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# Review of

# Captive Propagation Program Elements

## Programmatic Issue 12 for the Mountain Snake and Blue Mountain Provinces

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# Review of Captive Propagation Program Elements

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## Introduction

At the request of the Northwest Power and Conservation Council, the ISRP provides this review of the report *Review of Blue Mountain and Mountain Snake Province Captive Propagation Programs: Response to the Northwest Power and Conservation Council* (Kline et al. 2003), which was produced by the project sponsors for the Columbia River Basin's Fish and Wildlife Program's primary three captive propagation initiatives:

- Redfish Lake Sockeye Salmon Captive Broodstock Program;
- Captive Rearing Program for Salmon River Spring Chinook Salmon; and
- Grande Ronde Basin Spring Chinook Salmon Captive Broodstock Program.

The project sponsors' report was generated in response to conditions placed on the initiatives by the Council in April 2002 as part of the funding recommendations for the Blue Mountain and Mountain Snake Provinces. These conditions responded to review questions raised by the ISRP (ISRP 2001-12A). In 2003, the Council formally asked the captive propagation program sponsors to address the conditions by clarifying the intent, magnitude, and duration of their projects. The sponsors were specifically asked to address: 1) the issues and concerns raised by the ISRP in its review of the NEOH program during the Blue Mountain Provincial reviews (ISRP 2001-12A); 2) elements of the Interim Standards for the Use of *Captive Propagation Technology in Recovery of Anadromous Salmonids Listed under the Endangered Species Act* (NMFS 1999); and 3) consistency with Artificial Production Review policies and standards (NPPC 1999).

The sponsors responded to the Council in early 2004. The Council subsequently requested that the ISRP review the submitted materials to determine whether the responses adequately addressed the conditions (January 30, 2004 Memo from Mark Fritsch to ISRP). This review begins with a background section on captive propagation in general and as applied in the Columbia River Basin, follows with summary review comments on the programs, and ends with specific review comments describing how well each of the three programs addressed the Council's questions/conditions.

## Background on Captive Propagation Programs

Captive propagation is one of a number of emergency strategies that attempt to avoid extinction of an endangered species in the *final stages* of demographic collapse. In fact, this approach is often referred to as a "life raft" approach – that is, keeping a population temporarily alive while its very life support system (e.g., crucial or limited habitat) and reasons for decline are addressed. Population management under these circumstances involves developing schemes to: collect all or a portion of the extant wild population; propagate them in zoos, botanical parks, or aquaria; identify the reasons for the failure of the species to sustain itself in nature; ameliorate these limiting constraints; and finally, reintroduce individuals produced in captivity to their natural habitat. The World Conservation Union (IUCN) has a Conservation Breeding Specialist Group that tracks captive rearing programs for plants and animals worldwide (www.cbsg.org).

Captive propagation has only occasionally been successful. Very few species are "self-sustaining" in captivity, and incorporation of wild individuals and genes are usually needed to avoid negative inbreeding and fitness effects (Ebenhard 1995). Accounts from zoos demonstrate that most species brought into captivity have been very difficult to breed. Warm water chubs, pikeminnow, pupfish, and suckers are captively reared at Dexter National Fish Hatchery in New Mexico (Johnson and Jensen 1991) and darters, barrens topminnow, and madtoms are captively reared and bred by a private company, Conservation Fisheries Incorporated, in the southeast. As a conservation strategy, captive propagation requires successful reintroduction to the wild and subsequent reproduction.

The literature provides examples of mammalian and avian species that have been reintroduced into their natural habitat after at least one generation of captive propagation. In the case of Pere David's deer, Arabian Oryx, Guam kingfisher, Guam rail, and the California condor, the species were extinct in the wild at the time of reintroduction. Peregrine falcon, the bald eagle, the gray wolf, and the alpine ibex have been successfully reintroduced into portions of their range from which they had been lost. Even the success needs to be kept in perspective. Since captive propagation began in the early 1980s, the California condor population has grown to 89 repatriated and 126 captive birds. Six chicks have been produced in the wild, four of those died, one has been taken into captivity with a broken wing, and one fledged in the fall of 2004.

Examples of successful reintroduction and reproduction of fish species using captively propagated (rather than translocations of wild caught individuals) are insufficiently documented to establish generalizations (Maitland 1995, Minckley 1995, Philippart 1995). For example, the short-lived gila topminnow, established populations in approximately 25 % of the locations where it was stocked (Hendrickson and Brooks 1991). More than 12 million razor back suckers, a long-lived species, were reintroduced into the Verde, Gila, and Salt rivers in Arizona; however, only 118 individuals were recaptured, and evidence of establishing a population is lacking (Minckley et al. 1991).

Using the experience of captive propagation efforts in mammals and birds may not be entirely informative to captive propagation efforts with anadromous salmon. In many mammals and birds, the main obstacle has been nutritional and behavioral mysteries of how to get the captive species to breed in captivity. Those problems apply to salmon, but are manageable. The overwhelming problem for salmon is that the factors that led to the decline and the need for captive propagation, e.g., over-fishing, habitat degradation, and downstream hydrosystem mortalities on migrating juveniles and adults, have not been adequately resolved so that propagated salmon and steelhead released into the wild are capable of supporting positive population growth. Additionally, this problem has probably been exacerbated by the inevitable domestication that takes place during captive breeding.

Captive propagation and reintroduction experience with mammals, birds, other fish species, suggests that use of this technology to maintain and recover anadromous salmon is likely to encounter unforeseen challenges, be expensive over the long term relative to other approaches, have an uncertain outcome, and be a viable option for only a very limited number of populations (Ebenhard 1995). Even though there is a record of more than a century of full life cycle culture of non-anadromous trout and salmon, and partial life-cycle culture of anadromous species to draw upon, the complex (migratory, freshwater/saltwater) life history of anadromous species presents profound biological uncertainties, unpredictable responses, and numerous practical difficulties. Captive breeding for recovery involves three major challenges: the selection of parents and successful culture, successful reintroduction (which is much more difficult than developing culture techniques), and adequate survival of the second-generation progeny.

## Columbia River Basin Captive Propagation Programs

Since the early 1990s several "captive broodstock" programs have emerged for Pacific salmon populations in the Columbia River Basin, and elsewhere in western North America. Outside of the Columbia River Basin captive broodstock programs have been established for Sacramento winter-run chinook salmon, White River (coastal Washington) spring-run chinook salmon, Dungeness River spring-run chinook salmon and Hood Canal coho salmon (Flagg et al. 1995; Flagg and Mahnken 2000). Within the Columbia River Basin captive broodstock programs are established for Redfish Lake sockeye salmon, and Salmon River (IDFG), Grande Ronde River (ODFW), Tucannon River spring-run chinook salmon in the Snake River and the Wenatchee River (White River) spring-run chinook salmon in the Columbia Cascade province. The Redfish Lake sockeye captive broodstock program was initiated in the early 1990s when less than ten adult sockeye were returning to the Stanley basin annually. The remaining Snake River spring-run chinook salmon captive broodstock programs are operated in parallel with supplementation programs and were initiated because of the failure of existing supplementation programs to compensate for the rapid decline in salmon abundance.

In general, positive outcomes from the BPA-funded captive broodstock/rearing programs in the Columbia River Basin have been constrained by technological and biological limitations. Nevertheless, the programs have had notable successes that include collecting fry and eggs and rearing these life-stages to adult hood, release of juveniles and their return as adults, and release of adults with some evidence of their subsequent reproduction in the wild. Fish culturists and managers involved in these projects are understandably encouraged by these results. The technological and biological limitations have included smaller adult size and lower egg viability, asynchronous maturation of sexes, delayed age of maturation, water supply disruptions, diseases in wild caught juveniles, and destruction of several thousand smolts because of a viral infection.

From a fish culture perspective the successes are gratifying, and the limitations are challenges to further develop technological capabilities. As a management tool to delay extinction of lineages that cannot be replaced by migration or transplanting from other extant populations, the strategy has merit. Clearly in the case of Redfish Lake sockeye or Sacramento River winter-run chinook the lack of other options makes captive rearing a reasonable solution; however, depending on captive rearing as a primary recovery tool would be premature. The longest running captive broodstock program has returned 7, 257, 26, 22, 11, and 113 adult sockeye salmon to Lower Granite Dam or to Idaho's Stanley basin in 1999 - 2004, respectively. This level of abundance is barely enough to assert that the ESU is not quasi extinct - even as a partially captive population. Egg-to-smolt and smolt-to-adult survivals are insufficient to rebuild populations above adult-to-adult replacement. The constraints causing these low survivals must be corrected for recovery to occur.

## General Comments on Captive Propagation Review

The following comments summarize the ISRP's general concerns about the captive propagation programs. The ISRP has repeatedly asked these programs for a real decision tree that reflects the current state of the scientific understanding of the salient risks and incorporates pertinent data from the programs. This is a natural thing to ask from very expensive programs that understandably lack a track record of success, and for which there are theoretical evolutionary reasons for the success rate to be low. A "decision tree" should not only describe the biological and environmental considerations that led to a decision to bring a population into captive propagation, but also describe the biological and environmental factors that will lead to decisions to continue or discontinue the program. Are there "trigger points" or metrics that drive decisions about implementation of the program? We elaborate below on elements that could contribute to a more meaningful decision tree.

***1. A captive propagation framework***

The captive propagation guidelines and the paper published by Pollard and Flagg (2004) generally do not provide sufficient guidance for deciding whether captive propagation should be used. Rather, they focus on reducing various risks during the operation of these programs – not on a pre-operational decision model. The major elements of an appropriate framework are in the Blue Mountain captive propagation document, but need additional refinement and clear instruction (i.e., a formal decision tree or model). Similarly, while project sponsors provide text answers to the Council's APR principles (NPPC 1999), their responses are often not precisely relevant. The project sponsors addressed all the suggested reforms in the Scientific Review Team report (Brannon et al. 1999) – a cumbersome exercise that may have provided little real value. A number of the methods suggested by Pearsons and Hopley (1999) and Ham and Pearsons (2001) could be used to formalize a reasonable and transparent pre-operational logic path and decision process.

