Independent Scientific Review Panel
for the Northwest Power & Conservation Council
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Memorandum (ISRP 2014-9) **August 13, 2014**

To: Bill Bradbury, Chair, Northwest Power and Conservation Council

From: Greg Ruggerone, ISRP Chair

Subject: Review of 2014 Progress Report for the Yakama Nation's Upper Columbia Kelt Reconditioning Program, #2008-458-00, an Accord Proposal

Background

In response to the Council's July 7, 2014 request, the ISRP reviewed a progress report titled *Upper Columbia Kelt Reconditioning Program Update, 2014 ISRP Check-in* for the Yakama Nation's Accord project #2008-458-00, *Steelhead Kelt Reconditioning*. The progress report is intended to address the Council's recommendation from January 12, 2010, "Implementation beyond 2014 based on ISRP and Council review of the results report and recommendation of future work."

In reaching this recommendation, the Council explained – in a January 13, 2010 letter from Tony Grover to William Maslen, Bonneville Power Administration – why it recommended proceeding with this project despite an ISRP recommendation that the proposal did not meet scientific review criteria (ISRP 2009-39). The ISRP's review stated:

> The proposal does not meet review criteria because the overall assumed benefits to steelhead NOR abundance (or other VSP criteria) has not been established, the specific objectives in the proposal are inconsistently described, and the evaluation methods are not sufficiently detailed to determine the ability to measure any benefit that might occur.
>
> The ISRP believes that if further consideration is given to kelt reconditioning as a recovery strategy the appropriate beginning point is a review of iteroparity in UCR steelhead leading to simulation and recruitment analysis that includes historical and current rates of iteroparity, potential benefits of using reconditioned kelts, and the effect of altering the rates of iteroparity on steelhead life-history. This would serve the important function of identifying the potential benefit to steelhead VSP metrics that would need to be produced using kelt reconditioning as a recovery strategy and quantified during implementation. This background effort has not yet been completed.

After considering the ISRP's review and further response from the Yakama Nation, the Council summarized its recommendation: "Based on the current level of science and the needs for answers, the Council recommends that the proposal proceed with implementation … to provide

information to the current debate on the reproductive viability of reconditioned kelts. This recommendation for implementation is conditioned on the understanding that the project will have a performance check in 2014." The ISRP's review of the progress report is provided below.

Recommendation

Meets Scientific Review (Qualified)

The project has achieved a number of milestones over the past four years. A kelt reconditioning facility was designed and built at the Winthrop National Fish Hatchery. Agreements to live-spawn natural origin (NOR) female steelhead at the Winthrop and Methow hatcheries were established. Naturally spawning NOR kelts were collected at three temporary weir sites. Improvements in reconditioning methods were achieved, and some kelts were successfully reconditioned and released. Additionally, reconditioned live-spawned kelts, obtained from the Twisp River trap, will be incorporated into an existing multi-year study that compares the breeding and reproductive success of hatchery origin (HOR), NOR, and NOR reconditioned kelts spawning in nature. The future work elements described in the Update Report, however, do not address some substantial uncertainties. The project has the potential to make important contributions to kelt reconditioning research, currently occurring in the Columbia River basin, if it can be modified to address the qualifications listed below.

Qualifications

These five qualifications, and other ISRP comments listed below and in our previous reviews, need to be addressed in subsequent proposals and reports.

1) The prior recommendation, by the ISRP, to establish methods to assess how kelt reconditioning may benefit population growth, abundance, spatial structure, and diversity still needs to be addressed.
2) Some modeling and a power analysis need to be conducted to clarify how many juvenile and F_1 adults should be sampled to detect meaningful differences in the breeding and reproductive success of HOR, NOR, and reconditioned NOR females.
3) Methods to assess the fat levels, maturation timing, fecundity, egg size, and gamete viability of the project's reconditioned kelts need to be developed and implemented. The fate of non-maturing or skip-repeat reconditioned fish also should be disclosed.
4) Viable plans are needed to monitor the homing and straying rates of reconditioned kelts released by the project.
5) Experiments are needed to discover the best geographic locations and times of year for release of the project's reconditioned fish.

