Independent Scientific Review Panel
for the Northwest Power & Conservation Council
851 SW 6th Avenue, Suite 1100
Portland, Oregon 97204
www.nwcouncil.org/fw/isrp

Memorandum (ISRP 2010-36) **November 12, 2010**

To: Bruce Measure, Chair, Northwest Power and Conservation Council

From: Eric Loudenslager, ISRP Chair

Subject: Second Follow-up Review of CRITFC Fish Accord Proposal, Influence of Environment and Landscape on Salmonid Genetics, 2009-005-00

Background

This is the second follow-up review to an earlier ISRP and Council review of the Columbia River Inter-Tribal Fish Commission's Accord Proposal: Influence of Environment and Landscape on Salmonid Genetics, 2009-005-00. The information gained from this proposal is intended to facilitate understanding of adaptation of natural salmonid populations to their environment. CRITFC believes this information should benefit future management of natural, supplemented, and reintroduced populations.

Overall, this is the ISRP's fourth review related to this project. The ISRP's earlier reviews are described in the ISRP's latest review, which is attached below (ISRP 2010-21; June 18, 2010). In that review we stated, "This revised proposal is an improvement on the original but still does not have the level of detail essential for technical review (see comments below). Additionally, the revision did not provide a point-by-point response to the individual issues raised by the ISRP in the February 19, 2009 review. If a subsequent proposal is developed, in addition to a revised narrative, the ISRP requests that the proponents provide a document that succinctly responds to the individual points raised by the ISRP."

In addition, at the request of the Bonneville Power Administration, the ISRP participated in a teleconference with Shawn Narum, the project's principal investigator, on September 7, 2010.

Recommendation

Meets Scientific Review Criteria (Qualified)

The first qualification on this proposal is a caveat to Council, BPA and CRITFC that while it is likely possible to identify some of the genes that are important for adaptation of salmon and steelhead to the Columbia River environment, deliberately manipulating breeding populations to improve fitness as recovery actions proceed does not have established implementation protocols. The proposed work is justified as research, but the ISRP is unconvinced that it is currently useful for management application.

The second qualification is for the project proponents to consider the suggestions the ISRP offers below. The proponents can address these as appropriate in future reviews. The ISRP is not anticipating a response to address the comments and suggestions at this time.

Comments

The CRITFC response to the ISRP's June 18, 2010 referred to a substantial list of publications and annual reports, instead of providing detailed answers to most of the detailed ISRP questions. The ISRP expects that proposals and responses to the ISRP will include the relevant content of publications and annual reports. In particular, the performance trials in the lab/hatchery to validate putative adaptive genes were inadequately described. Plans for those trials should be developed in detail in future proposals.

Some of the confusion about how the 100 SNP markers of interest were chosen has been cleared up. The SNPs are associated with expressed sequence tags (genes that are being expressed) some of which are *a priori* candidate genes with known functions. The ISRP was referred to previous documents and publications for details, and while it is good to know that all of this information exists elsewhere in the public record, the response to our questions remained casual in describing the clues that suggest adaptive relevance for these candidate genetic loci. The fact that these genes are chosen from an EST battery (genes that are being actively expressed) is encouraging, but the distinction between expression *per se* and a presumption of adaptive relevance for the developmental traits of interest, in response to thermal regime or some other environmental variation within (and among) populations, is elaborated neither in the proposal itself nor in response to ISRP probing.

The decision to work on steelhead for two more years and then expand into Chinook is unrealistic in the view of the ISRP. Continuation of steelhead biogeographic surveys might be completed in this time period. The real question, however, is whether this biogeographic sampling of ESUs for both taxa is going to yield the information that is needed. One could make a case for concentrating on the rapidly-advancing steelhead initiative for the next five years, while developing a corresponding SNP panel for Chinook. During this time period the understanding of the "relevant loci" will continue to evolve with experience, as will understanding of the relevant environmental variables. Delaying a shift in focus on Chinook would profit from that, as there is plenty of work still to be done on steelhead.

The question of which populations to choose and which environmental features to examine is not self evident. Regarding the sampling of populations, the proposal is a standard survey of the patterns of natural variation. There is nothing wrong with that; at some point, it has to be done. However, the ISRP believes that genetic correlations with a collection of environmental variables, only crudely characterized over large stretches of geographic space although often conveniently available as GIS database layers, yield associations of a set of genetic markers with environmental conditions that may or may not identify the relevant genes that respond to natural selection based on ecological variables of real interest, but as yet, still not indentified with any confidence.

As long as the DNA samples are archived by location, one can go back later and examine other loci that turn out (*post hoc*) to be more relevant than the starting panel of 100, presumably working off environmental maps that have also improved in the interim. The important thing is that broad surveys can either suggest interesting loci and environmental features, to inform the experimental work, or they can yield field confirmation for particular loci yielding experimental evidence of the adaptive relevance of specific gene configurations. If elucidation is the key, however, it has to be viewed as ancillary to the major effort, which needs to be identification of the physiological and developmental relevance of candidate genes for environmentally sensitive adaptation.

Laboratory experiments are invoked (but still not described in detail), to validate whether particular candidate genes are performance-relevant. The question of what is going to be done experimentally has not been answered in the current proposal. The proponent argues that the polymorphic alleles of any particular SNP are included in the test, but if there are 100 loci of interest, all segregating simultaneously within experimental stocks, how is one to sort out which markers are responsible for any particular experimental response that is observable? Statistical evaluation is appropriate, but if a typical SNP is providing a binary polymorphism, that means there are 3^{100} genotypes to evaluate, and even the most internally diverse collection of genotyped stocks cannot be expected to produce that many genetic outcomes. Even if one assumes that each candidate gene is adaptively independent of all the others, and that is hardly realistic, one can only examine a few markers in any one experiment. It is important to remember that adaptive testing will require in excess of 100 (perhaps 200) individuals of each of the tested genotypes. Meaningful adaptive evaluation, using whatever design, will require thousands of fry and smolts. Since the species of interest are steelhead and Chinook, experiments of that size are certainly manageable in the hatchery, but the effort required will not be trivial. Experimental reality will probably dictate a modest number of comparisons for each experiment, and genetic breeding considerations will translate into large amounts of genetic non-independence among the outcomes available for even a modest number of well-studied loci. The experimental design has to be extremely clever to accomplish the task.

In summary, the benefits from elucidation of the adaptively relevant genetic structure of both natural and hatchery stocks of both species should be substantial. The proponent is likely correct assuming that we have about accomplished what we can for these species with the assessment of neutral genetic variation. It is appropriate to begin investigation of the genetic loci that actually matter for adaptation of the fish in the field. That improved understanding will help us preserve and recover these species, but how that is to play out is going to depend on what is discovered. It seems obvious that the critical genetic loci will vary among species, among ESUs within species, among populations within ESUs, certainly among our hatchery stocks, and probably among individuals within single populations. While we are still learning how to pose and answer the appropriate questions, the problem that motivates this proposal is clearly important. It is equally clear that the challenge, even with the modern molecular, statistical and GIS technology at our disposal, remains large. We will have to triangulate the answers from the field, lab, and experimental work to obtain managerially powerful guidance. It won't come all at once, and the way forward is still a little murky. The ability to plan a 10-year trajectory is still tenuous, but the proponent needs to lay out plans to execute the separate phases, at least.

c:\users\schrepel\downloads\isrp 2010-36 critfc accord landscape genetics 2009-005-00 12nov10.docx (Eric Schrepel)