



Independent Scientific Review Panel
for the Northwest Power & Conservation Council
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Memorandum (ISRP 2007-5)

May 10, 2007

To: Peter Paquet, Acting Director, Fish and Wildlife Division, Northwest Power and Conservation Council

From: Eric Loudenslager, ISRP Chair

Subject: Final Review of Proposal for Project 2003-063-00, *Natural Reproductive Success & Demographic Effects of Hatchery-Origin Steelhead in Abernathy Ck, Washington*

Background

At the Bonneville Power Administration and the Council's request, the ISRP reviewed the proposal for Project 2003-063-00, *Natural Reproductive Success & Demographic Effects of Hatchery-Origin Steelhead in Abernathy Creek., Washington* for the FY 2007 within-year request process. To complete this review, the ISRP reviewed an initial proposal, requested that the sponsors respond to a number of ISRP concerns, and reviewed the sponsor's response. Excerpts from our earlier memo requesting a response are appended below.

This project was originally conceived in response to the 1998 Biological Opinion on Artificial Production in the Columbia River Basin. In that opinion NOAA Fisheries identified that the common use of out-of-basin fish stocks in steelhead hatchery programs used to support fishing could be deleterious to declining natural populations. The project sponsors originally proposed to test whether juvenile steelhead could be collected and reared to maturation, spawned, and the resulting progeny released as a hatchery cohort for fishery mitigation and perhaps to spawn to reinforce a natural population. The goal was to use local fish, and to do so in a way that reduced the risks of broodstock mining. This proposal was reviewed by the ISRP as an innovative proposal in FY 2001, under the Lower Columbia/Estuary Provincial Review, and again under the Mainstem/Systemwide Provincial Review. Under these solicitations the proposal received favorable ISRP review, but was not funded. The project began nonetheless, using U.S. Fish and Wildlife Service resources.

The current project received an affirmative ISRP review, a Council funding recommendation, and Bonneville funding under a 2003 Request For Studies: Research, Monitoring, and Evaluation. Specifically, the ISRP found the proposal to be scientifically supportable with potential systemwide application (ISRP 2003-9). The Request For Studies was developed to address critical uncertainties under the 2000 Biological Opinion. Specifically, the project intends to address gaps and uncertainties identified in FCRPS 2000 Biological Opinion Action 182, "establishstudies to determine the reproductive success of hatchery fish relative to wild fish."

Review Summary and Recommendation

In general the sponsors made a diligent effort to rapidly respond to the ISRP's questions. For the most part, however, their answers are only partially satisfactory. One major difficulty with this project lies with the comparison of adult abundance estimates in the reference streams (Germany and Mill Creeks) and the treatment stream (Abernathy Creek). The sponsor's are apparently unable to verify (with presently collected data) assumptions involved with redd counts, which will be used to assess adult abundance in the reference streams. The response lacks a description of how the error associated with the abundance estimates will be assessed, and there is difficulty in accurately assessing other demographic characteristics such as sex ratio, age structure, and redds per female. The sponsors fail to plainly explain how they will account for confounding effects, such as habitat restoration actions, planned sometime in the future for Germany and Mill Creeks. Finally, the proposal elements related to causative agents such as residualism and physiology are interesting but not required to assess the relative reproductive success of hatchery-origin adults or supplementation. The contributions that those investigations' findings will make to hatchery reform or benefits to fish and wildlife are not sufficiently established.

In addition to the five major questions, the ISRP posed a number of specific technical questions relating to methods and assumptions. The sponsor's response to these questions is very limited. From page 9 onward the response does not adequately answer many of the ISRP's specific questions. The sponsor simply state that the ISRP's questions and comments will be addressed in future reports, or the sponsor's explanations are so general as to provide little insight into the ISRP's questions. It seems that many of the questions could have been addressed immediately with information in hand or with specific proposals and not postponed until future reports are written. This response detracts from the otherwise fine work the sponsor's are conducting.

