ISRP FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

1. Review Approach and LSRCP Report Contents

The snapshot provided by Table 1 gives an overview of performance across the LSRCP projects, summarizing performance metrics for each hatchery and the number of years that these have been achieved. Broodstock collection goals, which should be tied to ecological criteria such as carrying capacity and wild stock abundance, were not reported for any – an issue further addressed under findings and individual project reviews. As expected, within-hatchery production goals were largely met (pre-spawn mortality, egg-to-smolt survival). However, with few exceptions across the snapshot, smolt release goals and post-release survival goals were either not met for the most part, or if so, were not reported (NR), thus could not be evaluated.

Interaction performance (Table 1) refers to the collection of information on the program used for evaluation of effects on natural populations. The table summarizes whether data was collected, reported, and analyzed. Most biological traits of interest (age, size, and timing) were tracked. Evaluation metrics and experimental design (e.g., BACI), information on supplementation effectiveness, and information on compliance with HSRG recommendations were available from only a few hatchery programs. Recommendations and detail on these overall performance metrics are included in findings below. Genetic assessments and relative reproductive success information is available for only two projects.

Finding 1.1. The format used to provide an independent retrospective evaluation of the accomplishments of the LSRCP spring Chinook program worked well. Using the format, the program co-managers summarized the outcomes from implementing their individual program components and compared them to goals established in the LSRCP. Managers' summaries were presented during a three-day symposium, followed by written reports.

Recommendation. The LSRCP should proceed as planned in using this format to review the steelhead and fall Chinook components of the LSCRP in 2011/12, and 2012/13, respectively. The Council is encouraged to use this format for ISRP retrospective evaluation of Fish and Wildlife Program categorical and geographic projects. Having the project proponents develop a summary report that is evaluated by the ISRP would be more efficient and productive than attempting to extract summary information from proposal materials in TAURUS.

Finding 1.2. The presentations and written reports generally provided enough information for the ISRP to verify conclusions of the co-managers. The reports, however, were inconsistent in their presentation and should be standardized for assembly into a symposium proceedings. There were a number of important goals and evaluation endpoints that were not clearly and consistently presented in each of the reports. Most of these are designated NR (not reported) or are blank in the ISRP summary table (Table 1). The ISRP believes most of these data have been collected, but were not summarized in a sufficiently clear format. Additional data and analyses beyond the framework metrics in the ISRP table were found in many reports. These data and analyses should remain in the reports. These unique analyses were very important, but sufficiently report-specific, that they could not be applied to all the hatchery programs and effectively captured in the ISRP summary table. Specific comments to the authors from the ISRP are found in the individual report reviews.

Recommendation. The ISRP believes the data, evaluation, and conclusions provided by the LSRCP spring Chinook program is applicable beyond the Columbia River Basin and Pacific

Northwest. We encourage the co-managers to use the roll-up report as the foundation to develop a scientific paper for submission to a peer-reviewed fisheries, natural resource, or conservation journal.

2. How are the project fish performing in the hatchery?

2.1 *Are there unambiguous performance indicators and quantitative objectives for those indicators?*

Finding 2.1. There were four primary unambiguous performance metrics for in-hatchery performance: broodstock collection, pre-spawning broodstock mortality (<20%), egg-to-smolt survival (>70%), and smolt release numbers.

2.2. Are the performance indicators for fish in the hatchery environment adequately measured, reported, and analyzed?

Finding 2.2. Performance goals and empirical results for pre-spawning mortality, egg-to-smolt survival, and smolt release numbers were reasonably reported. Broodstock goals were unambiguously presented for only one program (Dworshak). Even in that case it was a line on a bar graph, and the ISRP was unable to read what the actual numerical goal is. For pre-spawning mortality and egg-to-smolt survival, many of the reports used bar graphs, and it was impossible for the ISRP to actually determine what the range and mean values obtained were. It was possible to determine the number of years the programs met goals in some cases.