Data used in Hatchery Genetic Management Plans (HGMPs) as well as other sources should be used explicitly in these planning documents. The sponsors must summarize data and the history of the decision process (i.e., how they followed a logic path). The questions and format should be crafted so project sponsors proceed through a formal decision pathway, rather than advocate for a specific project.

***2. Adaptive management made explicit***

An explicit adaptive plan for any captive propagation program undertaken within the Basin is required. Individual adaptive management plans must be formulated in the context of larger regional plans and ultimately of an integrated basinwide plan. For example, spring/summer chinook captive rearing efforts in Oregon and Idaho appear to have been divided to release juveniles (Oregon) or adults (Idaho) as tests of the efficacy of these approaches. Yet in the most recent version of the document, the two efforts remain disconnected. In fact, the Idaho model appears committed merely to refine the culture techniques aimed at releasing adults until it works, without adequate consideration of any alternative approach. At what point do the two approaches get contrasted and an integrated Basin decision get made on which approach(s) to pursue? Moreover, any proposed actions that are expected to have profound (temporally and spatially expansive) effects on the species and ecosystem in question need to be approached as a management experiment – that is, designed as a specific hypothesis to be tested with a robust monitoring program.

### *3. Risk management*

Each project should include an explicit strategy to manage ecological, health, and genetic risks. This would not be an evaluation of the risks posed by captive rearing to the viability of salmon in the ecosystem – such an evaluation necessarily precedes the instigation of any program – rather, it would be a management plan to ameliorate risks associated with all the culture/husbandry activities that are directed at the captive population itself. Specific topics in the plan would include "disease prevention/monitoring," "physical facility maintenance," "genetic breeding plan," etc.

### *4. Defining goals and success*

Any conservation strategy benefits from clear articulation of goals, objectives, and measures of success and from adjustment of the activity in response to those measures. As such, a primary difference between an emergency use of captive propagation to maintain a depleted species to avoid acute risks to extinction and its use to rehabilitate natural populations needs a clearer delineation. The sponsors' assertion of the success of these projects is mostly based on numbers of eggs, fry, and adults produced in captivity – rather than on the performance of these fish once released (e.g., population fitness, persistence, and even growth). Successful artificial culture of captive fish is an insufficient measure of success of the program. For each program, the overarching goal is to recover (and de-list) the ESU in question; thus, objectives to reach this goal along with appropriate measures of success are required.

### *5. Defining recovery and project termination*

Descriptions of these projects each stated a general expectation that they may not be terminated until the species (ESU) is de-listed. This expectation is paradoxical in that recovery cannot be truly recognized while the population is dependent on captive propagation. Moreover, the stated objective for the Redfish Lake sockeye delisting requires a Redfish Lake population of 1000 sockeye adults and 500 adults in other Stanley Basin lakes. By the criteria provided in the sponsor's response, captive propagation would continue until these objectives were achieved. Yet, it remains unclear why this program should continue after the population is growing and is large enough to be relieved of stochastic *demographic* risks of extinction within some timeframe - e.g., 100 years. This raises the question of whether the captive propagation program would remain active, if a 10-year average return to Redfish Lake had risen to 500 naturally-produced fish?

### *6. Links to data or analyses*

Throughout the documents, sponsors provide statements on the "success" of the projects – especially that they have reduced extinction risk. Their statements are not transparently linked to any data or analysis. While we suspect that data will support a contention that certain kinds of risk may have been reduced (e.g., demographic), other kinds may, in fact, be greater.

***7. Adequacy of responses***
Within the response document (Kline et al. 2003), the Grande Ronde Spring Chinook review section provided a more robust approach, assessment, and monitoring than either the Salmon River Spring Chinook or Redfish Lake Sockeye Salmon review sections. The Salmon River and Redfish Lake sections failed to provide even the most basic trend data supporting the need for captive propagation, an explanation of why the treatment populations were chosen, or a definition of the performance metrics and success thresholds.

***8. Captive brood programs and ESUs***
Program managers within the Snake River spring/summer chinook ESU are obliged to rigorously determine the number of "strata" that should be supported by captive rearing. Captive propagation is underway in the Tucannon, Grande Ronde, and main Salmon River populations. Within each stratum, the number of locations has not been yet decided and the Basin is at risk that every stratum, and every population will be under captive rearing. This would be expensive and undermines future alternative conservation strategies.

## ISRP Summary Review Statements

### Redfish Lake Sockeye

The Snake River sockeye salmon captive rearing project has been notably successful in rearing salmon to adulthood in captivity. How many generations this can be maintained before deleterious inbreeding effects, responses to unintended domestication selection, or other catastrophic events reduce this portion of the program is unknown. For instance 43,000 smolts were destroyed in 2002 at Bonneville Hatchery because of infection with IHN virus. This project’s emphasis on reporting the numbers of eggs, juveniles, and adults released from the program as a measure of success and accountability continues a practice that the ISAB and ISRP have criticized in the past as inappropriate to measure program success. While these are important elements in monitoring performance within a captive propagation program, these often-reported numbers do not constitute measures of program success. Only 7, 257, 26, 22, 11, and 113 adults have passed Lower Granite Dam or returned to the Sawtooth Valley in 1999 - 2004, respectively. These censuses do not demonstrate a viable population, even supported by captive propagation. The program sponsors suggest downstream conditions are largely responsible for these small returns. As such, as a key component of a basin-wide or ecosystem-wide adaptive recovery strategy, this captive rearing project is not meeting its objectives and should not be recognized as adequately restoring the population or compensating for those downstream conditions. Whether the program is working as a “life raft” during an interim period while environmental conditions are being addressed is uncertain, given the very low return numbers and the number of successive generations of captive breeding.

### Salmon River Spring Chinook

Conducting an experiment to find out whether collecting juveniles, rearing them under hatchery culture, and then releasing them as adults to spawn naturally was more or less effective than rearing juveniles, spawning them in captivity, and releasing their progeny is a fundamental and critical step in an Adaptive Management approach. That experiment is being conducted by contrasting the Salmon River captive rearing strategy with the Grand Ronde captive rearing strategy. The narrative in this captive propagation summary is very optimistic in contrast to the reports that the project sponsors submitted during provincial reviews (Hassemer et al 2001, Venditti et al. 2002). These reports state:

> "Based on behavioral observations, inspection of carcasses, and excavation of redds to search for viable eggs, several limitations associated with the reintroduced captive-reared Chinook salmon have been identified. These include:
> 1. Limited availability of age 4 and 5 captive-reared males,
> 2. Asynchronous spawn timing for captive-reared and wild/natural Chinook salmon, and incomplete or arrested maturation and ovulation in captive-reared females.
> 3. Questionable gamete quality
> 4. Insufficient physical ability of captive-reared adults to negotiate natural stream conditions, construct successful redds, and compete with other species for spawning privileges."

The implications of these ecological and behavioral performance dysfunctions for the likely success of this captive propagation strategy are quite significant, and seem largely absent from this review. They are also at odds with the optimistic narrative of the captive propagation summary in the response document.

## Grande Ronde Spring Chinook

The Grande Ronde program review was articulated more clearly, better substantiated, and more transparent than the Redfish Lake sockeye and Salmon River Chinook program descriptions. The Grande Ronde experimental design has the potential to provide meaningful insight into whether or not captive propagation can provide anything more than hatchery-origin adults returning from the ocean. The ISRP recommends that the experimental design remain intact. This includes a critical inspection of all culture activities in the basin to ensure that conventional and supplementation actions are not compromising or confounding the experiment.

## Concluding Summary Review Statement

Captive propagation has some potential to keep a lineage from extinction as it becomes extirpated in the wild, although its capacity to serve as a suitable or functionally adequate surrogate for viable populations remains controversial. Based on the larger scientific literature and on experiences within the Basin thus far, the outlook for using this technology to achieve recovery of populations near extirpation or reintroduce extirpated lineages is not at all encouraging.

It is clear that project sponsors invested a significant amount of time preparing these responses, and they have been quite helpful and insightful. Nevertheless, the documents are replete with redundancies. Perhaps as an aid to efficiency, the region should seek a common HGMP or other vehicle to better serve ESA permitting and Council/BPA proposal needs.

## ISRP Response to Council Questions

While specific comments are provided on the attached template(s) – one for each of the three captive propagation programs – this section responds to the expanded review questions asked of the ISRP.

## Expanded Review Questions

**1) Does the document address the additional questions raised by the ISRP (ISRP 2001-12A) for each of the projects?**

The Project Leaders responded to the questions under each of the programs. In some instances, the responses provided additional clarity, but for others the responses were somewhat (and unnecessarily) defensive in tone. This is unfortunate because the document, while incomplete, goes a long way in addressing the Interim Standards approach. A naive first reading of the proposed program suggests that there is often no clear answer or uniformly accepted approach to captive propagation as an emergency response to at-risk populations. The Project Leaders indicate that many of the stressors to the populations of interest are either out-of-Basin (e.g., oceanic conditions), or downstream (passage issues at the mainstem dams, non-native species, or altered habitat). However, the location of these stressors (factors of decline) reinforces the need for a basin-wide evaluation of their effects on metapopulations, community structure, trends, and efficacy of possible solutions. Specific examples of these evaluations will be provided on the individual templates for each project.

**2) Does the document explain how each project used and addressed the *Interim Standards for the use of Captive Propagation Technology in Recovery of Anadromous Salmonids Listed under the Endangered Species Act* (NMFS 1999)?**

The document explains the use of the 1999 document as well as more developed versions of the Interim Standards by Pollard and Flagg (2004). An explicit articulation of decision points, trigger points, metrics, or factors that were to be considered for particular populations was absent from the response document. Also missing was a basic "decision tree" describing the specific biological and environmental variables that directed the sponsors to conclude that bringing a population into (or continuing v. discontinuing) captive propagation was among the best alternatives. Such a fully vetted graphic decision tree with identified decision points (and associated data metrics that informed decisions) would be valuable information for the sponsors, reviewers, and the public.