- **Recommendation: Meets Scientific Review Criteria In-Part (Qualified).**
The ISRP has unresolved questions about 1) the difficulties with comparison of reference and treatment streams, 2) sufficiency of assessing the relative reproductive success of hatchery-versus natural-origin steelhead, 3) the growth modulation experiments that are coupled with the smolt physiology assessments, and 4) measurement of behavioral interactions. The evaluation of the demographic effects of steelhead supplementation in Abernathy Creek does not meet the scientific review criteria because the ability to measure important attributes of the adults spawning in the reference streams is lacking (objective 3, work element 3b, 3c). The ISRP recommendation is qualified because the relative reproductive success objective may not be achievable using young-of-the-year juveniles based on the 2005 report (objective 8, work elements 8a, 8b), and because the physiological assessment of smolt status that is intended to contribute to modification of hatchery practices is based on growth modulation experiments using feeding rates and feed formulation that have not been reviewed by the ISRP (objective 4, work element 4a). These should be addressed in developing project work elements and reporting during FY 2008 and 2009.

Comments on Responses to Primary ISRP Concerns

In the section below, the ISRP's five primary concerns with the proposal identified in the preliminary review are numbered and in italics. Each preliminary concern is followed by the ISRP's current review comments on how well the project sponsor addressed the concern.

- 1. Provide a more thorough treatment of the reporting of the reproductive success work-to-date in the project history section of the proposal.*

The sponsor provided results indicating they are making some progress in determining the relative reproductive success of steelhead. To date, they have been successful in assigning returning adults to parents of the previous generation for hatchery fish. They have been less successful in assigning naturally produced juvenile steelhead to anadromous hatchery-origin or natural-origin steelhead adults spawning in the stream.

The reporting of the reproductive success portion of this project is less thorough than it should have been, particularly since this objective served as the primary motivation for funding (under the auspices of fulfilling the 2000 FCRPS BiOp RPA 182). The response references the 2005 and 2006 annual reports but does not sufficiently summarize the work that was conducted for the ISRP to determine whether it is on track to achieve the project's objectives. The 2005 report was made available to the ISRP, the 2006 report was not. By comparing the 2005 report to the results reporting in the proposal and response to the ISRP, it is clear that important information is not being conveyed. The response still does not identify the numbers of adults passed above the Abernathy Fish Technology Center (AFTC) for spawning; summarize the number of progeny for each fish; or mention apparent problems with adult fish passing the weir, spawning, and then moving downstream and entering the AFTC ponds.

In the 2005 report a single parent could be identified for only 17% of the 300 young-of-the-year steelhead sampled and in no case could both parents be identified. Because of the small number of fish identified to parents, the difference between the reproductive success of hatchery and wild fish was not significant. Work element 8a in the proposal calls for genotyping only 500 young-of-the-year steelhead to evaluate the relative reproductive success of hatchery-origin adults compared to natural-origin adults.

The ISRP concludes from the 2005 report that insufficient sampling of parents (either anadromous adult returns or resident *O. mykiss*) and subsequent smolt progeny (sampled only by RSTs) limits the ability to obtain sufficient data for the calculation and comparison necessary to provide confident statistical analyses. The ISRP concern is to the point that an ability to complete the work is questionable. No indication of sample size requirements is indicated, but sampling requirements should have been possible through a simple modeling process.

A case needs to be made that the numbers of progeny that will be genotyped are sufficient for evaluation, given the low proportion of fish that can be assigned to parents.

The first sentence of the final paragraph in this response: "In order to estimate the relative reproductive success of hatchery and wild fish, we will need to sample at least the offspring of

hatchery fish, and optimally the returning offspring” is confusing. The sponsor needs to clearly identify the source of the fish that will be genotyped (who their parents were, and where they were spawned) and how the contrast of the precision in parentage assignment of these fish will be used to assess the relative reproductive success of hatchery- versus natural-origin adults spawning in the stream. To their credit, the sponsors indicate that a large number of steelhead are spawning below the AFTC weir, and this is posing some problems for the analysis. The sponsors need to provide compelling evidence that this problem will not compromise the experimental design to such an extent that the entire venture is doomed.