2.3. Are individual programs able to achieve the goals of the projects as planned?

Finding 2.3. Goals for pre-spawning mortality and egg-to-smolt survival were generally met within the program guidelines. The occasional years when pre-spawning mortality was high in specific facilities was usually associated with warmer water temperatures. In the last 10 years reported, egg-to-smolt survival failed to achieve the 70% standard only once, and in that instance it was just below 65%. The success in collecting broodstock was variable. Many of the established mitigation programs met collection goals (e.g., Dworshack), whereas some newer supplementation programs did not (e.g., Lostine). Spring Chinook smolt releases have never met the original LSRCP objectives. The causes of this deficiency have included difficulties in obtaining broodstock owing to poor adult survival (e.g., Sawtooth: upper Salmon River mainstem), reductions in program production effort to meet updated rearing density constraints (e.g., Dworshak), and inadequate water supplies at some hatchery facilities (e.g., Lookingglass Hatchery).

2.4. Is fish culture performance within standards expected for salmonids?

Finding 2.4. Yes, overall the in-hatchery performance was acceptable.

Conclusions/Recommendations. Revisions to the hatchery reports should address the ambiguity in broodstock collection goals and evaluation of success in achieving the objectives. There was no summary of differences among the hatcheries (or within years in a hatchery) in the fish culture practices such as acclimation versus direct release, on-site versus satellite facility release, and rearing densities, size and timing at release that might contribute to explaining differences in the performance of smolts after release.

3. How well are project fish performing once released?

3.1. *Are there unambiguous performance indicators and quantitative objectives for those indictors?*

Finding 3.1. The primary indicators of fish performance following release were smolt survival from release to Lower Granite Dam (LGD) and adult production by release/broodyear measured back to the mouth of the Columbia River and to LGD. No goal has been established for juvenile survival to LGD. Adult abundance expressed both as numbers of fish and as rate of return was used as the adult life-stage performance metrics. The rate for return to the Columbia was smolt-to-adult survival (SAS) and rate for return to LGD was smolt- to-adult return (SAR). For a number of programs adult recruits-per-spawner was estimated for both hatchery and natural spawning adults and compared. This provided a measure of the full life-cycle benefit of hatchery rearing to total adult abundance. Information on harvest and straying was inconsistently presented across the reports. The hatchery reports also provided hatchery smolt arrival time at LGD compared to natural smolts, adult migration time, age class, and in some reports spawning distribution compared to natural fish. The ISRP discusses these migration timing, age class, and other life-history metrics below under the topic of hatchery:natural salmon interactions.

3.2. Are performance indicators for fish after release from the hatchery environment adequately measured, reported, and analyzed?

Finding 3.2. Adult SAS and SAR and actual abundance at the Columbia River mouth and LGD were adequately measured, reported, and analyzed. Smolt survival to LGD and comparison to natural smolt survival was difficult to interpret. In some instances bar graphs were used, making it difficult to determine the actual values for a project. Natural smolts will often leave the natal stream as parr, hold in larger streams, and then continue migration the following year. How a comparison of survival was made between this group and those released from a hatchery program was not clearly discussed. Since there were no standards for survival, the interpretation of the survival rate is ambiguous. There was no analysis of the factors that might affect smolt survival to LGD. The subdivision of the adults that do return from the ocean and reach LGD and then contribute to tribal harvest, sport harvest, broodstock, and natural spawning escapement was insufficiently presented for most projects. Some projects reported the number of years that harvest occurred for both tribal and sport fishing constituents, but others only mentioned that there had been fishing seasons some years.

3.3. Are they able to achieve the goals of the projects as planned?

Finding 3.3. No, the LSRCP spring Chinook program has not achieved adult production goals to the Columbia River mouth or to the project area. The LSRCP spring Chinook production was planned to return 293,500 fish to the mouth of the Columbia River and 58,700 fish to the project area (generally considered at LGD). Most years, the production to the mouth has been less than 10% of the goal; the year with the largest returns (2001) produced just over 20% of the goal. Production to the project area has been variable over the last 10 years. In 2001 nearly 90% of the 58,700 fish goal was achieved, in 2005 it was less than 20%. The LSRCP had an SAR to LGD of 0.87% as a planning assumption which also assumed substantial harvest in the lower Columbia River. The 10-year mean SAR was 0.52% with almost no harvest below the project area. A comparison of recruits-per-spawner for hatchery and natural spawning adults did reveal a substantial full-life cycle benefit from the LSRCP. There are many more adult fish as a consequence of the hatchery production.

