Responses to Comments Provided by the ISRP and the H/H Subgroup

Proposal Number: **Proposal 1**

Proposal Title: **"Investigation of the Relative Reproductive Success of Hatchery and Wild Steelhead in the Deschutes River Basin"**

Sponsor: **Oregon Department of Fish and Wildlife (ODFW)**

Principle Investigator: **Richard W. Carmichael (ODFW)**

Cooperators: **Dr. William R. Ardren (USFWS)**
Dr. Donald E. Campton (USFWS)

Responses to ISRP Comments

ISRP Comment:
The evaluation does not include a design to extend to F_2 adult returns. The degree to which any difference in reproductive success of hatchery spawners persists in subsequent generations (beyond F_2) was not included in the proposal, but could be addressed.

Response:
We agree the proposal should be modified to extend beyond the F_2's. Thus we will modify the proposal to allow for evaluation of the reproductive success beyond the F_2 generation. The identical techniques used to determine the relative reproductive success of original parents and F_1's will be used to determine relative reproductive success of the F_2's (see objective 1 in the proposal). We want reviewers to be aware that the timeframe for evaluating F_2's is quite long. We planned initial treatment application for five years 2004-2008. The F_1 adult offspring will return from the original parents from 2008-2013. The F_2 adult offspring from the F_1 adult spawners will return to spawn from 2010-2018. Thus, the F_3 adult offspring from the F_2 adult spawners will return to spawn from 2014-2023.

ISRP Comment:
The sponsors indicate they will estimate the heritability of life-history characters. This will be less informative than establishing phenotypic and genetic correlations between "traits" and "fitness."

Response:
We agree. We will record the length, weight, date of return, and age (obtained from scales) of all fish released above the weirs to spawn. In addition, we plan to take a digital photograph of each adult passed upstream, and this will allow us to obtain morphometric measurements of all potential spawners via multivariate analyses of the digitized images. We will then examine the distribution of those same traits in the fish that successfully spawned to measure the selection gradients on these characters (Morgan and Conner 2001). We will also estimate the number of outmigrating smolts and determine the number of returning adult progeny produced by each adult fish passed upstream. We can then easily calculate correlation coefficients between measurements on adult spawners passed upstream and (a) the estimated number of smolts and (b) the number of returning adult progeny produced by each of those adult parents.

ISRP Comment:
The primary weakness of this study is unknown implementation conditions in the two creeks. The applicants should first document the incidence of straying in each stream and the degree of genetic difference between naturally spawning adults and hatchery strays.

Response:
We agree that estimates of the abundance and proportion of strays as well as a comparison of genetic characteristics would be valuable. We believe this information could be gathered during the first two years of the study without delaying implementation of the treatment. The project is designed to genetically characterize every adult that returns and is released upstream to spawn. In addition, we will sample all hatchery adults that are trapped and removed in the treatment stream. We will determine the level of genetic divergence between natural-origin adults and hatchery-origin strays captured at the Bakeoven and Buck Hollow weirs. This task will be accomplished by examining the fish at the same sixteen microsatellite loci Paul Moran (NOAA-Fisheries, Northwest Fisheries Science Center) used to characterize the genetic population structure of the steelhead throughout the Grande Ronde River basin and adjacent watersheds in the Snake and mid-Columbia rivers (Moran 2003). This approach will allow us to compare levels of genetic divergence between natural-origin adults and hatchery strays captured at the Bakeoven and Buck Hollow weirs with levels of genetic divergence Moran (2003) found among 100 population samples representing over 5,000 wild and hatchery adults and juveniles.

ISRP Comment:
If genetic introgression has been extensive the genetic makeup of "hatchery" strays and "wild" spawners may be similar reducing the ability of the researchers to detect genetic differences between progeny of strays and "wild" fish.