**3) Does the document articulate how each project is consistent with Council's Artificial Production Review report (Council doc. 99-15) policies and standards? Specifically:**

a. **The purpose and use of artificial production must be considered in the context of the ecological environment in which it will be used.**

This is the fulcrum on which all other descriptions and rationale are balanced. For example, the purpose and use of captive propagation for Redfish Lake Sockeye is justified as a "lifeboat" measure for an acutely endangered salmon ESU while downstream issues (factors of decline) are addressed. While the need for such an extreme emergency response is rather disturbing, the use of captive propagation as a transitional measure is permitted under the ESA if part of an approved recovery plan. However, let us be clear that in spite of some recent administrative and judicial decisions to the contrary, the weight of scientific evidence indicates that captively bred populations are not ecologically or functionally equivalent to populations bred continuously without interference from propagated fish. As far as the context of the ecological environment, the sponsors indicate that the measure is a temporary (transitional?) approach. While the sponsors are indefinite about how long the strategy will be employed, it should be possible to model and predict the ranges of parameters needed to reach adult recovery goals under various scenarios. Moreover, it would be helpful to those not familiar with downstream reparation efforts to have these described, along with some indication as to when dividends might reasonably be realized (2 years, 20, 200?). Moreover, "downstream conditions" is used as code for a suite of problems stemming from dams and impoundment, water withdrawal, watershed modifications, poor ocean conditions, etc. A direct or citable reference to the downstream reparation efforts (either underway or planned) would demonstrate this key linkage.

Some very rough forecasting using different scenarios of smolt to adult survival rates (SAR) indicates that even with a doubling or quadrupling of survival it would take well over ten generations to reach demographic goals for adult sockeye (1000/500/500 for each year in the three Sawtooth Mountain lakes). This assumes female fecundity ~2000 at age three, survival to smolt (50% - in captivity or locally wild), current SAR of 0.3%. If correct, this time requirement is inconsistent with the stated temporary nature of the program. To shorten this timeframe, SARs will need to increase by at least an order of magnitude. What will be required to achieve such survival rates?

**b. Artificial production must be implemented within an experimental, adaptive management design that includes an aggressive program to evaluate the risks and benefits and address scientific uncertainties.**

More important than merely acknowledging this consideration, is a detailed description of appropriate metrics. The sponsors appear to have a fairly comprehensive set of metrics that include demographic (e.g., numbers of returning adults, redd counts, age structure, sex ratio), genetic diversity (estimated from molecular markers), life history (e.g., age at maturity, proportion of jacks), and others (e.g., straying rates).

**c. Hatcheries must be operated in a manner that recognizes that they exist within ecological systems whose behavior is constrained by larger-scale basin, regional and global factors.**

This relationship appears clearly recognized by the sponsors, who must manage and conserve salmon biodiversity and resources upstream of many of the in-basin problem areas and oceanic regimes.

**d. A diversity of life history types and species needs to be maintained in order to sustain a system of populations in the face of environmental variation.**

The sponsors appear to clearly recognize the role of multiple species (sockeye, spring/summer Chinook) as well as multiple life history forms (migrants, residents, kokanee) and regional/temporal population uniqueness of the resources they are addressing. Aside from the evolutionary and ecological role of this multi-tiered biological diversity, the sponsors appear to appreciate the cultural roles and values of this diversity.

**e. Naturally selected populations should provide the model for successful artificially reared populations, in regard to population structure, mating protocol, behavior, growth, morphology, nutrient cycling, and other biological characteristics.**

The sponsors address the desire to mimic natural population (which by definition would experience the full constellation of appropriate natural selection pressures) as a means for recovering the metapopulations in question beyond mere persistence, but to ecologically viable and preferably sustainably exploitable conditions. Demonstrating viability will not be an easy exercise. It is premature to suggest that we understand the set of ecological variables most critical to mimicking natural selection pressures.

**f. The entities authorizing or managing an artificial production facility or program should explicitly identify whether the artificial propagation product is intended for the purpose of augmentation, mitigation, restoration, preservation, research, or some combination of those purposes for each population of fish addressed.**

The sponsors address the expected role for captive propagation in each case. For Redfish Lake Sockeye, sponsors identified preservation, restoration, and even research, while restoration is apparently more of a focus for the Chinook populations. The expected role is driven in large measure by ESA status. However, if and when successful in achieving stated goals, the sponsors do not address whether shifts in the role for captive propagation might be attempted or warranted. If such changes are undertaken, there will be a need for re-examining risks and benefits in such circumstances.

**g. Decisions on the use of the artificial production tool need to be made in the context of deciding on fish and wildlife goals, objectives, and strategies at the subbasin and province levels.**

See latter part of ISRP comment on “f” above.

Cited in the Preface (pg. 1) of the sponsors' review document is a reference to the Council's 1994 Fish and Wildlife Program, which apparently identified the need to develop captive broodstock as "the most cost effective means of accelerating recovery of severely depleted stocks." Ultimately, decisions to use or explore alternatives rest on the merits of the proposal, the conditions of the populations and associated supporting aquatic environments, and the various "values" imparted on the resource.

**h. Appropriate risk management needs to be maintained in using the tool of artificial propagation.**

Authors such as Currens and Busack (1995), Busack and Currens (1995), and Pearsons and Hopley (1999) clearly argue for the need for risk management approaches, especially in a genetics context. However, as Waples (1999) suggests, it is perhaps possible to minimize risks, but probably not possible to eliminate multiple risk classes simultaneously. As such, some serious examination and scientific discourse needs to be undertaken *a priori* to examine whether risk averse approaches are sufficient or whether alternatives might prove more beneficial.

**i. Production for harvest is a legitimate management objective of artificial production, but to minimize adverse impacts on natural populations associated with harvest management of artificially produced populations, harvest rates and practices must be dictated by the requirements to sustain naturally spawning populations.**

In each of the three Captive Propagation programs outlined by the sponsors, fishable condition is a desired, but distant goal. Metapopulation stability, then viability (as a recovery standard) must precede any decisions aimed at harvesting local or system-wide production surplus.

**j. Federal and other legal mandates and obligations for fish protection, mitigation, and enhancement must be fully addressed.**

The sponsored programs address ESA and other concerns and will need to be viewed within these contexts for the foreseeable future until recovery is judged. At such time, other mandates and obligations under co-managed authority will presumably be triggered.

## ISRP Review Comments on Specific Sponsor Responses to Past ISRP Reviews and NOAA Interim Standards

Template (ISRP responses or comments are in blue text and follow the title "ISRP Analysis:" or "ISRP Responds:" etc.)

### I. Redfish Lake Sockeye Salmon Captive Broodstock Program

#### *Question 1: Adequacy of Response to ISRP Issues from Provincial Review*

> **Project ID: 199107200, Redfish Lake Sockeye Salmon Captive Broodstock Program**, IDFG and IOSC
> **ISRP Final Review Comments:**
> Fundable, but low priority -- The project sponsors prepared detailed and responsive answers to reviewer questions and comments. The program benefits from the authors' participation in the program.
>
> The ISRP does not question the credentials of the technical oversight panel or of experts brought in to provide input on specific aspects of the program. The ISRP does, however, remain committed to a detailed and rigorous review of this large and expensive program by a team of outsiders directed to ***(Question 1)*** address the performance and continuing need for each element of the program.

ISRP Analysis: Program Sponsors challenged the assertion that it is their responsibility (or even their appropriate position) to initiate an independent outside review. The responsibility/ appropriateness issue, of course, depends on the role of such a review. If it is purely advisory, it is certainly within their right and purview. However, if such a review has attached a binding oversight or authority (because of use of federal funds or legal implications) then it is best to have some distance between those convening the review and those reviewed. At issue is the credibility of findings. In such cases, a higher-level coordinative entity could convene a review.

Regardless, we interpret the sponsors' response as tacit agreement *in principle* to participate in such a review. The structure and timing of the review as well as the composition of a review team may well be a collaborative decision process. A collaborative approach would help focus and identify specific questions. The recommendations regarding the conduct of Independent Scientific Review are offered by Meffe et al. (1998).

It appears that the Redfish Lake Sockeye Technical Oversight Team is composed largely of members of the sponsoring organizations. If true, then an independent assessment could identify weaknesses or inconsistencies in the plans or reaffirm for the Council and Bonneville that these projects warrant continued support.

**Project ID: 199107100, Snake River Sockeye Salmon Habitat and Limnological Research,** SBT

**ISRP Final Review Comments:**

Fundable in part at a reduced level to ***(Question 1)*** develop and implement an operational plan based on what they judge can be concluded from the results obtained to date. Further research is not likely to produce substantial additional information in the near future. Results are highly variable, some suggesting a benefit and others no-benefit. Stanley Lake is mentioned as a reference location, but the data for that lake are limited to limnological observations.

ISRP Analysis: Project sponsors note ***"****O. nerka foraging conditions in the Sawtooth Valley lakes are presently diminished by losses of marine derived nutrients and grazing pressure exerted by nonnative kokanee".* This should be a working hypothesis, not an assertion stated as fact unless there are appropriate data and analysis supporting this assertion.

Project sponsors also note ***"****In addition to monitoring limnological variables, O. nerka population abundance is monitored each year in the Sawtooth Valley lakes. These data are used to make decisions (at the SBSTOC level) regarding kokanee population control and to determine appropriate stocking rates for individual lakes (allocation between lakes). Kokanee control has been implemented in spawning tributaries at Redfish and Alturas lakes".* An example of how the limnological data varied across years, and resulted in different allocations of sockeye juveniles to the lakes would clarify for reviewers the use of the data. Also, evidence that kokanee population control and variable allocation produced improved growth or survival of repatriated sockeye juveniles would be appropriate and beneficial. There should be sockeye salmon population metrics (growth, survival) to evaluate the efficacy of the management action. In addition to earlier expressed concerns about high variation in response variables and the adequacy of Stanley Lake as a reference site, it would be valuable to have some commentary on the expected response on kokanee from nutrient enhancement.

If kokanee are a limiting factor, and they can't be completely controlled or eliminated, why do the sponsors believe that fertilization will enhance sockeye preferentially to kokanee? "Adaptive management" suggests an experimental approach in which strongly contrasting treatments (nutrification, kokanee control?) are applied (in different lakes/at different years/depending on rainfall?) and outcomes are observed (limnology, fish).