Recommendations/Conclusions. During the Boise symposium, LSRCP co-managers gave the ISRP the impression that they believed smolt survival from the hatchery or release locations to LGD was reasonable and not an impediment to the program's success. The ISRP believes that smolt survival to LGD needs to be better understood, and that improvements in this river reach might lead to greater numbers of returning adults. The tributary programs with the largest survival to LGD, South Fork of the Clearwater and Imnaha, yielded adult production closer to LSRCP goals and supported fisheries. The written reports should clarify how the returning adults originating from individual tributaries or hatcheries are intended to be used for tribal and sport fisheries, hatchery broodstock, and natural spawning escapement, the number of years that harvest seasons have been allowed, and the extent to which objectives have been achieved. This information was lacking.

4. What are the demographic, ecological, and genetic impacts of the programs on wild fish?

4.1. Are there unambiguous performance indicators and quantitative objectives for those indictors for natural and hatchery fish?

Finding 4.1. There were no easily-obtained, unambiguous, scientifically-justifiable indicators for evaluating the ecological (predation and competition) or genetic (fitness effects of interbreeding between hatchery and natural-origin fish) impacts of hatchery programs on wild salmon populations. The LSRCP is not alone in having challenges in developing indicators to quantify and evaluate these vitally important uncertainties. There was no apparent explicit evaluation of the impact of hatchery smolts on the parr and smolt populations that are resident at the time of releases, including potential residualism of hatchery smolts. Genetic effects were indirectly investigated by comparing age of return of hatchery and natural fish, and tracking the trend in this life-history characteristic in natural fish. Adult females from hatchery-reared spring Chinook cohorts produced more three-year-old fish and fewer five-year-old fish than their natural counterparts. It is not known the extent to which this alteration in life-history may involve selection for specific genotypes. By monitoring the trend through time, the rationale is that if the trend in hatchery fish increased over time it might have a considerable genetic component. If the trend in the natural population started to indicate that younger age fish were increasing, it would support the idea that interbreeding between the hatchery and natural salmon was leading to changes in the genetics of natural populations. The collection of this information is important, but the interpretation is fraught with complications.

The trends over time in both the hatchery and natural populations need to be contrasted to an unsupplemented reference population that is carefully monitored. Without that contrast, trends in the natural population and hatchery population may reflect natural selection to a changing environment. Analysis of the current data does not permit identifying the genetic component of any change or any environmental causes.

There is an ongoing relative reproductive success investigation at Catherine Creek that should provide a better understanding of the effect on population demography from supplementation. Stray rates were estimated for some programs, but this metric was not uniformly presented in the reports. In some streams, the distribution of natural and hatchery spawners (breeding locations) were monitored. Natural- and hatchery-origin salmon spawning distribution is worth continuing and may provide insight into differences in natural and hatchery fitness in the wild.

4.2. Are performance for ecological and genetic impacts adequately measured, reported, and analyzed? See response to 4.1.

Finding 4.2. The information on age structure, migration timing, and spawning distribution was reasonably collected, presented, and analyzed.

4.3. Are they adequately evaluating supplementation (for example using AHSWG recommendations)?

Finding 4.3. The Before-After-Control-Impact (BACI) model used to evaluate supplementation in the Imnaha River is a method that the ISRP believes is scientifically valid. We recommend that this method (or alternatives of similar validity) be used at all locations that have programs that plan to use returning hatchery fish to spawn in the streams. No other program besides the Imnaha evaluates supplementation for the critical endpoint, i.e., a gain in natural-origin adult salmon abundance as a consequence of spawning by hatchery fish. In a stream that is being supplemented, the primary treatment of interest is the natural spawning by hatchery adults and the endpoint of interest is production of adult offspring from the hatchery fish that adds, not replaces, natural production in the stream. The second critical endpoint, the density independent recruits-per-spawner (R/S, productivity) as a measure of the fitness of the natural spawning population, is also evaluated with this BACI model. The analysis of natural-origin return (NOR) abundance evaluates the demographic benefit of supplementation; the analysis of R/S evaluates the fitness cost of supplementation.