2. *Clarify and explain how the use of Mill and Germany Creeks as reference locations can be used to evaluate the demographic effects of hatchery-origin steelhead in Abernathy Creek, when no adults are being counted in the reference streams.*

Adult abundance is being assessed through redd counts in Abernathy, Germany, and Mill Creeks. The sponsors recognize the inherent error involved with this method and have taken some steps to minimize it. The sponsors do not discuss how they will differentiate redds constructed by hatchery fish (including stray hatchery origin fish) from those made by naturally spawning steelhead indigenous to the stream. This differentiation is important as it will permit relative assessment of differences in abundance of hatchery and wild fish both within and between the three streams. Nor do the sponsors discuss how error in abundance estimates will be estimated. The sponsors do not discuss how they will determine other demographic parameters such as sex ratio, redds per female, and age structure in Mill and Germany Creeks. Recognizing the problematic nature of redd surveys, the sponsors began assessment of adult abundance in Abernathy Creek using mark-recapture methods. It is unclear how this work will be extended to Mill and Germany Creeks. In summary, because of the sponsor’s apparent inability to verify assumptions of the redd count technique used to assess adult abundance in Germany and Mill Creeks, the lack of a description of how the error associated with the abundance estimates will be assessed, and, apparently, the difficulty in assessing other demographic characteristics, the accuracy of the comparison of adult demographic parameters among the three creeks may be problematic.

It is essential that sex ratio and age-structure of the populations in Mill and German Creeks be determined. An abundance estimate of steelhead is not sufficient for evaluating the demography of steelhead in these streams, and will be inadequate to make an assessment of the demographic effects of hatchery-origin steelhead in Abernathy Creek. Smolt age and sea age of each fish must be identified (or estimated) so the returning adults can be assigned back to the return year where they originated. This will permit determining that the presence of hatchery-origin adults added to the spawning population in year X yielded additional naturally produced adults at some point in the future.

Beyond this essential requirement, however, there are the confounding effects of hatchery straying, and perhaps even natural straying, in these systems. The 2005 annual report indicates that nearly a third of the adults captured in the AFTC ponds were stray hatchery fish. Given the small number of fish returning to Germany and Mill Creeks it is possible that these locations are

primarily populated by stray hatchery steelhead, and are not sufficiently “independent” to serve as a reference for evaluating the presence of hatchery fish in Abernathy Creek.

From inspection of the objectives and work elements it appears that the counts of adults in Mill and Germany Creeks are undertaken by projects funded by other means. This should be identified in section d under relationships to other projects. It appears that only smolt counts at screw traps in Mill and Germany Creeks are included in this proposal.

If the need to collect more rigorous life-history information from returning adult steelhead cannot be achieved, this objective could be deleted from the proposal without compromising the integrity of the relative reproductive success portion of the studies.

3. *Clarify and explain how Mill and Germany Creeks can serve as reference locations if these streams are part of an Intensively Monitored Watershed project and are receiving habitat improvement treatments different from each other and Abernathy Creek.*

Sponsors state that habitat restoration efforts will not take place until 2009 at the earliest and that the restoration actions taken will likely differ between streams. If and when restoration actions begin the sponsors maintain that they will evaluate them but they do not propose very specific methods for assessing the impacts of the actions other than some possible statistical tests.

As stated in the response the Germany, Abernathy, and Mill Creek watersheds do have similar habitat (managed Douglas-fir plantations) and there is little reason to doubt that the conditions in the stream channels differ very much in a way that confounds the analytical design. The forests have likely been logged 2-3 times and the primary in-stream restoration activity will be large wood reintroduction and road-related erosion control. Most of the area is owned by Weyerhaeuser. However, there is no obvious reason why Mill Creek would have fewer adult steelhead than Germany Creek (Table 1), which suggests some other factor is present that is not described in the response. If for some reason Mill Creek is not particularly suitable for winter steelhead, perhaps it should not be a reference site in this particular study.

4. *Describe how the physiological data on out-migrating hatchery steelhead smolts will be interpreted and subsequently used to modify hatchery practices.*

The sponsors state that they have ongoing growth modulation experiments using a portion of the fish produced under this project to evaluate whether one-year-old smolts with a size and physiological conditioning similar to natural smolts (2 year olds?) have improved survival and subsequent reproductive success. There is no mention of these experiments in the objectives or work elements in the proposal or identification of a relationship to another project in section d of the proposal narrative to suggest that these are other than opportunistic “add on.”

The sponsors found that differences in certain physiological characteristics between hatchery and wild smolts rendered the hatchery smolts more vulnerable to predation by piscivorous birds and they used the information to suggest to hatchery managers how practices could be improved to enhance survival of smolts. Nevertheless, overall, the ISRP is unable to evaluate the

contributions these experiments could make to improving fish culture practices. Consequently the justification for this portion of the project is tenuous.