**Project 1993005600 –**

*Point #1: Adult releases.*

The ISRP and Council expressed concerns that the release of captive propagated adults is a risky strategy (ecological and genetic risks). The sponsors point out that decisions for this kind of approach are beyond their authority and that they propose to monitor outcomes of the action. The release of captively propagated adults apparently has been/will be undertaken by co-managers. If so, co-managers should be alerted to the risks and asked to provide full disclosure of the decision criteria for moving forward (this issue is addressed in the Interim Standards section).

The sponsors indicate that the releases will be undertaken on a "small (experimental) scale." This scale should be articulated specifically to permit examination of risks v. benefits.

*Point #2: Inbreeding study baseline reference.*
The sponsors clarify the intent of design and definition of baseline reference for inbreeding study.

## *Question 2: Adequacy of Meeting NOAA Fisheries Interim Standards*

2) Does the document explain how each project used and addressed the *Interim Standards for the use of Captive Propagation Technology in Recovery of Anadromous Salmonids Listed under the Endangered Species Act* (NMFS 1999)?

An important element of the sponsors' responses for this item will be an explicit articulation of decision points or factors that are considered for the particular population that the project is dealing with when proposing the use or continuation of a captive propagation technology. A "decision tree" should be described that explains what biological and environmental considerations led to a decision to bring a population into captive propagation, and what biological and/or environmental factors will be considered to drive decisions about continuing or discontinuing the program. Are there "trigger points" or metrics that are established that drive decisions about implementation of the program?

**ISRP Analysis:**
**Item 1. Decision Standards.**
***Technical Issue 1. Population status:***
An interesting historical perspective on the decline and listing of Redfish Lake sockeye salmon is provided. It would have been more useful to provide the weir or redd counts to demonstrate the decline in counts leading up to the decision in 1991. There is no doubt that the population status qualifies the population (and ESU) for captive propagation consideration.

***Technical Issue 2. Importance of the population:***
The text provided sufficient evidence that Redfish Lake sockeye salmon are genetically distinct from other anadromous sockeye in the Columbia River basin, and from resident kokanee in Redfish, and other Sawtooth Valley lakes. Moreover, the functional importance and unique value of this suite of sockeye populations is well described.

***Technical Issue 3. Guideline 1. Scale of the Project. Total captive production should be based on the number of fish needed to prevent extinction:***
The response does not address the issue. The text provides a brief summary of the physical facilities used in the project, the initial number of fish collected to populate the program, reproductive success with captively reared salmon, and anadromous returns from repatriated juveniles. The response seems to miss the point. What is asked is how large does the captive program need to be (numbers of adults maintained) to release sufficient juveniles to achieve the program's adult anadromous returns objective. This objective should be based on the size of the population needed to transition from using captive reared adults to provide juveniles to using anadromous adults to provide juvenile production (whether in the lakes or in a hatchery).

***Adequately represent genetic variation for life history traits of the wild population and minimize genetic change during captivity.***
The reply is adequate.

***Guideline 2. Duration should be as short as possible.***
Sponsors answer that program duration is indeterminate, and may continue until recovery is complete. The interim recovery goal is stated as an eight-year geometric mean of at least 1,000 natural spawners to Redfish Lake and 500 to each of two other lakes in the valley. No explanation of this rationale is provided. We would expect that the program could be proposed to transition to a "supplementation" type project once anadromous returns can sustain the hatchery propagation required to stock the lakes. This decision point should be identified.

***Technical Issue 4. Measures of success.***
The answer provided summarizes the results achieved to date for this program. This step in the guidelines for the use of captive broodstocks is to provide decision standards. What is needed here? Is it an identification of measures of success and the basis for believing the program can achieve minimal standards of "reducing extinction risk", "causing minimum genetic change", and "increase the number of individuals reproducing successfully in the wild"? We don't find fault with the sponsors here – it is not clear what NOAA wants from sponsors on this issue. In later steps they want goals stated.

**Item 2. ISRP Operational Standards.**

***Issue 1. Choice of Broodstock. Adequate presentation of the individuals collected. Inadequate detail on which individuals were spawned and contributed to the subsequent captive population.***

The numbers of captive reared and anadromous individuals that contributed to each generation needs to be provided somewhere in the documentation. The program has established the guideline that a significant proportion of these returning adults be incorporated into the broodstock to counteract the effect of any unintentional domestic selection that may be occurring. There are no plans to incorporate additional residual sockeye salmon or out-migrating smolts in the broodstock program. All other anadromous, returning adults are trapped, genetically identified to determine relatedness, and either incorporated in a spawning matrix to maintain genetic diversity or released to spawn volitionally.

***Issue 2. Captive Broodstock Spawning.***
***Guideline 1 and 2.***
The response is adequate. With respect to Guideline 1d, the sponsors correctly indicate that downstream conditions and activities greatly influence SAR. What conditions in the basin, estuary, and ocean need to occur to elevate SAR from 0.3% to excess of 1.8% (replacement)?

***Guideline 3a.***
There is no mention of incorporating anadromous individuals as spawning parents to advance the captive brood line (same comment as above) or of moving fish from salt to freshwater.

***3b. Cryopreserved sperm.***
A short description acknowledging the use of cryopreserved sperm is provided. What is needed, however, is an outline of the decision process leading to its use, particularly as the rate of fertilization is usually much less (<50%) in eggs fertilized with cryopreserved sperm than with live sperm. Consequently it is important to describe and justify the conditions under which cryopreserved sperm be used to fertilize eggs? A direct logic pathway/decision tree will help here.

***3c. Induced Spawning.***
Acknowledgements that GnRH analog implants are used with males and females to synchronize and induce ovulation and spermiation. How extensive is this practice? What are the consequences for reproductive success? How is the decision to use GnRH implants reached? A direct logic pathway/decision tree will help here.

***Issue 3.***
No comments or questions.

***Issue 4. Guideline 1a.***
Sponsors suggest here that, "*Program reintroductions have substantially reduced the risk of extinction*" (p. 30 and elsewhere throughout). While the ISRP agrees that short-term extinction risk to some subset of stochastic processes has been lessened, we are less convinced of this on a longer-term timescale. Some reference to the findings of a formal viability analysis (PVA) would provide some needed credibility and specific meaning to the term "substantially."

***Issue 4. Guideline 1c.***
While volitionally spawning captively reared adults *might* produce young with "increased fitness for the natural environment," they also *might not* depending on the levels of prior domestication effects on diversity, on various kinds of accumulated genetic loads, etc. While this assertion is presented in a matter-of-fact manner, the lack of a foundational basis and the absence of data (or even predictive models) to support this contention for releasing adults v. other life stages are troubling.

***Issue 5. Management of Returning Adults.***
Since the inception of this program in 1991, all wild anadromous sockeye salmon captured at Sawtooth Valley weirs have been incorporated into the hatchery breeding program. Ten, four, and six, unmarked adults returned to the Redfish Lake Creek weir or Sawtooth trap in 2000, 2001, and 2002 respectively. Were they incorporated into the captive broodstocks, or permitted to spawn naturally? Eleven sockeye passed Lower Granite Dam in 2003 and 113 in 2004. Is it known whether they were unmarked or juveniles released from the project? Did they migrate to the Sawtooth Valley, and how were they used in natural or captive rearing propagation?

**From Response Document:** "*The Shoshone-Bannock Tribes and the IDFG have conducted residual sockeye salmon spawning surveys since 1993. Numbers of residual sockeye salmon observed during these surveys have ranged from zero fish to more than 50 fish. Between 1999 and 2002, less than 10 residual sockeye salmon have been observed annually. While it remains possible that a small wild residual sockeye salmon component still exists in Redfish Lake, our* *ability to differentiate wild from hatchery-origin residuals has been lost. Residuals should be considered the same population as anadromous sockeye and components of the Snake River ESU, which has only one extant population. To be able to differentiate between residuals and anadromous sockeye would show an emphasis on the separation of these two subsets based solely upon a decrease in random mating, which naturally occurs as a result of life history variation. From a programmatic standpoint, residual gene pools have not been incorporated into the broodstock program for anadromous adults (they have not been crossed with anadromous returns). This strategy was deemed appropriate, since there is evidence the residual life history pattern may have a genetic component to it, and the emphasis on the program is to increase the number of returning anadromous adults*."

The rationale for the procedures outline above needs thorough review. On the one hand, there is the claim that residual sockeye and anadromous sockeye are components of the same populations and ESU. But, sponsors imply they may not interbreed. They go on to state that, "*residual gene pools have not been incorporated into the broodstock program for anadromous adults (they have not been crossed with anadromous returns.*" We need to know what they did with the adult residual sockeye they captured and spawned. Did any of them produce smolts that outmigrated? If they believe that there are residual and anadromous sockeye, and kokanee (resident sockeye), and that the former but not the latter are one population and ESU, how do they decide there are not one sockeye and two kokanee populations?

***Outline of captive Propagation Operation Plan.***
***Issue 5. Program Goals.***
There are two goals to a captive rearing (conservation breeding) program. The first is to preserve the germ plasm in hope of avoiding extinction. The species may be near extinction in the wild at the outset of such a project. Redfish Lake sockeye fit this criterion and could easily be described as extinct in the wild. The second objective is to provide individuals for reintroduction/repatriation. Achieving the first goal is likely a necessary but not sufficient condition for achieving the second goal. Each goal will have a different decision framework and performance metrics. The sponsors recognize the different goals, but they are intermingled in the narrative so that they inadequately convey the distinctions between them. The consequence is that the release of captively reared sockeye is taken as evidence of success by decision makers and the public.

No additional substantive comments on the remainder of NOAA Fisheries Interim Standards for Using Captive Rearing to Support Anadromous salmon recovery.

***Table 1. Issue 5. Guideline 4.***
"*Negative effects … not been observed to* date" (p. 33). Is this conclusion based on measurement or empirical analysis with indicator traits (susceptible to captivity effects such as inbreeding depression effects, domestication effects, other)?