Response:
To some extent, this concern has some merit. However, the molecular genetic analyses described in the preceding paragraph will allow us to test the null hypothesis that hatchery strays and natural origin adults represent random samples from a single gene pool. Significant allele frequency differences between the two groups, that were temporally consistent between years, would reject the null hypothesis of a single gene pool and, thus, reduce substantially the reviewers' concerns. On the other hand, studies of steelhead populations in other Columbia River tributaries (e.g. Kalama River, Hood River) have clearly shown that stocked, out-of-basin hatchery-origin steelhead have a reproductive success substantially lower than natural-origin adults despite decades of direct hatchery releases. The absence of such differences in the Deschutes River, despite the large number of hatchery strays, would warrant more detailed studies to evaluate the extent to which the fitness of steelhead populations in the Deschutes River may be compromised genetically by the large number of strays and their natural reproductive success.

We believe answering this question is one of the principal objectives of the study (i.e., Do the hatchery strays reproduce with the natural-origin steelhead in the wild?). For example, the two extremes of what we could find in these creeks are described below.

Case One: The level of introgression between the wild populations and the hatchery strays has been great in the past so the two groups look essentially the same at neutral genetic makers.

Case Two: There has been little or no introgression between the wild populations and the hatchery strays.

Using parentage analysis we will be able to address the following questions in each of the two cases. If case one is true we will determine the relative fitness of wild fish (one or more generations removed from the hatchery) vs. the hatchery strays. Because our experimental design has hatchery strays released above the weir in one creek and no strays released above in the other we can see the impacts of continued hatchery stray introgression on the fitness of the wild population vs. the naturalization of the wild population in the stream in which hatchery strays are not allowed to spawn. If case two is true we would conclude the hatchery strays are ineffective at mating in the wild, with natural-origin fish, or produce offspring that have greatly reduced fitness.

ISRP Comment:
It is not clear whether the abundance of juveniles will be sufficient to sample contributions from the spawning adults.

Response:
Based on redd counts from recent years and the expected number of juveniles produced per redd, we are confident that enough juveniles will be produced to allow for an adequate sample with acceptable impact to the population. In recent years (1998-2002) redd counts have ranged from 68-480 in Bakeoven Creek and 82-445 in Buck Hollow Creek. This level of spawning escapement will produce an adequate number of juveniles to meet sample needs.

ISRP Comment:
The proposal does not carefully describe how the principle investigator would evaluate differences in the reproductive success if they find large effects of resident fish (no testable hypotheses) but other proposals did not do that, either.

Response:
Some of the full-sized anadromous steelhead trout released above the weir may spawn with nonanadromous fish or sexually mature parr. This result would not be unexpected based on parentage analysis in Atlantic salmon populations (e.g., Garcia-Vazquez et al 2001) and other preliminary findings in steelhead trout populations (Ardren 2003; Paul Moran, NOAA-Fisheries, Northwest Fisheries Science Center, Personal Communication). Indeed, phenotypic plasticity resulting in sexual maturation prior to smoltification for some proportion of juveniles (primarily males) may be a key, natural

life history trait of "steelhead", particularly those native to the inland Columbia River basin, that distinguishes them biologically from Pacific salmon. Moreover, one would predict that phenotypic plasticity for this alternative life history strategy may be positively correlated with upstream migration distance for anadromous adults. These are major scientific unknowns for all steelhead populations regardless of geographic location. Using parentage analysis derived from multi-locus DNA genotypes, we will be able to ascertain if each full-sized anadromous steelhead trout released above the weir was the parent of a sampled progeny even if the other parent was not sampled. The parentage analysis results for each anadromous steelhead trout released above the weir will allow us to directly compare the fitness of the natural-origin and hatchery stray full-sized anadromous steelhead trout released above the weir.

As indicated in our proposal, if we are unable to assign a mother, father, or both parents (using the full-sized anadromous steelhead trout released above the weir as the potential parent pool) we will conclude these progeny were parented by resident trout or sexually mature parr. If we find these non-anadromous fish are contributing a large proportion of the sampled progeny we will utilize a parentage method that has been developed to account for incomplete sampling of the parents (Neff et al. 2000).

ISRP Comment:
"It seems that the study plan should also somehow incorporate the local Round Butte or Warm Springs hatchery fish."

Response:
We agree that the study could be enhanced if the local Round Butte hatchery fish (there are no Warm Springs hatchery steelhead) could be used. However, at this time the co-managers have no plans to conduct intentional supplementation with Deschutes Hatchery fish; therefore, we cannot include outplanting of Round Butte fish in our study.