5. *Describe how the behavioral studies on residual steelhead and steelhead smolts can be used to estimate the population level effects of steelhead hatchery programs on natural steelhead, coastal cutthroat trout, and coho salmon production.*

The sponsors presented a more thorough discussion of behavioral studies and residualism over that presented in the proposal. This work is important and can contribute significantly to knowledge about interactions between hatchery and wild steelhead. The sponsors have already produced some significant findings such as demonstrating a low level of residualism among hatchery juveniles, and, apparently, habitat displacement of wild fish by hatchery fish does not take place in Abernathy Creek. Some questions remain, however. The sponsors could have provided a more detailed explanation of how foraging success, predator avoidance, and other behavioral characteristics will be determined. They also do not discuss adequately how variation in physical conditions in streams (e.g., discharge, water temperature) will affect interactions.

The response to the question about residualism and competition on page 19 appeared focused almost exclusively on counting fish, whether remaining in the streams or emigrating. If all hatchery steelhead are CWT-tagged (and adipose clipped) and naturally spawned fish are not, it should be possible to look at behavioral interactions by direct observation when snorkeling. Short of bringing wild and hatchery fish into a controlled lab situation, recording foraging and agonistic behavior in the field would provide useful data for assessing the importance of competition. Direct snorkeling observations would also provide evidence of interspecific interactions (e.g., steelhead and coho).

It should be noted also that determination of the impacts of behavioral differences on survival to maturity will be difficult to assess, but this should not detract from the importance of the proposed work.

Appendix. Excerpts from ISRP Memo Requesting a Response, March 29, 2007

Summary

Before the ISRP can make a final recommendation on this proposal, we request a response from the sponsor to:

6. Provide a more thorough treatment of the reporting of the reproductive success work-to-date in the project history section of the proposal;
7. Clarify and explain how the use of Mill and Germany Creeks as reference locations can be used to evaluate the demographic effects of hatchery-origin steelhead in Abernathy Creek, when no adults are being counted in the reference streams;
8. Clarify and explain how Mill and Germany Creeks can serve as reference locations if these streams are part of an Intensively Monitored Watershed project and are receiving habitat improvement treatments different from each other and Abernathy Creek;
9. Describe how the physiological data on out-migrating hatchery steelhead smolts will be interpreted and subsequently used to modify hatchery practices; and,
10. Describe how the behavioral studies on residual steelhead and steelhead smolts can be used to estimate the population level effects of steelhead hatchery programs on natural steelhead, coastal cutthroat trout, and coho salmon production.

...

The current project received an affirmative ISRP review, and Council funding recommendation under a 2003 Request For Studies: Research, Monitoring, and Evaluation. The project intends to address gaps and uncertainties identified in FCRPS 2000 Biological Opinion Action 182.

....establishstudies to determine the reproductive success of hatchery fish relative to wild fish.

As a continuation and extension of the original proof-of-concept proposal, the project has five essential objectives. The objectives, along with the ISRP's assessment of progress toward achieving them, follows:

1. *Evaluate whether the strategy of collecting juvenile steelhead and rearing them to maturity to provide hatchery broodstock is efficacious, and can be used as a standard method instead of collecting returning adults.*

This objective has largely been addressed in the affirmative.

2. *Measure the relative reproductive success of natural- and hatchery-origin steelhead to help fulfill the information gap identified in the 2000 FCRPS Biological Opinion.*

Reasonable progress has been made on this objective and the ISRP believes this evaluation can be completed by this project/proposal. A very thorough treatment of the analysis of this objective was provided by the sponsors in an annual report. In the proposal insufficient information was provided for the ISRP to evaluate whether this project is meeting its goals and benefiting fish and wildlife. More of the information from the annual report needs to be incorporated into the project history section.