***Table 2. Issue 6. Guideline 2c.***
The monitoring data presented/summarized (p. 43) don't really seem to address "*ability to successfully produce offspring in the wild.*" How accurate is a "*suspected*" redd in indicating success in wild production?

***Table 3. Issue 1. Description 6.***
While predicting the time required to reach demographic goals is difficult, some timeframe should be offered (e.g., six generations if SAR is increased 25 fold or 20 generations if SAR is increased seven+ fold, or whatever the range the models predict).

***Table 3. Issue 2. Ecological Interactions 2b & 3b.***
The interactions are discussed by illustrative examples and largely dismissed (p. 48-9). In most cases, some causative explanation would be appropriate as to why these interaction effects should be dismissed. For example, "*harvest is not expected to significantly impact …goals and objectives*." There is a reason for this expectation, but it is not obvious.

***Table 3. Issue 6. Operating protocols 1a.***
There are numerous references throughout that refer to "*adherence to conservation hatchery principles*." Some articulation of these specific principles would be in order as this is not a commonly known (or accepted) set of principles.

***Table 3. Issue 7. Release.***
Based on a review of the "*spread the risk*" philosophy, which of the numerous strategies is showing greatest success at achieving goals? This multiple treatment approach is well suited for empirical evaluation of treatment impact on recruitment as long as it is designed up front to do so. Retrospective assessment might be difficult if appropriate marking is not instituted.

## *Question 3: Consistency with APR Report Policies and Standards*

**1. The purpose and use of artificial production must be considered in the context of the ecological environment in which it will be used.**

ISRP Response: The sponsor response did not provide substantive comments on this standard.

**2. Artificial production must be implemented within an experimental, adaptive management design that includes an aggressive program to evaluate the risks and benefits and address scientific uncertainties.**

ISRP Response: The answer to this Council policy is inadequate. The NOAA Fisheries HGMPs have a section asking about experimental hypotheses that the programs recognize. They require a statement of the methods being used to address these uncertainties. There is a need to have an Adaptive Management Plan for each hatchery program. These could be housed within the HGMPs. They would describe the uncertainties they are addressing at hierarchical levels including, fish husbandry (the efficacy of using cryopreserved milt), the project (which reintroduction strategies work), and regional framework (does captive rearing extend the time line to extinction, do captive reared individuals support recovery of natural populations). The experimental designs for uncertainties at each level would be explicit, and a reasonable termination for the experiments could be planned.

**3. Hatcheries must be operated in a manner that recognizes that they exist within ecological systems whose behavior is constrained by larger-scale basin, regional and global factors.**

**From Response Document:** *"In addition, the Redfish Lake Sockeye Salmon Captive Broodstock Program is managed to generate its own broodstock annually and not to solely rely on anadromous, hatchery-produced adult returns to source spawning adults. While the return of anadromous, hatchery-produced, and natural-origin adults is desirable, the program is capable of maintaining a continuum of spawning adults without relying on the environment to produce anadromous returns."*

ISRP Response: This statement highlights a conundrum posed by these programs. Once they are established and can maintain a line of germ plasm (Goal 1), there is no urgency to succeed at providing support to reestablish a sustainable natural population (Goal 2). Who would be willing to advocate pulling the plug on a regional and national icon like the Redfish Lake sockeye?

**4. A diversity of life history types and species needs to be maintained in order to sustain a system of populations in the face of environmental variation.**

ISRP Response: The sponsor response did not provide substantive comments on this standard.

**5. Naturally selected populations should provide the model for successful artificially reared populations, in regard to population structure, mating protocol, behavior, growth, morphology, nutrient cycling, and other biological characteristics.**

ISRP Response: The sponsor response did not provide substantive comments on this standard.

**6. The entities authorizing or managing an artificial production facility or program should explicitly identify whether the artificial propagation product is intended for the purpose of augmentation, mitigation, restoration, preservation, research, or some combination of those purposes for each population of fish addressed.**

ISRP Response: The sponsor response did not provide substantive comments on this standard.

**7. Decisions on the use of the artificial production tool need to be made in the context of deciding on fish and wildlife goals, objectives, and strategies at the subbasin and province levels.**

ISRP Response: A discussion emphasizes that recovery of sockeye salmon is a subbasin, province, basin, state, federal, and tribal goal. That is understood. Clarification of how this goal may be compromised by other fish and wildlife goals, objectives, and strategies in the subbasin and province is needed. For example, is the use of transportation to provide mitigative support to chinook and steelhead smolts failing to meet the needs of sockeye? Do bypass, spill, and other hatchery programs conflict with sockeye recovery?

**8. Appropriate risk management needs to be maintained in using the tool of artificial propagation.**

ISRP Response: Along with the adaptive management plan recommended earlier, it would be worthwhile for each program to have a risk management plan. The plan would contain the standard operating protocols (SOPs) for each risk. Many of these are in fact already written. Executing them is part of the joint responsibilities of NOAA, the Tribes, the State, and the University. For example, the breeding plan is a risk management measure to avoid sibling matings and maintain the genetic variation of the founding individuals. Disease management, fish culture, and release procedures also exist. By placing these issues in a risk management context, the vague notion of risk in these captive propagation documents can be treated more seriously and rigorously.

**9. Production for harvest is a legitimate management objective of artificial production, but to minimize adverse impacts on natural populations associated with harvest management of artificially produced populations, harvest rates and practices must be dictated by the requirements to sustain naturally spawning populations.**

ISRP Response: The sponsor response did not provide substantive comments on this standard.

**10. Federal and other legal mandates and obligations for fish protection, mitigation, and enhancement must be fully addressed.**

ISRP Response: The text explains how the sockeye salmon captive rearing program is consistent with existing tribal, state, and federal law. It would be equally useful to identify those laws and executive rules that make it more difficult to implement various aspects of the project.

## ISRP Summary Review Statement

The Snake River sockeye salmon captive rearing project has been notably successful in rearing salmon to adulthood in captivity. How many generations this can be maintained before inbreeding or catastrophic events reduce this portion of the program is unknown. 43,000 smolts were destroyed in 2002 at Bonneville Hatchery because of IHN virus infection. The emphasis on reporting the numbers of eggs, juveniles, and adults released from the program as a measure of success and accountability continues a practice the ISAB and ISRP has argued against in the past. While these are important elements in monitoring production and performance within a captive propagation program, they do not constitute measures of program success. Only, 7, 257, 26, 22, 11, and 113 adults have passed Lower Granite Dam or returned to the Sawtooth Valley in 1999 - 2004. This level of production can hardly be viewed as a resounding success at a programmatic level.

## II. Captive Rearing Program for Salmon River Spring Chinook Salmon

### *Question 1: Adequacy of Response to ISRP Issues from Provincial Review*

**Project ID: 199700100, Captive Rearing Project for Salmon River Chinook Salmon,** IDFG and IOSC
**ISRP Final Review Comments:**
Fundable, but low priority – Sponsors provided reasonable and detailed answers to reviewers' questions and comments. Questions remain, however, ***(Question 1)*** about the need to alter the performance traits of the captive brood to make them similar to fish in nature. These characters are largely dependent on environment so characteristics of fish reared in hatcheries will reflect those conditions, and of fish produced in nature will reflect those conditions. Detailed and careful work to produce fish with similar characteristics from either set of conditions is certain to require a continuing, and long-term effort, and in the view of some reviewers, perhaps a flawed strategy. ***(Question 2)*** Sponsors need to reassess what they are doing in his project. It appears from the review that the project will never be "complete."

ISRP Analysis: The sponsors adequately address the question of developing fish culture protocols sufficient to produce captive-reared adults with performance similar to wild adults. In other reports, the sponsors have acknowledged that captive reared adults do not perform well. They are seeking culture protocols to improve that performance rather than make them similar to wild fish. Nevertheless, it is unclear how this captive rearing program is supposed to be an advantage over captive broodstock. It seems that handicaps of both the included strategies — adult release and egg stocking — are likely to erase the demographic reason for undertaking the program. For adult release this is because the tank-reared fish won't breed successfully, and for egg stocking it is because the survival of planted eggs is low. One persistent issue with the use of captive adults is the selection of performance characteristics. Specifically, the definition of fitness parameters that are indicators of success or failure remains somewhat elusive. Therefore, the ISRP seeks an explicit disclosure of these indicators along with support for their use.

### *Question 2: Adequacy of Meeting NOAA Fisheries Interim Standards*

**2) Does the document explain how each project used and addressed the *Interim Standards for the use of Captive Propagation Technology in Recovery of Anadromous Salmonids Listed under the Endangered Species Act* (NMFS 1999)?**

ISRP Response: An important element of the sponsors' responses for this item will be an explicit articulation of decision points or factors that are considered for a project population when proposing the use of captive propagation technology. A "decision tree" should describe the biological and environmental considerations that led to a decision to bring a population into captive propagation, as well as the biological and environmental factors that will lead to decisions to continue or discontinue the program. Are there "trigger points" or metrics that drive decisions about implementation of the program?

**ISRP Analysis:**

**Item 1. Decision Standards.**

***Technical Issue 1. Population status:***

There is no doubt that the ESU is depleted, and there is apparent justification for the ESA listing (the basis for this conclusion is found within NMFS status documents). However, no evidence is presented to indicate that the individual populations selected for captive rearing experiments in the Salmon River basin are at abundance levels that would warrant intervention. A summary of the population declines in these tributaries and other streams in the subbasin is needed, along with a rationale of why these populations were chosen for intervention (and others were not).

***Technical Issue 2. Importance of the population:***

There is no evidence provided to indicate that these populations are unique among the Snake River spring and summer run Chinook salmon. A more compelling response is needed. We assume that much like the Redfish Lake sockeye, these Chinook runs represent a unique component of the basin's Chinook metapopulation. The response needed to describe the populations' status within the ESU and confirm this assumption.

***Technical Issue 3.***

***Guideline 1. Scale of the Project. Total captive production should be based on the number of fish needed to prevent extinction:***

A rationale for the size of the program is needed. First, determination of the size of the adult population needed to reduce the demographic risk of extirpation to a specified level is needed. Then the numbers of adults to be released from the captive broodstock program can be established as a goal or objective. Finally, the numbers of juveniles or eggs that need to be collected can be determined.