Justification for using reconditioned kelts to supplement steelhead populations in the Methow Basin is partially based on the assumption that habitat in the Basin can accommodate these fish in addition to NOR and HOR adults and their offspring. Habitat restoration actions are occurring in the Methow River Basin. Whether the Basin can support additional spawners and juveniles

given the large number of HOR spawners present, however, is not considered. Analyses by Zabel and Cooney (2013) indicate that many steelhead populations in the upper Columbia Basin, including the Methow, have recently received relatively large numbers of spawners, leading to reduced productivity of their progeny. A discussion is needed on how changes in VSP parameters will be assessed. Without such a discussion, doubts will continue to exist about how the project will determine if its reconditioned kelts are helping to recover and sustain Methow River steelhead. A report, cited in the Update Report, presents six possible management benefits associated with increasing iteroparity in steelhead populations (see Appendix D; pp 223-224 in Hatch et al. 2012). Some of these proposed benefits might serve as beginning points for a monitoring and evaluation program that could appraise the project's effects on Methow River steelhead populations.

Ultimately the efficacy of reconditioning and releasing kelts to spawn in nature will depend on the demographic and genetic effects the strategy has on targeted populations, MPGs, and ESUs. At present, it remains to be seen if reconditioning is a viable recovery strategy. The Upper Columbia Kelt Reconditioning Project may be able to provide information on the usefulness of this approach if the Twisp project is successful at producing reliable estimates of the breeding and reproductive success of reconditioned NOR kelts. Additionally, if the project can establish a monitoring and evaluation program that assesses VSP parameters in the Methow Basin, it could serve as an important model for other kelt reconditioning projects. However, it is unclear whether the number of reconditioned kelts surviving and returning to spawn in the Twisp River will be sufficient to conduct a parental analysis and to confirm or refute successful reproduction. Reconditioned kelts will likely represent a small percentage (perhaps < 3%) of females spawning in the Twisp. Thus, some modeling and a power analysis is needed to help clarify how many juvenile and F_1 adults should be sampled to detect differences in the breeding and reproductive success of HOR, NOR, and reconditioned NOR females.

Additionally no plans are being made to evaluate the fat levels, maturation timing, fecundity, egg size, and gamete viability of the project's reconditioned kelts. Assessing and comparing these traits in all three female types (maiden NORs and HORs plus reconditioned NOR kelts) may help the proponents interpret results produced from the Twisp study. Some questions to consider include: did reconditioned kelts possess adequate energy stores to migrate and spawn under natural conditions; were their maturation schedules similar to maiden NOR and HOR steelhead; and if they did successfully spawn, were their eggs viable?

Another important assumption of the project is that reconditioned kelts will return to their natal spawning locations. The PIT tag arrays and weirs in the Methow Basin make it possible for the project to evaluate the homing fidelity of reconditioned kelts, but it is unclear whether this metric will be examined. The proponents indicate that uncertainty also exists around where (geographically) and when (time of year) the project's reconditioned fish should be released. They do not mention, however, how release locations and timing might be experimentally evaluated.

Comments on the Progress Report

1. Program History

The general goal of the project is to determine if the abundance of upper Columbia River (UCR) NOR steelhead, on natural spawning grounds, can be increased by using "long-term" kelt reconditioning. The project has three objectives: (a) recondition UCR NORs using "long-term" methods, (b) evaluate kelt survival and effectiveness of various reconditioning methods while the fish are held at the Winthrop Hatchery, and (c) collaborate with ongoing monitoring and evaluation studies to document the reproductive success of kelts released from the reconditioning program. The report provides a succinct time line of project activities in its Table 1.1.

A variety of actions were taken by the proponents to meet the project's objectives. A reconditioning facility for kelts was designed and built at the Winthrop National Fish Hatchery during 2010–2011. This facility has been used since 2012 to recondition steelhead kelts. A substantial challenge for the project is the acquisition of newly spawned female kelts. Three approaches were used. First, the feasibility of using compressed air to "live-spawn" steelhead (i.e., spawn without killing the fish) was examined at the Winthrop hatchery in 2011. Results of this study led the U.S. Fish and Wildlife Service to reach an agreement with the Yakama Nation (YN) to live-spawn NOR steelhead at the Winthrop Hatchery. Additionally, the Washington Department of Fish and Wildlife (WDFW) agreed to live-spawn NOR steelhead collected at the Twisp River weir at WDFW's Methow Hatchery. These two agreements may provide the project with up to 60 NOR female kelts per year. Second, attempts were made to capture naturally spawning female kelts using temporary weirs placed in the Methow Basin. Third, in 2014 kelts captured at Rock Island Dam were also brought into the reconditioning program. Kelts captured at Rock Island, however, could originate from a number of upper river tributaries, e.g., the Wenatchee, Entiat, Methow, and Okanogan rivers. It was not clear how the project intends to evaluate the performance of reconditioned fish obtained from the Rock Island site.