3. *Evaluate the demographic effects of steelhead supplementation in Abernathy Creek by using contrasts of production in Abernathy Creek with Mill and Germany Creeks as reference locations.*

In principle the ISRP endorses the need for this research and the strategy of contrasts between streams being supplemented and reference locations. There are two primary concerns about whether the data generated from this project will be suitable to arrive at conclusions regarding the demographic effects of supplementation in Abernathy Creek. First, based on the proposal, only smolt emigration is being enumerated in Germany and Mill Creeks. It appears that returning adults are not being enumerated in these creeks. In this case that could be a fatal flaw for the experiment. A contrast of fish production between a supplemented stream and a reference stream as a measure of the effect of supplementation assumes that the adults spawning in a particular stream originated in that stream in the previous generation. If migration between streams is unknown, but appreciable, the contrast is meaningless. At this point the ISRP has no information on the composition of the spawning population in Germany and Mill Creeks. From information provided in the proposal nearly a third of the adults in Abernathy Creek are from out-of-basin hatchery steelhead. The ISRP is not convinced at this time that the treatment – reference contrast in this circumstance – is justified.

Second, Germany, Mill, and Abernathy Creeks are a suite of streams in an Intensively Monitored Watershed assemblage. In a supplementation evaluation, under ideal circumstances, the supplemented stream and reference stream(s) would not receive different habitat treatments. If they do, then changes in abundance might be due to the different habitat treatments, not due to the supplementation action. If there are differences in the habitat restoration actions in the different streams they need to be identified and a method developed to account for these effects as a covariate in the final analysis. This issue is not addressed in the proposal and needs to be.

4. *Assess the physiological status of hatchery and natural smolts out-migrating from Abernathy Creek.*

The sponsors measure sodium/potassium ATPase enzyme, and perform a salt water challenge test accompanied by plasma sodium and plasma osmolality measurement to assess the readiness of hatchery smolts to migrate to the marine environment compared to natural smolts. In recent releases there have been differences between the hatchery and natural steelhead. The sponsors do not indicate how this information

is going to be used to modify the fish culture practices used in this program or inform practices elsewhere in the basin.

5. *Evaluate residualism, displacement, and ecological interactions between yearling hatchery steelhead and natural salmonids (steelhead, coastal cutthroat trout, and coho salmon) in Abernathy Creek. Determine the impacts of hatchery releases at the individual and population levels.*

This objective addresses uncertainties about the effects on natural populations arising from using artificial production. The work elements in the proposal and the annual report identify what they are going to measure, but it does not describe how the data collected will be analyzed to draw conclusions about the impacts of hatchery releases on natural populations owing to ecological interactions. Accomplishment of this objective could be confounded by complexities such as annual variation in juvenile densities and habitat conditions (e.g., low water levels or high temperatures), both of which could alter behavioral interactions between hatchery and natural juveniles. The sponsors do not adequately explain how they will deal with these complexities analytically. Moreover, personnel with specific expertise in fish ecology and behavior should be involved in the project.

Specific Review Comments

1. Technical and/or scientific background

The sponsors provide a well-described discussion of the context for their proposed work. The research addresses one of the major *critical uncertainties* relating to recovery of Columbia River steelhead populations, namely - the positive and negative impacts of supplementation on naturally spawning populations and the appropriate role of supplementation in steelhead recovery. The sponsor's laboratory is uniquely situated (location, available expertise, and record of work) to conduct relatively small scale, experimental studies to evaluate the genetic and demographic impacts and benefits of supplementation.

More specifically, the technical and scientific background touches on most of the important issues arising from using artificial production and release of steelhead to provide 1) fishing opportunities and 2) a conservation benefit to natural spawning populations, by covering the entirety of the life-cycle and ultimately generational issues of relative fitness and reproductive success.

The sponsors have reported analytical results that demonstrate continued review and evaluation toward reaching project objectives as opposed to simply amassing uninterpreted data and making unsubstantiated claims of "success." The eight objectives are, by and large, each independently important elements and necessary to address the ultimate question regarding whether the local, native brood stock developed from juvenile capture is a viable strategy. Moreover, from a design perspective, including untreated reference streams is an important advancement for the many supplementation "experiments" ongoing throughout the basin.

The original scope of work for this program began under the auspices of U. S. Fish and Wildlife Service funding to explore whether steelhead hatchery broodstocks could be established by collecting juvenile fish and rearing them to mature adults. This objective has been reached, and there is a demonstrated proof of concept. By using eggs and sperm from this source, rather than collecting gametes from natural-origin adults, mining the natural population can be avoided, thus avoiding an important risk category. Moreover, the initial scope of work also provided a case study opportunity to examine and quantify the net consequences (benefits, impacts, or no-effect) for natural steelhead production from *in-situ* hatchery production. Lastly, through an experimental design that included reference stream(s) not receiving supplemental releases, there emerged a greater potential for establishing a causative link and response from supplemental releases. Ultimately and as a consequence of the project's history, the emphasis of the sponsor's current proposal is focused more on quantifying the benefits of hatchery production to rebuilding natural populations and further evaluating the efficacy of using parr as future broodstock.