***Adequately represent genetic variation for life history traits of the wild population and minimize genetic change during captivity.***

The reply is inadequate. The project should be genotyping the wild and captive populations to monitor whether the captive component is representative. The use of molecular markers for monitoring contribution is well established in the technical literature.

***Guideline 2. Duration should be as short as possible.***

Sponsors answer that the program duration is indeterminate, and may continue until recovery is complete. No interim recovery goal for these tributaries is provided. No conditions for termination are provided. Logically, the program should transition to a "supplementation" type project once anadromous returns can sustain the hatchery propagation required to stock the stream. This decision point should be identified. See additional comments under the Red Fish Lake sockeye section.

***Technical Issue 4. Measures of success.***

The answer summarizes the results achieved to date for this program. This step in the guidelines for the use of captive broodstocks is to provide decision standards. What information is needed regarding the standards? Is it an identification of measures of success and the basis for believing the program can achieve minimal standards of "reducing extinction risk", "causing minimum genetic change", and "increase the number of individuals reproducing successfully in the wild?"

We don't find fault with the sponsors here. It is not clear what NOAA wants from the sponsors on this issue. In later steps, they want goals stated.

***Technical Issue 5. Changing or Terminating Program.***
The reply is inadequate. Clear trigger points are needed to identify that the strategy is successful and should now be terminated, or that the strategy has been unsuccessful and should be terminated, or that progress is being made and should continue.

**Item 2. Operational Standards.**
***Issue 1. Choice of Broodstock.***
Adequate presentation of the individuals collected.

***Issue 2. Captive Broodstock Spawning.***
***Guideline 1 and 2.***
The response was adequate.

***Guideline 3a.***
The response was adequate.

***3b. Cryopreserved sperm.***
A short description acknowledging the use of cryopreserved sperm is provided. What is needed, however, is an outline of the decision process and justification leading to its use. This is important because the rate of fertilization is usually much lower (<50%) in eggs fertilized with cryopreserved sperm than with live sperm. How is the decision to use the cryopreserved sperm made? Further, how is the decision reached on planting eyed eggs from hatchery test matings into streams? The numbers of stocked eggs could overwhelm the numbers of natural eggs deposited if there are few natural spawners. (See comments on Red Fish Lake sockeye for this item also.)

***3c. Induced Spawning.***
The response acknowledges that GnRH analog implants are used with males and females to synchronize and induce ovulation and spermiation. How extensive is this practice? What are the consequences for reproductive success? How is the decision to use GnRH implants reached?

***Issue 3 and Issue 4.***
No comments or questions.

***Issue 5. Management of Returning Adults.***
No comments or questions.

***Outline of captive Propagation Operation Plan.***
***Issue 5. Program Goals.***
There are usually two goals to a captive rearing (conservation breeding) program. The first is to preserve the germ plasm with the aim of avoiding extinction. The second is to provide individuals for reintroduction/repatriation. The strategy employed in this project – collecting naturally produced juveniles and returning them to the stream to spawn naturally just before the

normal reproductive season - puts a twist on the usual theme. While fish are captively reared for a period of time, the entire life cycle from egg to egg is not under culture. The appropriate numerical target in a project like this would be to release enough adults capturing sufficient and representative genetic diversity to produce sufficient smolts to seed the available habitat. The numbers of juveniles needed to populate the captive rearing phase would be estimated from the proportion that survive to reproduction, and their success in spawning in the streams. The appropriate contrast to measure success would be a comparison of smolt production between test and reference streams.

**Summary of Hazards Related to Captive Propagation Technology**

***Hazard 1. Negative effects associated with small population size.***

***A. Inbreeding depression.***

There is an adequate discussion of inbreeding depression, but insufficient attention is given to evaluating assortative mating among captively reared individuals that originated from excavation of eggs from the same redd.

***B. Loss of within-population genetic variability.***

Sponsors mention studies of allele frequencies in the eggs collected to populate the captive phase of the project. The results of these investigations should be included. These evaluations should be codified in a risk management plan. Only by monitoring these metrics can problems be detected.

No additional substantive comments on the remainder of NOAA Fisheries Interim Standards for Using Captive Rearing to Support Anadromous salmon recovery.

## *Question 3: Consistency with APR Report Policies and Standards*

**From Response Document: p 211. "***Rationale–-Biological Problem: Extremely low population abundance has the potential for causing extinction or loss of genetic diversity. Spring chinook salmon stocks selected for this program had recent annual escapements of less than 20 fish, adequate habitat for successful spawning and rearing, and demonstrated poor resiliency from the last major documented bottleneck (1979-1984)."*

ISRP Response: This is the type of data, with even more detail, that would have provided the necessary justification for implementing a captive rearing program for the NOAA Fisheries Interim Standards. In this instance, it is also necessary to know whether the 20 fish is per stream or is the total among the three streams. Also, the data leading to the conclusion that these populations demonstrated poor resiliency in the last bottleneck should be provided.

**1. The purpose and use of artificial production must be considered in the context of the ecological environment in which it will be used.**

**From Response Document:** *"The Captive Rearing Program for Salmon River Spring Chinook Salmon focuses on three ESA-listed wild/natural stocks. Stocks were selected based on their relative importance to the ESU, estimated demographic risk, history of hatchery intervention, and risk of exposure to experimental techniques. In addition, stock selection was based on the presence of a minimum level of adult escapement and on the availability of suitable spawning habitat in target streams. These criteria were critical to meeting post-release adult evaluation objectives related to spawning behavior, interactions between hatchery-reared and wild/natural adults, and spawning success. The three stocks that were selected (Lemhi River, East Fork Salmon River, West Fork Yankee Fork Salmon River) satisfied the above criteria."*

ISRP Response: These stock selection criteria need specific clarification. For example, stocks were based on their relative importance to the ESU. Were they selected because they are very important? Or, were they selected because they are of no importance and consequently could be used for experimentation? See also Technical Issue 2: Importance of the Populations above.

**2. Artificial production must be implemented within an experimental, adaptive management design that includes an aggressive program to evaluate the risks and benefits and address scientific uncertainties.**

**From Response Document:** *"Although not without risk, captive rearing technology is sufficiently advanced to provide the measures necessary to amplify depressed populations and reduce extinction risk (Flagg et al. 1995; Schiewe et al. 1997)."*

ISRP Response: We disagree. As described in the background information at the front of this report, the record of achievement/success with captive propagation for vertebrates is hardly encouraging. The sponsor's assertion that captive rearing technology is sufficiently advanced to provide the measures necessary to amplify depressed populations and reduce extinction risk is actually one of the working hypotheses being tested by this project. The project could have three levels of experiments. A description of the success of captive husbandry and contrast to the minimum performance necessary to make the effort worthwhile, a contrast of smolt and adult production in streams with and without this type of captive rearing project, and finally a contrast between this type of captive rearing and the captive strategy employed on the Grand Ronde River.

**3. Hatcheries must be operated in a manner that recognizes that they exist within ecological systems whose behavior is constrained by larger-scale basin, regional and global factors.**

ISRP Response: Management of artificial production, and the expectations of that management, should be flexible to reflect the dynamics of the natural environment. Production and harvest managers should anticipate large variation in artificial production returns similar to that in natural production.

**From Response Document:** *"Program managers are aware of the need to incorporate flexibility into annual production plans to accommodate the inherent variability and dynamics of the natural environment. The Captive Rearing Program for Salmon River Spring Chinook Salmon is managed to source annual rearing groups from progeny of natural spawning events that occur in study streams. If low adult escapement is predicted in any year, the program has the ability to generate safety net broodstocks by conducting in-hatchery spawning to prevent the loss of year-specific cohorts. Managed properly, this approach can ensure a continuum of spawners while minimizing risks associated with traditional breeding programs."*

ISRP Response: It seems unlikely that the proposed action – spawning captively reared adults in captivity – when the abundance of natural origin adults is low is what is intended by the policy. How would altering the protocol impact the experimental design?

The management and performance of individual facilities cannot be considered in isolation but must be coordinated at watershed, subbasin, basin, and regional levels, and must be integrated with efforts to improve habitat characteristics and natural production where appropriate.

**From Response Document:** *"Individual hatchery facilities operated by the IDFG and NOAA Fisheries that produce eggs and fish for the Captive Rearing Program for Salmon River Spring Chinook Salmon are guided by outcomes of the coordinated processes described above. By no means are the actions of these individual facilities "isolated"."*

ISRP Response: As above, the sponsors miss the point. The issue is whether this project will compromise, or be compromised by, other projects. A check on other projects is needed.

4. **A diversity of life history types and species needs to be maintained in order to sustain a system of populations in the face of environmental variation.**

ISRP Response: The sponsor response did not provide substantive comments on this standard.

**5. Naturally selected populations should provide the model for successful artificially reared populations, in regard to population structure, mating protocol, behavior, growth, morphology, nutrient cycling, and other biological characteristics.**

ISRP Response: The sponsor response did not provide substantive comments on this standard.

**6. The entities authorizing or managing an artificial production facility or program should explicitly identify whether the artificial propagation product is intended for the purpose of augmentation, mitigation, restoration, preservation, research, or some combination of those purposes for each population of fish addressed.**

ISRP Response: The sponsor response did not provide substantive comments on this standard.

**7. Decisions on the use of the artificial production tool need to be made in the context of deciding on fish and wildlife goals, objectives, and strategies at the subbasin and province levels.**

ISRP Response: A discussion emphasizes that recovery of chinook salmon is a subbasin, province, basin, state, federal, and tribal goal. That is understood. What is needed is a clarification of how this goal may be compromised by other fish and wildlife goals, objectives, and strategies in the subbasin and province.

**8. Appropriate risk management needs to be maintained in using the tool of artificial propagation.**

ISRP Response: Along with the adaptive management plan recommended earlier, it would be worthwhile for each program to have a risk management plan. The plan would contain the standard operating protocols (SOPs) for each risk. Many of these are in fact already written. Executing them is part of the joint responsibilities of NOAA, the tribes, the state, and the university. For example, the breeding plan is a risk management measure to avoid sibling matings and maintain the genetic variation of the founding individuals. Disease management, fish culture, and release procedures also exist. By placing these issues in a risk management context, the vague notion of risk in these captive propagation documents can be treated more seriously and rigorously. A more rigorous approach would be to treat the risks as hypotheses that need to be tested within an Adaptive Management framework, rather than as stand alone hypotheses.