Reconditioning of kelts began in 2012 at the Winthrop facility. A number of fish health and condition issues occurred. Modifications to holding tanks, fungal treatments, and diets were made in 2013, and substantial improvements in fish health and survival were observed. NOR females collected at the Twisp weir, live-spawned at the Methow Hatchery, and reconditioned at the Winthrop facility will be used in an ongoing study taking place in the Twisp River. In this study, the breeding (production of juvenile offspring) and reproductive success (production of adult offspring) of these reconditioned fish will be compared to that achieved by NOR and hatchery-origin steelhead. It appears that between 8 to 14 reconditioned NOR Twisp River kelts will be available to this study each year. Whether this number will be sufficient to detect biologically important differences in outcomes among the three groups is not addressed.

In the original project proposal, the proponents planned to tag and release up to 20% of the kelts captured at tributary weirs. The survival of these fish was to be compared to the survival of kelts undergoing reconditioning. In an earlier review of the project, the ISRP indicated that

the survival of the in-river group would be biased unless wild-caught and hatchery-obtained kelts were randomly assigned to each group. In the current proposal "reference" groups of pre-spawning adults and juvenile steelhead are being tagged. Data from these fish will be used to calculate smolt-to-adult return values (SARs) and rates of repeat spawning for UCR steelhead. Other changes were made to (a) objectives, (b) kelt collection areas, (c) number of kelts collected, (d) kelt collection methods, (f) the location and size of the reconditioning facility, and (g) where the reproductive success of kelts would be evaluated. Reasons for each change are provided, and current methods and techniques are adequately described.

How actions performed during 2010-2014 to help the project meet its new objectives are discussed. The establishment and subsequent modifications to a reconditioning facility at the Winthrop NFH has aided the project in meeting its first objective (Objective 1: *recondition UCR kelts via long-term methods*). Additionally, the acceptance of live-spawning via compressed air by Winthrop (USFWS) and Methow (WDFW) hatchery personnel has allowed the project to obtain high quality, NOR females for reconditioning. Some progress in meeting Objective 2 (*evaluating kelt survival and effectiveness of reconditioning methods*) has also occurred. Changes in diet, food delivery, tank conditions and treatment for fungal infestations have improved kelt survival and quality. Collaboration with CRITFC researchers, who are using hormone levels in blood to determine gamete maturation, will help determine if reconditioned fish are re-generating gametes. However, important metrics associated with reconditioning are not being measured. The fat levels of reconditioned fish, for example, should be compared with those obtained from maiden (first time) spawners. This type of information would help determine whether the project's reconditioned females have enough energy reserves to complete egg development, ascend to appropriate spawning locations and successfully spawn. Additionally, maturation timing, fecundity, egg size, egg color, and egg viability of the project's reconditioned females should be evaluated. Egg size strongly affects fry size at emergence and carotenoid levels in eggs control fry color which is important for crypsis and possibly in intraspecific interactions. Encouraging – but preliminary results by Hatch et al. (2011) – have indicated that reconditioned steelhead have greater fecundities and equivalent egg viability when compared to maiden steelhead. Repeating and expanding their work on project fish would increase the knowledge about these important questions.

In the past, the project successfully reconditioned hatchery-origin females for research purposes. It would increase the value of this study if that could be done in the future so that the assessments suggested above could be completed. Live-spawning also provides the proponents with the capability of comparing a female's fecundity, egg size, egg color, and viability as a maiden fish with these same traits after she has experienced reconditioning. Fecundity studies by Hatch et al. (2011), on a relatively small number (8) of reconditioned kelts, should be repeated with UCR fish. This would not only provide an estimate of gains in lifetime fecundity achieved by reconditioning but may also offer insights in how reconditioning protocols could be improved if gamete quality or quantity was less than expected. It would also offer valuable information to the study of relative reproductive success taking place in the Twisp River.

A basic assumption, one that apparently has not been tested, is that reconditioned females will return to natal spawning areas. It would be useful to document homing fidelity and possible stray rates of such fish. This could be done by determining if reconditioned kelts, collected at the Twisp weir or at temporary weirs, return to the same streams where they were originally captured. Additionally, determining when and where to release reconditioned fish is another area where further information is needed. Why, for example, were four reconditioned NORs produced by the project released in November? Presumably they could have been held for an additional three months and released in early February. A delayed release would have likely reduced mortality (both natural and fishing), likely increased energy reserves, and allowed a more definitive assessment of maturation status.

The proponents have made progress in achieving Objective 3 *(collaborate with ongoing M&E studies to document the reproductive success of kelts released from the reconditioning program*) by working with WDFW to incorporate reconditioned NORs into the relative reproductive success study taking place in the Twisp River. No mention, however, is made on when or where the reconditioned fish used in this study will be released. Will they be released from the Methow Hatchery, transported to the Twisp River or released at other locations and when will the release(s) take place – in the fall like previous releases or later on in late winter? These details and the rationale behind them are needed right away.