While ISRP gives an overall favorable review for extending the breadth and depth of the current project, there are areas that need to be more thoroughly justified:

- The background description would be more effective and be of broader benefit to others in the basin if it more clearly distinguished which objectives address the two major goals of 1) examining the use of parr as broodstock, and 2) addressing the benefits/risks of supplemental releases. While these are both part of this project, they are separable issues in a broader context. The inherent difficulty in estimating natural population productivity in the presence of hatchery fish on natural spawning grounds was the motivation for funding the current project as one element to fulfill obligations to meet RPA 182 for the 2000 Columbia River hydrosystem biological opinion. The need to understand if and how supplemental releases (where some natural production yet occurs) affects natural productivity (positively, negatively, or not at all), such as estimations of productivity and abundance of natural production for ESA status needs further consideration if this project continues beyond the current funding cycle.
- The report included with the application informally references hypotheses tested under each objective. An easy improvement would be to more formally state the hypotheses in the proposal (where appropriate).
- Under Objective 1, the local, native, and naturally-produced juveniles that were collected to be reared as broodstock was undertaken to minimize certain risks (e.g., interbreeding with non-native genomes, brood mining, increased straying, etc.). However, this approach is not entirely immune from creation of other risk classes (e.g., potentially lower N_e if juveniles are collected as shoaling siblings, etc.). Not all or any of these may be realized, but they deserve full airing and address.
- Table 1.1 has size and fecundity information for NORs. Is there HOR data to compare? This appears to be a basic question (and null hypothesis) to test with data in hand.

- Given that the HOR are released as marked smolts, is there a way to examine and easily calculate smolt to adult ratios. How stable are these survival estimates and how do they compare with their NOR counterparts?
- The letters above the bars in Figures 2 and 3 need further explanation. The sponsors maintain that they denote significant ($P < 0.05$) differences between the groups, but it is unclear which groups are being compared. The sponsors make broad generalizations about differences but without any textual discussion of the actual significance of the differences. For example, the sponsors state that “NOR fish performed better in saltwater when compared to HOR fish as indicated by better regulation of plasma osmolality and $[Na^+]$ ” and cite Figure 3. However, visual inspection of Figure 3 suggests that the differences are far from clearcut. Discussion of significant differences in the text would improve understanding of both Figure 2 and 3.
- While the inclusion of untreated reference streams at the outset is a major improvement over other experiments in the basin, the focus on a single treatment stream limits the inferential power for other situations/cases. Moreover, if this is to be a true treatment/reference experiment, all other variables need to be held constant or determined to be effectively unimportant. Are there no other variables being addressed in these watersheds (that these are part of the IMW suggests not)? Perhaps, this is where the Subbasin Plan’s assessment can inform the science a bit. Lastly, the documents describe Abernathy Creek to a fairly detailed level, but less detail is given for the reference streams. Recognizing such difficulties, how comparable are the treatment and reference streams – other than they will receive no smolt releases?

2. Rationale and significance to subbasin plans and regional programs

In general, the sponsors provide a good discussion of the context for their proposed work. The research addresses one of the major critical uncertainties relating to recovery of Columbia River steelhead populations, namely the positive and negative impacts of supplementation on naturally spawning populations and the appropriate role of supplementation in steelhead recovery. There is a brief statement that the work was initiated to develop technologies for generating “local” source populations for the culture and release of steelhead, and that goal was drawn from the 1998 NOAA-Fisheries Biological Opinion (BO) on Artificial Propagation in the Columbia River Basin. Further, sponsors indicate this work responds directly to the 2002 Mainstem and Systemwide Province Draft Artificial Production Program Summary, FCRPS – RPA 182, and the 2005 draft Council Research Plan. For these latter plans and actions, the specific element that is being addressed by this proposal (project) is not overtly identified. This should be an easily correctable omission.