**9. Production for harvest is a legitimate management objective of artificial production, but to minimize adverse impacts on natural populations associated with harvest management of artificially produced populations, harvest rates and practices must be dictated by the requirements to sustain naturally spawning populations.**

ISRP Response: The sponsor response did not provide substantive comments on this standard.

**10. Federal and other legal mandates and obligations for fish protection, mitigation, and enhancement must be fully addressed.**

ISRP Response: The text explains how the Chinook salmon captive rearing program is consistent with existing tribal, state, and federal law. It would be equally useful to identify those laws and executive rules that make it more difficult to implement various aspects of the project.

## ISRP Summary Review Statement

Conducting an experiment to find out whether collecting juveniles, rearing them under hatchery culture, and then releasing them as adults to spawn naturally was more or less efficacious than rearing juveniles, spawning them in captivity, and releasing their progeny is worth doing. That experiment is being conducted by contrasting the Salmon River captive rearing strategy with the Grand Ronde captive rearing strategy. The narrative in this captive propagation summary is very optimistic in contrast to the reports they have submitted during provincial reviews (Hassemer et al. 2001, Venditti et al. 2002). These reports state:

> Based on behavioral observations, inspection of carcasses, and excavation of redds to search for viable eggs, several limitations associated with the reintroduced captive-reared chinook salmon have been identified. These include:
>
> 5. Limited availability of age 4 and 5 captive-reared males,
> 6. Asynchronous spawn timing for captive-reared and wild/natural Chinook salmon, and incomplete or arrested maturation and ovulation in captive-reared females.
> 7. Questionable gamete quality
> 8. Insufficient physical ability of captive-reared adults to negotiate natural stream conditions, construct successful redds, and compete with other species for spawning privileges.

The implications of these dysfunctions for the likely success of this captive propagation strategy are quite significant, and seem largely absent from this review.

## III. Grande Ronde Basin Spring Chinook Salmon Captive Broodstock Program

### *Question 1: Adequacy of Response to ISRP Issues from Provincial Review*

**Project ID: 199801006, Captive Broodstock Artificial Propagation, NPT**
**ISRP Final Review Comments:**
Fundable. The response comprehensively addresses the review comments. This proposal is for monitoring and evaluation of progeny of the captive brood stock collected and reared under project #199801001. The proposal involves co-ordination with state and federal agencies, assistance in the monitoring and evaluation of juveniles and brood adults reared at Bonneville Hatchery and Manchester Marine Laboratory, monitoring and evaluation of the F1 generation juveniles and returning adults, and reporting. Like proposal #199801001, this is a well-written proposal that focuses on research and evaluation of alternative approaches to supplementation through captive broodstock. The proposal presents a thorough technical background that puts the project in context, the rationale and significance to regional programs is detailed and clear, and project history section includes results to date, with some comparisons between stocks and/or rearing treatments. Objectives are again stated as tasks, and not measurable comparisons or tests, but the intentions in this context are clear. In a past review, there was a question concerning overlap between this program and M&E associated with the conventional hatchery production activities. Our understanding is that these M&E tasks are discrete. However, ***(Question 1)*** there is an important question associated with these marking programs. The comparison of natural, conventional, and captive brood production will obviously be based on the extensive use of PIT tags in many of the proposals reviewed. Have the co-managers considered the adequacy of marking rates to compare these three types of spring chinook production, and if so, what level of difference in performance may be detectable? This latter issue is not only relevant to this one proposal, but other NPT proposals have noted methods for estimating the numbers of PIT tags required for comparisons. A statistical basis to the tagging program would clearly strengthen this, and related, proposals.

ISRP Comment: The project sponsors address the concern raised by the ISRP.

### *Question 2: Adequacy of Meeting NOAA Fisheries Interim Standards*

**2) Does the document explain how each project used and addressed the *Interim Standards for the use of Captive Propagation Technology in Recovery of Anadromous Salmonids Listed under the Endangered Species Act* (NMFS 1999)?**

An important element of the sponsors' responses for this item will be an explicit articulation of decision points or factors that are considered for the particular population that the project is dealing with when proposing the use or continuation of a captive propagation technology. A "decision tree" should be described that explains what biological and environmental considerations led to a decision to bring a population into captive propagation, and what biological and/or environmental factors will be considered to drive decisions about continuing or discontinuing the program. Are there "trigger points" or metrics that are established that drive decisions about implementation of the program?

ISRP Response: A transparent decision tree has not been developed. Transparent trigger points (thresholds for performance metrics) are not presented. Numerical targets for juvenile collections, egg and smolt production are clear and provide a mechanism to evaluate whether the project can achieve its objectives. These numerical targets for juvenile collections and smolt releases are based on a desired return of 150 adults from each cohort released. There are two reference streams. Contrasts between the reference locations and test streams should permit sorting out treatment effects from larger scale environmental effects on survival.

**Item 1. ISRP Decision Standards.**

***Technical Issue 1. Population status:***

The response adequately covered the issue was the best response among the three captive propagation programs under review.

***Technical Issue 2. Importance of the population:***

The sponsors provide an acceptable explanation that Grande Ronde spring-run chinook are distinct from other units within the ESU, and that the target streams are important to the persistence of this portion of the ESU. The response on the likelihood of recolonization from other populations was unconvincing. If there is some stray rate data for this subbasin, it could have been used to provide a more thorough consideration of recolonization. The explanation of potential productivity presented only percentage of productive capacity lost. It would have been helpful if this had been translated into numbers of returning females. Recent analysis of the supplementation efforts in the Umatilla River concluded that tributary incubation and rearing capacity was less than assumed. Could more of the recruitment failure in these populations be due to tributary capacity than to downstream mortalities, for example?

***Technical Issue 3. Guideline 1. Scale of the Project. Total captive production should be based on the number of fish needed to prevent extinction:***

The decision process that led to the scale of the project is transparent.

***Adequately represent genetic variation for life history traits of the wild population and minimize genetic change during captivity.***

The explanation of how they collect, rear, and spawn wild fish to obtain an adequate representation of the genetic background is clear.

***Guideline 2. Duration should be as short as possible.***

The sponsors provide a clear explanation of the time line for each cohort. The experimental component of the project has a span of 19 years. These are positive developments. However, in the next paragraph the final sentence states that achieving a target of 150 wild salmon in each stream will determine the longevity of the program. Apparently then, if captive reared salmon return to spawn, but they do not provide a corresponding increase in natural production the program would continue indefinitely. The project sponsors should be encouraged to identify this as a trigger point to reevaluate the conceptual basis for the program.

***Technical Issue 4. Measures of success.***
Program evaluation metrics and reference streams provide a means to determine whether the captive rearing adds, rather than replaces, natural production.

***Technical Issue 5. Changing or Terminating Program.***
The relationship between the captive program and the supplementation program is clear, as are the guidelines for collecting broodstock for the supplementation program. However, similar threshold points that would compel the Technical Oversight Team to recommend terminating the program have not been developed. They should be. Clear thresholds are needed to identify outcomes and actions: e.g., 1) the strategy worked and the project should be terminated; or 2) the strategy has not worked and the project should be terminated; or 3) that progress is being made and the project should continue.

**Item 2. Operational Standards.**
***Issue 1. Choice of Broodstock.***
Adequate presentation of the individuals collected. The proportion of the population that can be collected is not presented, but should be. There is a 50 fish minimum. If they could collect 500 parr, and that was the total population, would they collect them? This should be clarified. Sponsors note that after 2002 the parr collected could be the progeny of captive reared salmon. Sponsors indicate there is no efficient means to determine this. This can be accomplished by genotyping. They could genotype the fish and determine pedigrees. They should consider doing this. They might not be able to return parr to the stream, but they could avoid mating close relatives and at least monitor the genetic consequences of their program.

**Issue 2. ISRP Captive Broodstock Spawning.**
***Guideline 1 and 2.***
The response is adequate.

***Guideline 3a.Use protocols that maximize the effective genetic population size.***
**From Response Document: p 280** *Program spawning protocols are adjusted, as necessary, to maximize program success.*
An example and explanation of these adjustments are required to know whether these protocols are consistent with conservation of these stocks.

***3b. Cryopreserved sperm.***
A short description acknowledging the use of cryopreserved sperm is provided. What is needed, however, is an outline of the decision process and justification leading to its use. This is important because the rate of fertilization is usually much lower (<50%) in eggs fertilized with cryopreserved sperm than with live sperm. How is the decision to use the cryopreserved sperm made? Further, how is the decision reached on planting eyed eggs from hatchery test matings into streams? The numbers of stocked eggs could overwhelm the numbers of natural eggs deposited if there are few natural spawners. (See ISRP comments on Red Fish Lake sockeye for this item also.)

***3c. Induced Spawning.***

The response acknowledges that GnRH analog implants are used with males and females to synchronize and induce ovulation and spermination. How extensive is this practice? What are the consequences for reproductive success? How is the decision to use GnRH implants reached.

***Issue 3 and Issue 4.***

No comments or questions.

***Issue 5. Management of Returning Adults.***

No comments or questions.

***Issue 6. Other Disposition of Fish.***

**From Response Document: p 289. "***The $F_2$ Generation Phase begins once embryos resulting from $F_1$ Generation fish are formed and ends when fish from these embryos die. This phase is composed of the presmolt, smolt, post-smolt growth, adult return, and spawning periods. During this period, we measure variables in the natural environment to assess the natural production performance of captive fish reproducing in nature. Variables include egg-to-fry survival, egg-to-smolt survival, juvenile tributary migration patterns, growth rates, parr and smolt production, smolt migration patterns, smolt-to-adult survival, catch distribution, run timing, age structure at return, size and age at maturation, sex ratios, prespawn survival in nature, spawning distribution in nature, spawning success, straying, and productivity (progeny-to-parent ratios).*

*We measure an array of variables in each phase/period of the cycle. The information we collect and analyze will allow us to compare our experimental treatments (FN, FA, SN, and SA), to develop relationships between treatments and performance."*

There is no explanation of how these parameters are estimated in fish spawning in the treatment streams. In these streams, adults will be from natural, supplementation, and captive programs. How can the sponsors estimate these for the progeny ($F_2$) of these treatments? How is an individual $F_2$ classified that is the progeny of mating between a natural and captive program?