2. Future Activities 2014-2018

Project activities planned for the future include (a) continued live-spawning at the Winthrop and Methow hatcheries, (b) collections of kelts at the Rock Island bypass facility and at temporary weirs, (c) continued reconditioning of live-spawned and natural kelts at the Winthrop facility, (d) tracking of released kelts via PIT tag detection arrays located in the upper Columbia, (e) PIT tagging pre-spawning steelhead adults and juveniles to assess SAR and repeat spawning rates of upper Columbia River steelhead, and (f) reconditioning and releasing Twisp River NORs to compare their breeding and reproductive success to maiden natural- and hatchery-origin steelhead spawning in the Twisp River.

Any potential population benefits derived from reconditioned kelts collected at the Rock Island bypass facility may be difficult to assess. As mentioned earlier, these fish could be from any number of upper Columbia River steelhead populations. Consequently, more information is needed on how the project intends to assess straying rates and possible juvenile and adult contributions to the respective native populations. Without such an evaluation, the risks and benefits of reconditioning and releasing fish remain unknown. All temporary weirs being used to collect NOR kelts are located in the Methow River Basin. The proponents have installed PIT tag monitoring arrays to ascertain whether steelhead migrating to upstream spawning areas are impeded due to the presence of the temporary weirs. The ISRP compliments them for this precautionary step. However, a description is needed on how the project may respond if delays are discovered.

The relative reproductive study (RRS) in the Twisp River has the potential to provide important information about the value of using reconditioned kelts to boost steelhead abundance and possibly genetic diversity. Yet, little information about this study is provided making it uncertain whether desired study outcomes can be achieved. A brief description of when and how many juveniles and adults would be sampled in the Twisp River along with some estimates of the numbers of each type of adult steelhead used in the study is needed. For example, knowing the percentage of the female reconditioned kelts spawning in the Twisp would help establish the probability of capturing progeny produced from these fish. On average, 59 NOR females, plus an unknown but presumed larger number of HOR females, return each year to spawn in the Twisp. Thus, it is likely that the 8 to 13 reconditioned kelts released each year by the project could represent 3% or less of the females spawning there. As a result, any progeny produced from these reconditioned fish may be relatively uncommon compared to offspring from the other two types of females. Information is needed on how the percentages of parr and smolts will be estimated from the three female types.

The proponents also claim that benefits to the natural steelhead population in the Methow will grow as the numbers of fish reconditioned and released increases. However, this assertion will remain a speculation until a monitoring and evaluation plan is implemented to assess how VSP parameters are changing in the Methow. Since freshwater and ocean conditions affect VSP parameters, it is important to establish appropriate reference or control streams to tease out trends caused by planned treatments (e.g., release of reconditioned kelts) versus those largely due to environmental variation. Currently, none of the project's planned activities are designed to objectively assess VSP parameters. The project's value would be enhanced if an M&E plan designed to track changes in VSP parameters was developed and implemented. The project's value also could be increased if the scope of future activities is expanded to include research on (a) the fecundity, egg size, viability, and egg color of reconditioned females, (b) the effect of reconditioning on the lifetime fecundity of reconditioned fish, (c) possible genetic effects, e.g., genetic amplification and reduction in effective population size (N_e) due to reconditioning, (d) homing fidelity of reconditioned females, and (e) the costs and benefits of different release times, e.g., late fall vs. late winter.

3. Project Results

The proponents evaluated whether live-spawning via compressed air could be used to collect viable eggs and also provide NOR kelts for reconditioning. Fifteen steelhead were spawned lethally while seven were live-spawned using compressed air. The number of eggs retained by each live-spawned female, along with the number of eyed eggs obtained from every female used in the study, was determined. An ANCOVA analysis was used to assess if the number of eyed eggs collected per female was affected by how the females were spawned. Fork length was used as a covariate. The proponents found no difference in the mean number of eyed eggs collected by each spawning method even though the live-spawned females had retained, on average, 522 eggs (or approximately 10% of their eggs). The fecundity of steelhead with similar lengths can be quite variable (Fig 3.1 in the Update Report), and thus a more straight forward approach would have been to compare the two spawning methods by determining the

percentage, rather than the number, of each female's total eggs that produced eyed eggs. The ISRP calculated these percentages from data provided in the report and compared the percentages with a Mann-Whitney U Test. Two of the females that were live spawned were partially green, and data from those fish were not included. Lethally-spawned females converted about 97% of their total eggs to the eyed stage while those that were live-spawned had a conversion rate of 88% resulting in a 9% difference between the two methods. Even though the sample size was small (15 lethal vs. 5 live) the Mann-Whitney U Test result was statistically significant (P = 0.006). The probable reason that the proponents found no difference in the means in their analysis was because of the variation that exists in the relationship between female length and fecundity.

