has enough genetic variation to allow for successful adaptation to very novel conditions.

The proponent's contingency plan presents operational alternatives if expected outcomes are not accomplished. For instance, if the Broodstock Development Phase 2 cannot be accomplished in the Wenatchee River, options for accomplishing this objective are presented. The first proposed step is an examination of possible causes for failure, e.g., low SARs due to ocean or in-river conditions, poor adult trapping efficiency, or high fertilized egg-to-eyed egg mortality. If possible, corrective actions will be taken. On the other hand, if too few fish are able to ascend the Tumwater Canyon, the proponents then suggest selecting broodstock based on traits that are related to successful passage—mainly early arrival and early maturation status. It is proposed that these fish be used in a two-generation breeding program to develop coho with traits that will allow them to colonize upper Wenatchee River habitat. However, as suggested above, the two-generational time limit should be verified by careful experimentation before proceeding to other steps. It may take more generations than first hypothesized. If selective breeding fails to create suitable numbers of coho capable of migrating through Tumwater Canyon the contingency plan proceeds with another step. In this case, Methow River coho would be integrated into the Wenatchee River broodstock in an effort to increase the migratory capacity of the Wenatchee River population. Any use of out-of-basin broodstock will involve poorly understood trade-offs and should be done experimentally with proper controls.

Additional contingency options are described in Chapter 4, Section 4.3.5 for each phase of the project until a final step is reached. When the cause of low adult abundance is due to out-of-basin effects, broodstock development would continue for another two generations. If low abundance is not the result of out-of-basin effects and all corrective actions have failed, a

harvest augmentation program is proposed. The ISRP notes that failure to achieve desired coho production might arise from factors acting over multiple life stages rather than within a single life stage. A combination of survival during freshwater residence, smolt emigration, rearing in the ocean, harvests, and migration back to the spawning grounds is likely to influence success, and it will be difficult to tease out the relative effects of each factor. No timeline was established for when the project would stop supplementation of the natural stock or when the project might switch to a harvest augmentation effort. These are difficult decisions that likely reflect both science and policy. However, considerable habitat restoration has occurred in the Wenatchee and Methow subbasins, and more is planned for the future. Benefits from habitat restoration actions may take years before they are fully achieved. Therefore, the project should avoid switching too soon to a harvest augmentation program before the full benefits of habitat restoration have been achieved.