3. Relationships to other projects

The proposed research is related to other studies of reproductive success of salmon and directly addresses elements of the Biological Opinion (see Item 2 above) relating to the use of non-native

and native broodstocks to enhance populations. The study is unique, however, because it assesses not only reproductive success but also possible mechanisms that may be responsible for differential reproductive success between hatchery and naturally produced fish.

The sponsor identifies the other studies ongoing in the Columbia River Basin that are evaluating the relative reproductive success of hatchery-origin adults spawning in mixtures with natural-origin adults. Similarities and differences between this project and others are emphasized in the narrative, thus they provide an adequate context.

The sponsor also identifies that Washington's Salmon Recovery Funding Board funds an Intensively Monitored Watershed (IMW) evaluation using Abernathy, Mill, and Germany creeks, and that data collection and analysis is routinely shared between this project and the IMW – this is critical to ensure inadvertent disruption of the experiment and ultimately to provide a calibrated context for the experimental results. As part of IMW evaluations, we surmise that much work must be ongoing to both improve habitat and to enumerate fish. The sponsor indicates that WDFW maintains downstream migrant traps on these creeks for demographic monitoring purposes. Those kinds of data are fundamentally important and the role of this effort needs a little more elaboration in the proposal, as well as some discussion of the interaction between this project and these others.

4. Project history

The sponsors generally provided a good discussion of results to date and, when combined with the 2005 Annual Report, indicate that considerable progress has been made toward each of the objectives. As a summary element, the sponsors might have stated each of the project objectives and then provide the results related to that objective. The sponsors should have ended the section with a list of conclusions and questions that need to be addressed. so as to lead into the subsequent objectives, thus demonstrating the linkages between the objectives and why this is a project with multiple integrated parts.

5. Proposal biological objectives, work elements, and methods

Objectives:

- The biological objectives identified are largely tasks to be completed rather than approaches to address articulated hypotheses. Future proposals should emphasize the end biological state that the project intends to achieve.
- Ultimately, as this proposal expands on previous work, there is ample opportunity to link preliminary analyses among the Objectives. For example, for Objective 1, the sponsors provide the numbers of juvenile fish collected, adults spawned, and smolts released. How does this tie in with Objective 2 (or subsequent objectives)? For Objective 2, they provide information on genetic variation in samples of fish from the project and compare this with naturally produced steelhead. How does this tie in with Objective 3 (or subsequent objectives)? For Objective 3 the sponsors will compare smolt production in

Abernathy Creek to production in Germany and Mill Creeks. How does this tie in with Objective 4 (or subsequent objectives)? For Objective 4, they provide data on the physiological status of the released fish and corresponding natural fish. How does this tie in with Objective 5 (or subsequent objectives)? - and so on.

- For Objective 3 the sponsors will compare smolt production in Abernathy Creek to production in Germany and Mill Creeks. Because no explicitly stated hypotheses are provided, we are left to surmise why the comparisons are being made and what will be achieved with the comparisons. What hypothesis is being tested? What will the comparison of smolt production between the three streams indicate about supplementation in Abernathy Creek?
- Objective 6: Why are coho and cutthroat returns being monitored? How will this information be used in assessing steelhead supplementation?
- Objective 8: The presentation of information on the reproductive success evaluation appears preliminary and of a “range-finding” scale (a limited number of adults whose reproduction was tracked). The numbers of adults that were released to spawn in the stream was not given, nor was the number of juvenile fish screened. There was no discussion of the numbers of fish that could not be assigned to parents, which would indicate either strays were spawning, or perhaps resident rainbow trout. Tasks associated Objective 8 of the current proposal will expand on this with a more powerful and robust data set, however, the “range-finding” work to date can and should support (with data) the overall utility for the approach. For example, is there sufficient variation with markers used and proposed to detect a significant signal from all the potential background noise?

Methods:

Generally the methods are largely acceptable, but occasionally sketchy. Presentation of design and implementation is not explicitly presented. Were it not for the 2005 Annual Report, which provides more methodological detail, it would be difficult to understand the sponsors’ approach.