One potential risk of using air pressure to expel eggs is the possibility that some may break after being expelled. Material from broken eggs can block micropyles and significantly reduce fertilization rates. We used data in the Update Report to determine if live and lethally spawned females had different green egg-to-eyed egg survival rates. Green egg-to-eyed egg survival values were determined by dividing the number of eyed eggs each female produced by the number of eggs collected from that female. Another Mann-Whitney U test was performed using these data, and in this case the null hypothesis of equal green egg-to-eyed egg survival was not rejected (P = 0.189). The green egg-to-eyed egg survival rate for lethally-spawned females was 97% versus 96% for live-spawned females.

Data from Hatch et al. (2011) suggest that the loss of eggs through live-spawning is compensated by the additional production of viable eggs from the same fish after it has been reconditioned. Thus, even though there is a cost to live-spawning, it is likely exceeded by the extra eggs produced by reconditioned females. That assumption could be examined by evaluating the fecundity of some reconditioned females produced by the project. If that was done, other egg traits, size, color, and viability could also be evaluated. The proponents also indicated that during live-spawning they inject air into the coelomic cavity by inserting a needle several inches above the pelvic girdle. Has any thought been given to inserting the needle higher up, for example, just below the transverse septum? Such a location might facilitate the removal of eggs located higher up in the coelomic cavity. If such exploratory work has not been done in the past, it may be worthwhile exploring the effects of a higher needle insertion point on egg retention.

The report does a good job describing the efforts used to capture NOR kelts at the permanent Twisp weir and at temporary weirs in the Methow River. Additionally, modifications implemented at the Winthrop reconditioning facility are adequately presented, as are the results of the reconditioning efforts that took place at the facility. Changes made regarding diet and pathogen treatments for fungal and copepod infestation are also well described. So far, just a few reconditioned kelts have been released, and thus any conclusions on post-release migration and spawning distribution would be premature. Tracking and reproductive success investigations will provide important insights into the consequences of kelt reconditioning, but additional evaluation of adult and juvenile abundance and diversity are needed to establish the potential benefits of reconditioning and releasing kelts.

4. Rationale for Continuing

The idea of reconditioning and releasing kelts that would otherwise die seems attractive. Yet, it remains unclear that the effort, even if some of these fish do spawn successfully, could be used as a general conservation strategy. The proponents argue that the project should be continued because it is "*uniquely poised to help answer the question of the reproductive viability of reconditioned kelts through our collaborative efforts with WDFW and their ongoing RRS study which is quantifying the relative reproductive success of natural and hatchery-produced fish at three life stages (parr, smolt, and adult).*" If adequate data on the breeding and reproductive success of reconditioned kelts spawning in nature can be obtained from the Twisp River project, it would help clarify the value of using this strategy to boost population abundance in depressed steelhead populations. However, uncertainties exist on whether the project will be able to release enough reconditioned kelts so that any progeny produced from successful spawning events could be detected. A power analysis is needed to see if juvenile and adult production by reconditioned kelts can be detected under current study conditions. Results elsewhere on this topic have not been promising, except perhaps in the case where 2 kelts (1 male and 1 female in different years) were shown to have contributed progeny in Omak Creek (Hatch et al. 2011). Furthermore, the investigators should consider whether progeny from additional steelhead spawners can be supported by the habitat given that recent analyses suggest the capacity might have been exceeded in recent years (Zabel and Cooney 2013).

Besides possibly providing data on the reproductive contributions of naturally spawning, reconditioned kelts, the project does have the potential to provide information on the (a) fat levels, (b) maturation timing, (c) homing fidelity, (d) fecundity, (e) egg size, and (f) egg viability of reconditioned kelts. Questions concerning when and where reconditioned kelts should be released could also be examined by the project along with how such fish may influence VSP parameters. None of the above potential benefits will be realized unless the project expands its future work objectives. We encourage the proponents to do so. Otherwise, there is a real risk that essential questions will remain unanswered and that the project will make a minimal contribution to answering the questions surrounding kelt reconditioning.

References

Hatch, D., R. Branstetter, J. Stephenson, and A. Pierce. 2011. Steelhead kelt reconditioning and reproductive success 2010 annual report. Columbia River Inter-Tribal Fish Commission Technical Report 11-22. 231pp.

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