Finding 4.4. The BACI analysis of NOR abundance indicated that when contrasted to nine unsupplemented reference locations, the Imnaha River showed decreased abundance post-supplementation relative to five sites, and increased abundance post-supplementation relative to four sites. The BACI analysis found that productivity in the Imnaha River had decreased relative to all nine unsupplemented sites. Based on this analysis and inspection of the trends in NOR abundance in the other supplementation projects, the ISRP concludes that a conservation benefit in terms of NOR abundance is unlikely from supplementation. Based on the analysis of productivity loss in the Imnaha River, the ISRP concludes that costs to population fitness are likely. Quantification of supplementation effects on abundance and productivity needs to be evaluated at the other locations to establish whether this is a case-specific finding or a general one.

Finding 4.5. Relative reproductive success investigations in Catherine Creek established that hatchery-origin adult spring Chinook produced progeny that survived and returned as adults. Hatchery-origin adults spawning in the stream produced parr at slightly higher rates than natural-origin fish (1.03:1), produced smolts at an equal rate (1:1), but produced adults at a lower rate (0.77:1).

Finding 4.6. Inspection of smolts-per-spawner yield in the Lostine River and analyses from Catherine Creek and the upper Grande Ronde River strongly suggest density dependence in smolt production. Density-dependent survival in these watersheds was a factor that appeared to be restricting the increase in smolt production that was expected from increased spawner abundance in the streams.

Finding 4.7. Most of the hatchery programs were self-sustaining. At least one adult female returned to the hatchery or tributary weir from the spawning of an adult female in the hatchery. On this basis, the program might maintain an important genetic lineage that otherwise would become extirpated. Over the long-term, however, hatchery-dominated programs that are implemented to reduce extinction risk will result in genetic changes owing to domestication selection and drift that are likely to offset any demographic benefit.

Recommendation/Conclusions. Analysis of abundance and productivity in the supplemented locations, especially those tributaries where there is a conservation objective in the management plan, is urgently required. The ISRP concludes that there is an absence of empirical evidence from the ongoing projects to assign a conservation objective other than preventing extinction. The supplementation projects as they are currently conducted with high proportions of hatchery fish in the hatchery broodstock and on the natural spawning grounds are likely compromising the long-term viability of the populations. Evaluation of most supplementation projects would benefit from a more thorough comparison with life-stage specific productivity of salmon from unsupplemented reference streams. All programs should evaluate the potential influence of density-dependent effects and investigate why density-dependence was occurring at such low population levels in those streams where it has been observed. In other words, is the capacity of spawning and/or rearing habitat restricting production of smolts when additional adults reach the spawning grounds?

5. How are programs being modified and problems achieving objectives being addressed?

Finding 5.1. Recently, there has been an HSRG and a Service HRT review of the LSRCP hatchery programs. This represents the best available science related to the hatchery programs and their evaluations. Although the LSRCP reports and presentations identified some HSRG recommendations, in general they did not elaborate sufficiently on the recommendations from those reviews and how they were being addressed by the co-managers. For example, for the Sawtooth program (to be split into a segregated mitigation program and an integrated conservation program), quantitative objectives for the integrated program were not provided, nor was there any evidence presented that habitat conditions were suitable for a conservation program. Each report should be specific and provide sufficient detail on the response to the HSRG and USFWS HRT recommendations.

Finding 5.2. The LSRCP analysis and discussion of smolt survival needs to be expanded to incorporate available survival information to the mouth of the Columbia River and to consider transport, hydrosystem passage, and losses to avian, mammal, and piscivorous predators. LSRCP smolts are PIT-tagged at the hatcheries and again at Lower Granite Dam to provide the fish used in the Fish and Wildlife Program Comparative Survival Studies, NOAA survival studies, and the Corp Anadromous Fish Evaluation Program (ACE AFEP) investigations. The insights on juvenile salmon survival from these investigations do not appear to be integrated into the planning to address the inability of the LSRCP spring Chinook program to achieve the SAS and SARs necessary to mitigate for the four lower Snake River dams. In other words, how much additional survival during each life-stage is needed to provide some anticipated level of abundance or harvest (not the original LSRCP goals, which were unrealistic)? A more thorough examination of the life-stage and migration-stage survivals might reveal key limitations and suggest where additional survival benefits are required and may be possible.

CONCLUSIONS AND RECOMMENDATIONS

Conclusion 1. Available evidence suggests that the SAS, SAR, and overall mitigation goals established and the assumptions behind them were overly optimistic. The goals are probably unobtainable even with substantial improvements in Snake and Columbia River environmental conditions.