***Outline of captive Propagation Operation Plan.***

***Issue 1. Program Description. 5. Program Goals.***

The goals of the program are clear. Goal 3. Ensure a high probability of population persistence well into the future once the causes of basin wide population declines have been addressed, seems redundant with Goal 1, to prevent extinction of Catherine Creek chinook.

***9. Duration of Program.***

As commented earlier, the experimental phase is clear and has a timeline. Once that time limit is reached, the plan permits continuation, rather than an evaluation based on the outcome of the experiment. This is a concern because these programs have a history of becoming institutionalized.

**Issue 2. Relationship of Program to Other Management Objectives. 1. Relationship to habitat protection and recovery strategies.**

**From Response Document:** *"Within the Grande Ronde River subbasin, riparian and in-stream habitat degradation has severely affected spring chinook salmon production potential. Many of these impacts have been reduced in recent years. Reduction in quantity and quality of rearing habitat have reduced the capacity of some streams in the Grande Ronde Basin to support juvenile chinook salmon by approximately 30 percent in the upper Grande Ronde River and Sheep Creek, 20 percent in the Lostine River and Bear Creek, and 70 percent in the Wallowa River and Hurricane Creek (Carmichael and Boyce 1986)."*

The reduction in capacity was estimated nearly 20 years ago. Analysis from the Umatilla River indicates that the capacity of tributary habitat was substantially overestimated. The scale of the project is based on planning documents 10 years ago. The suitability of these estimates and the scale of the project should be addressed as the project proceeds.

**From Response Document:** *"A number of habitat protection and recovery efforts are underway in the Grande Ronde Basin (ODFW 2001)."*

There is no linkage of habitat protections and improvements necessary to achieve production levels for success of the program to the subbasin planning effort currently underway. While any absolute or confident prediction is not likely feasible, some level of expectation is possible. For example, if habitat improvements include the rehabilitation of an additional 10% of spawning reach, we might anticipate a related level of increased juvenile production. Ultimately, the reason to implement habitat protections and improvements is because they address causes of decline, rather than because they are easily achievable.

***Issue 3. Origin and Identity of Broodstock 3a. History of broodstock.***

**From Response Document** *"The captive broodstock program began in 1995, with collection of the 1994 cohort and continues with collection of the 2002 cohort in August 2003. All fish collected have been age 1 parr that were spawned in nature. We have collected eight cohorts (1994-2001) of spring chinook salmon juveniles from Catherine Creek and Lostine River in 1995-2002 and six cohorts from the upper Grande Ronde River. Each year, we collected 500 (or nearly) fish from Catherine Creek and the Lostine River. Only 110 fish were collected from the Grande Ronde River in 1995 (1994 cohort), and no fish were collected from the 1995 and 1999 Grande Ronde River cohorts."*

ISRP Response: Sponsors propose a captive brood program to include five full cycles (including ~ 19+ yearly cohorts). As the program is presently two full cycles (and eight cohorts) into the broodstock program, we assert this would be an appropriate opportunity to review progress toward meeting biological goals and objectives (return numbers, return rates, growth of the population, genetic structure of the populations, and so on). In short, is the program achieving its stated goals of increasing population size and stability through captive breeding or not? If not, some comment on why not is needed, and will the goals be amended or abandoned.

The sponsors indicate that local stock has been used to develop the stock. While this diminishes the risks to the population from introgressing non-native genomes into the local target stock, it is not clear whether it is benefiting the local stock in negating or reducing demographic or other local population risks in any material way.

Ultimately, without some assessment of the ongoing risks to the local stock from the release of captive brood, the sponsors risk entering a perpetual pattern of propagation and release at the expense of any remnant wild population (i.e., the entire population will be captive without any viable component in the wild).

***Issue 8. Monitoring and Evaluation. 1. Biological and propagation parameters monitored. b. Age at maturity, sex ratios, fecundity, viability of gametes.***
**From Response Document: "***We expected fecundities to be approximately 1,200, 3,000 and 4,000 eggs for females at ages 3, 4, and 5, respectively, approximating that of wild fish. Growth of captive broodstock fish has been slower than expected and, subsequently, fecundity was also lower. Mean fecundities for ages 3, 4, 5, and 6 females were 1421, 1865, 1770, and 1369 eggs/female, respectively. Mature females of ages 3 and 6 are rare in this program. Mean fecundity was higher in the Freshwater Natural and Freshwater Accelerated groups than the Saltwater Natural treatment group. Captive broodstock females also had fewer eggs/kg body weight than conventional broodstock (naturally-reared) females."*

These observations made by the sponsors affirm the challenges the captive propagation strategy is likely to encounter. These challenges are unlikely to be resolved easily.

***Summary of Benefits Attributed to Captive Propagation Technology***
***Benefit 1, 2, 3. Increasing and preserving the total, and natural-origin population.***
There is an inadequate presentation of how contrasts of abundance in treatment and reference streams can be used to account for captive propagation treatments. No data are presented anywhere in the review on the reference streams, yet contrasts between treatment and reference locations will provide the most informative analyses.

No additional substantive comments on the remainder of NOAA Fisheries Interim Standards for Using Captive Rearing to Support Anadromous salmon recovery.

## *Question 3: Consistency with APR Report Policies and Standards*

**1. The purpose and use of artificial production must be considered in the context of the ecological environment in which it will be used.**

ISRP Comment: The success of artificial production depends on the quality of the environment in which the fish are released, reared, migrate, and return.

**From Response Document:** *"The Grande Ronde Basin once supported large runs of chinook salmon and peak escapements in excess of 10,000 occurred as recently as the late 1950s (U.S. Army Corps of Engineers 1975). There have been anthropogenic habitat alterations in the Grande Ronde Basin—sometimes extensive—but habitat quality and availability has not changed substantially since the late 1950s when large runs of chinook salmon were present in the basin (Currens et al. 1996; ODFW 2001). Spawning and rearing habitat in the streams from which fish are collected for the captive broodstock program have been subjected to human alteration, primarily in the lower reaches of the streams but good habitat remains upstream of these perturbations. Access to this habitat is either unlimited (upper Grande Ronde River and Catherine Creek) or seasonally limited and the fish are assisted by being trapped and transported around dewatered sections (Lostine River)."*

ISRP Response: This suggests the potential for severe freshwater limits to juvenile production. Captive propagation programs often minimize the degree to which tributary habitat could compromise any benefit. See ISRP comments on Issue 2 above, Relationship of the program to habitat recovery efforts.

**2. Artificial production must be implemented within an experimental, adaptive management design that includes an aggressive program to evaluate the risks and benefits and address scientific uncertainties.**

**From Response Document:** *We are extensively monitoring and evaluating survival of captive broodstock offspring in nature. All progeny of captive broodstock released into nature are adipose clipped and coded-wire tagged. A portion is also PIT-tagged for examination of downstream migration survival. Approximately 1.2 million smolts and 55,000 parr have been released from the 1998-2001 cohorts. Between 2001 and 2003, a total of 1,592 adults have returned from the ocean from captive broodstock releases (Hoffnagle et al. 2003). It is too early to make conclusions about return rates but the early data are promising.*

ISRP Response: The critical test is whether there is a response in the $F_2$ production. This requires the contrasts to reference streams. Those contrasts should be part of an adaptive management plan for this project.

**3. Hatcheries must be operated in a manner that recognizes that they exist within ecological systems whose behavior is constrained by larger-scale basin, regional and global factors.**

ISRP Response: There is a lack of consideration of how the Lower Snake River Compensation Plan conventional and supplementation projects in the subbasin could compromise the estimation of benefits from the captive propagation.

**4. A diversity of life history types and species needs to be maintained in order to sustain a system of populations in the face of environmental variation.**

**and**

**5. Naturally selected populations should provide the model for successful artificially reared populations, in regard to population structure, mating protocol, behavior, growth, morphology, nutrient cycling, and other biological characteristics.**

**From Response Document:** *In the future, adult releases will be considered as a tool to allow fish to spawn naturally and planting of eggs may also be considered.*

ISRP Response: The contrast of Grande Ronde captive propagation to Salmon River captive propagation should inform whether one strategy or the other is more efficacious. Only one strategy should be employed in a subbasin.

**6. The entities authorizing or managing an artificial production facility or program should explicitly identify whether the artificial propagation product is intended for the purpose of augmentation, mitigation, restoration, preservation, research, or some combination of those purposes for each population of fish addressed.**

**and**

**7. Decisions on the use of the artificial production tool need to be made in the context of deciding on fish and wildlife goals, objectives and strategies at the subbasin and province levels.**

ISRP Response: A more useful reply to this policy is a description of how the Technical Oversight Team interacts w/subbasin, provincial, and basin groups to coordinate consistency among objectives.

**8. Appropriate risk management needs to be maintained in using the tool of artificial propagation.**

**and**

**9. Production for harvest is a legitimate management objective of artificial production, but to minimize adverse impacts on natural populations associated with harvest management of artificially produced populations, harvest rates and practices must be dictated by the requirements to sustain naturally spawning populations.**

**and**

**10. Federal and other legal mandates and obligations for fish protection, mitigation, and enhancement must be fully addressed.**

**ISRP Summary Review Statements**

The Grande Ronde program review was better articulated, better substantiated, and more transparent than the Redfish Lake sockeye and Salmon River Chinook program descriptions. The Grande Ronde experimental design has the potential to provide meaningful insight into whether or not captive propagation can provide anything more than hatchery-origin adults returning from the ocean. The ISRP recommends that the experimental design remain intact. This includes a critical inspection of all culture activities in the basin to ensure that conventional and supplementation actions are not compromising the experiment.

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