- In this section the sponsors indicate they expect 500 adult steelhead to enter Abernathy Creek in 2007. The data from 2004, 2005, and 2006 do not appear to indicate that those numbers of fish return to the system. This expected increase should be explained along with a “what if they don’t” scenario. Also, at this point a discussion of the efficacy of collecting sufficient genetic data to make the assessment of relative reproductive success of hatchery-origin adults is warranted.
- To fully evaluate the demography of the Abernathy Creek population and determine whether or not hatchery fish were adding to natural production or just substituting for natural production, adult enumeration is needed in Mill and Germany Creeks. If this is part of the work elements and methods, it was not obvious. Alternatively, if this is not part of the project, this is a serious flaw in the experimental approach, and should be discussed in a response to the ISRP or in the next proposal cycle. Ideally, hatchery fish

would be excluded from Mill and Germany creeks so the affect from naturally spawning by hatchery-origin fish could be evaluated without confounding from hatchery strays. If this is not possible, at minimum the proportion of hatchery strays need to be known for inclusion in the analysis as a covariate. A similar issue is accounting for stray natural steelhead. The vital parameters for all the populations will be biased if there are substantial numbers of stray fish from other streams.

- For Objective 2: in addition to smolt production comparisons, why can't the reference streams also be used compare genetic composition and genetic "change" relative to treated stream and residualism between the three streams? Objective 2b: how will "genetic change" be measured?
- For Objective 3: How will the data be analyzed? What is the justification for estimating smolt outmigration of coho and cutthroat? How will the information on coho and cutthroats be used to assess steelhead supplementation effects? Part of the smolt production in Abernathy will be from releases directly from the hatchery. Will these released smolts be differentiated from naturally produced smolts in Abernathy? Will just the naturally produced smolts be compared to those in Germany and Mill Creeks?
- Objective 5: It is not clear how residualism will be determined. How will the data from monitoring of PIT tagged fish at permanent arrays be used to estimate residualism (5a)? How will survival and recapture probabilities be estimated, what population models will be used to estimate the probabilities, and how will this information be used to estimate residualism (5b)? How often will snorkel surveys be conducted, how will habitat preferences be determined (or do the sponsors simply mean habitat use?), and how will this information be used to quantify competition and predation risks (5c)? The sponsors should keep in mind that rigorously quantifying competitive effects has proven to be difficult outside a controlled, experimental setting. Macro- and microhabitat shifts are often a result of species interactions. How will habitat use be assessed on a macro- and microscale? Species interactions are likely to be density-dependent, that is, interactions and shifts in habitat usage are more probable when population densities are high than when they are low, or when habitat conditions are poor (say, a low water year with high temperatures) than when they are good. As a consequence, meaningful information probably can only gained if behavioral and habitat monitoring occurs several times per year over a several year period. Although the questions the sponsors' intend to address with this objective are important ones, the kinds of behavioral studies that the sponsors are proposing to address the questions need to be carefully designed and implemented for all of the reasons given above.

6. Key personnel, facilities, and equipment

In spite of some omissions and criticisms identified above, the Abernathy Lab is a high quality facility and the personnel have high credentials (especially in genetics and physiology) for producing excellent research. The ISRP recommends including expertise in demography or population dynamics (the proposal is examining demographic changes in the population), and

habitat ecology and fish behavior (relevant to objective 5) to more fully take advantage of the data and to ensure these design elements.

7. Information Transfer

Acceptable. The sponsors have produced annual reports, presented at technical meetings, published in the peer reviewed literature, and have manuscripts in review. The 2005 Annual Report is an important addition to the proposal as it clarifies a number of issues and presents at least preliminary findings.

The sponsor identifies that Washington's Salmon Recovery Funding Board funds an Intensively Monitored Watershed (IMW) evaluation using Abernathy, Mill, and Germany creeks, and that data collection and analysis is routinely shared between this project and the IMW – this is critical to ensure inadvertent disruption of the experiment and ultimately to provide a calibrated context for the experimental results.

8. Benefits to Fish and Wildlife

The project has the potential to make a significant contribution by addressing key questions related to the effects of supplementation on naturally spawning salmon. The work could be applicable to recovery of listed species.

The benefits to fish and wildlife will be indirect, by reducing the uncertainty in estimating the status of ESA listed steelhead and by providing information to design improved hatchery approaches (especially in procurement of broodstock). There are direct benefits to fish and wildlife if we learn and then apply lessons learned in an adaptive context. The great challenge will be to broaden the inferential power of the information gathered (likely through meta-analysis with similar kinds of studies within the basin) from this enterprise and apply more broadly on a routine operational basis.