Recommendation 1. A scientifically-justified (ecologically-based) approach is needed to develop empirical guidance on a realistic harvest mitigation level that might be attainable at some specific time in the future.

Conclusion 2.a. The observation that most hatchery programs have self-sustaining broodstocks supports the argument that these programs may reduce the risk of complete population extirpation. However, the risk of functional extirpation of the natural spawning population is unlikely to be reduced by these programs.

Conclusion 2.b. The BACI analysis from the Imnaha River and inspection of data and trends from other programs with a supplementation design indicate that these programs are not yielding an increase in natural-origin adults over unsupplemented reference locations. There is an absence of support for the argument that these programs provide a conservation benefit by reducing demographic risk. Some analyses suggest habitat improvement is needed in the watersheds before benefits from supplementation might be realized.

Conclusion 2.c. Implementing conservation/supplementation programs using the sliding-scale broodstock management where, over the long-term, the hatchery broodstock has little gene flow from the natural population, and the natural population has a large proportion of hatchery-origin adults, is inconsistent with the scientific framework guidance on the operation of an integrated hatchery program. Operating these programs using the sliding scale over many years carries a high risk that both abundance and productivity will decrease.

Recommendation 2. Take action wherever needed to rapidly establish natural populations that are viable. The LSRCP needs to integrate information on the status of the natural populations into adaptive management of what can or should be done within the hatchery programs to enhance the natural populations.

To ensure that the LSRCP spring Chinook program is conducted using the best scientific information available, it needs to be consistent with the Council's APR (NPCC 1999-15), HSRG scientific framework (HSRG 2004) and HSRG Columbia River basin findings (HSRG 2009).

The 2009 NPCC Fish and Wildlife Program generally adopted the HSRG framework of integrated and segregated hatchery programs, with conservation and harvest mitigation purposes. While the ISRP concludes that conservation purposes beyond reducing extinction risk are unsupportable with the available empirical evidence, we recognize that integrated and segregated harvest mitigation is possible. It is generally accepted that more fish for harvest can be provided using segregated hatchery programs. There are also some examples – spring Chinook in the Deschutes River reared at the Warm Springs Hatchery – of functioning integrated harvest programs (Olson et al. 2004[13]).

The HSRG has argued, and the ISRP concurs, that scientific foundations from population genetics and demography demonstrate that integrated harvest programs require a natural population that is replacing itself, a program where the size of the natural population exceeds

13 Olson, D. E., B. Spateholts, M. Paiya, and D. E. Campton. 2004. Salmon hatcheries for the 21st century: A model at Warm Springs National Fish Hatchery. American Fisheries Society Symposium 44:585-602.

the size of the hatchery population, and a situation where gene flow is greatest from the natural population to the hatchery population (HSRG 2004).

The original, and a primary ongoing, purpose of the LSRCP is to provide harvest mitigation for fish losses attributable to the Snake River dams. Achieving this goal, at any scale, using hatchery production managed consistent with conservation of natural populations will require improving the viability of the natural populations.

ISRP COMMENTS ON INDIVIDUAL PROGRAM SUMMARIES

1. Salmon River

A. Yankee Fork

I. INTRODUCTION

The Yankee Fork Chinook Salmon Supplementation (Yankee Fork) Program was initiated in 2006 (*Intro of written report says 2006, but later (p.11) says 2008*). Chinook in the Yankee Fork are one of the nine populations of Snake River spring/summer Chinook salmon within the Upper Salmon Major Population Group. The ICTRT currently rates the Yankee Fork Chinook population at high risk of extinction; the population is not replacing itself and the geometric mean abundance of 13 spawners is far from the recommended 500 spawners.

In 1977, when Chinook salmon runs across Idaho began to dwindle, the Tribes established sanctuary areas in the Salmon River to allow rebuilding to occur. At the time, the Yankee Fork, along with several other tributaries were designated as permanent areas for Tribal fishing. Hatchery fish from three different Salmon River sources were released to support Tribal fishing; however, once the ESA listing of Chinook occurred in 1992, hatchery fish were not released into Yankee Fork to support Tribal fishing opportunity.