References

Ardren WR. 2003. Genetic Analyses of Steelhead in the Hood River, Oregon: Statistical Analyses of Natural Reproductive Success of Hatchery and Natural-Origin Adults Passed Upstream of Powerdale Dam. Report to Bonneville Power Administration In Partial Fulfillment of BPA Contract No. 00013429

Garcia-Vazquez E, Moran P, Martinez JL, Perez J, de Gaudemar B, Beall E. 2001. Alternative mating strategies in Atlantic salmon and brown trout. *J. Hered.* 92:146-149.

Moran P. Magnitude of spatial genetic structuring among populations of *O. mykiss* throughout the Grande Ronde River basin and adjacent watersheds in the Snake and mid-Columbia rivers. Draft report to U.S. Fish and Wildlife Service.

Morgan MT, Conner JK. 2001. Using genetic markers to directly estimate male selection gradients. *Evolution.* 55: 272-281.

Neff BD, Repka J, Gross MR. 2000. Parentage analysis with incomplete sampling of parents and offspring. *Mol. Ecol.* 9: 515-528.

Responses to H/H Subgroup Comments

HHS Comment:
"A comparison of the reproductive effectiveness of stray hatchery fish with wild fish was not the intent of the Action 182 needs statement in the RFS."

Response:
We are somewhat puzzled by this comment because the language in Section 2.2, Requirements Specific to Action 182, are contrary to the H/H Subgroup comment. We believe the requirements indicate that the intent of Action 182 includes the need to study both intentional supplementation as well as unintentional supplementation that results from straying. Our conclusion is supported by the following statements taken directly from Section 2.2:

> "Research proposals are sought…..to conduct scientifically sound studies that focus on the biological question(s) to determine relative reproductive success of natural-origin and wild-spawning hatchery-origin anadromous salmonids in the Columbia Basin."
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> "Determining the reproductive success of natural-origin and hatchery-origin fish addresses critical uncertainties regarding population status assessment and recovery planning."
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> "Anadromous salmonids in the Columbia River Basin are artificially propagated at an extremely large scale to mitigate for development, support fisheries, and/or contribute to recovery. One result of these programs, intentional in some cases and inadvertent in others, is that many populations in the Basin are comprised of both natural-origin and hatchery-origin spawners."
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> "Studies must be designed to provide data that will improve parameter estimation for hatchery-origin spawning effectiveness in models currently used by NOAA Fisheries during extinction risk assessment."

There appears to be some confusion between the needs and requirements of Action 182 and Action 184, as was pointed out in the ISRP comments. It is unclear why the RME group would give priority to state-of-the-art hatchery programs if one of the key objectives is to determine how to factor hatchery fish spawning in nature into the calculation of lambda as is specified in Action 182. As stated by the ISRP, this project would "evaluate hatchery-origin adult strays from variable unknown sources that create the dilemma for ESA calculations of lambda." Most all of the hatchery steelhead produced in the Columbia Basin are from non-local origin stocks from traditional-type hatchery programs. One of the most important management issues for steelhead in the basin is the impact of stray hatchery fish on the productivity of natural populations. We are convinced this project would contribute significantly to Action 182 and Action 184.

HHS Comment:
"The focus of this study on stray hatchery fish would severely limit the applicability to other ESU's."

Response:
It is unclear to us what this comment is based on. The applicability to other ESU's is based entirely on whether stray hatchery fish are present in populations in other ESU's and what the origin of the strays are. In the Columbia Basin most hatchery stocks were not derived from local-origin fish. For example, in the Snake Basin there are only two steelhead hatchery stocks that were derived from local origin—the Clearwater and the Imnaha. A majority of the production comes from non-local stocks such as Idaho's Snake River stock used throughout the Salmon River Basin and Wallowa stock used throughout the Grande Ronde River Basin. It is likely that a majority of the hatchery fish spawning in nature in all ESU's are from non-local-origin stocks produced from traditional-type hatcheries. The H/H Subgroup provided no data or evidence to indicate that other ESU's do not have stray hatchery fish spawning naturally. It is our belief that the Snake and upper Columbia steelhead ESU's do have stray hatchery fish spawning naturally and that the results of this study would have broad application to all Columbia Basin steelhead ESU's.