The Tribe's goal is to use hatchery supplementation as a short-term option for increasing Chinook abundance to meet harvest and conservation objectives. The Tribes are working to achieve the long-term goal of returning 2,000 naturally spawning Chinook salmon to the Yankee Fork; consequently, the program will focus on providing natural spawning escapement. Long-term management strategies also include restoring habitat, managing harvest, and monitoring and evaluating fisheries activities to learn adaptively.

The Tribe's long-term adult goal for the Yankee Fork system is divided into four objectives: 1) provide 750 adults for natural spawning (Conservation); 2) provide up to 1,000 adults for harvest in Columbia, Snake, Salmon, and Yankee Fork fisheries (Harvest); 3) allow Tribal harvest using traditional hunting methods including spear fishing, netting, and snagging; and 4) smolt releases of 200,000 – 400,000 initially, until Crystal Springs Fish Hatchery is online, then increase to ~600,000 smolts.

The Tribe's first phase is to develop a locally-adapted Chinook salmon run. Because there are very few natural-origin adults returning to Yankee Fork, the sponsors will release of up to 1,500 pre-spawn adults and 200,000 – 400,000 smolts per year, obtained from Sawtooth Fish Hatchery. Sawtooth hatchery fish will be crossbred with the naturally returning Yankee Fork adults. Once the locally-adapted run is developed, broodstock will be collected entirely from the natural-origin adults returning to Yankee Fork.

<u>Historical data</u>. It would be helpful to provide information in the history/background section on the adult returns and harvest that was achieved during the 1977 – 1991 period when many spring Chinook were stocked into the Yankee Fork.

<u>Genetic and Stock Background</u>. One issue not discussed in the report is the conservation planning for the Yankee Fork independent population of the Upper Salmon MPG. How is it that a Yankee Fork independent population is identified as having persisted at very small adult abundance after having Mackay, Pahsimeroi, and Sawtooth populations introduced into the stream? If there is an independent Yankee Fork population, how can the Sawtooth hatchery

population, which is the primary component of a different independent population, be used to establish the locally adapted stock?

The small redd counts and TRT analysis provide ample evidence that the Yankee Fork spring Chinook population is at high risk of extirpation. The background section emphasizes a non-normal distribution of adult spawning abundance measured as redd counts across years as additional evidence. There is no citation that this criterion serves as an indicator of population risk. Such citation should be provided. If none is available, it would be better to just use the TRT analysis. Otherwise, this criterion will sneak into the grey literature and potential gain usage that is not based on thorough analysis.

It would also be useful to provide a brief discussion of the use of Yankee Fork for Idaho Supplementation Studies (ISS) and Captive Brood projects, and confirm how any conflicts between the projects have been considered and whether these conflicts (if any) are resolved.

Goals and Objectives. The 2,000 adult spring Chinook goal should be partitioned into hatchery and natural-origin goals, and these returning adults should be further partitioned into fish for harvest, fish for hatchery broodstock, and fish for natural spawning. From the second paragraph it appears that 750 adults will escape to spawn, 1000 harvested, but the balance is not allocated to hatchery broodstock. It is not transparent that 250 fish can provide the needed adult returns given existing SARs. There should be a table that summarizes the natural and hatchery smolt production, assumed SARs, adult returns and disposition from each group of fish. This table should also provide the mix of hatchery fish permitted on the spawning grounds, and the natural and hatchery-origin fish used in the hatchery broodstock.

Monitoring and Evaluation. The Yankee Fork project plans on releasing both smolts and adults to provide “supplementation.” The monitoring section states that a BACI design will be used for evaluation, which is welcome, but the details of the methods and the sufficiency of the tagging rates and recovery of fish is not thorough enough to reach a conclusion on the robustness of the plan.

II. DATA

The Tribes plan to use a treatment and control study design to monitor and evaluate the program. Select treatment tributaries such as the South Fork Salmon River, Upper Salmon River, Pahsimeroi River, and Johnson Creek will be used to evaluate supplementation. Control streams will be selected from streams already being evaluated for supplementation under the ISS, since data are already being collected. The study design intends to assess performance of multiple groups of fish within the Yankee Fork and compare their performance to salmon in natural-only control streams.

The Tribe's Monitoring and Evaluation program is largely conceptual at this point as presented in the written project report. Details of the M&E and genetic parentage analysis need to be developed and documented within the project report in order to provide a baseline implementation document. Project cooperators intend to manage adaptively; consequently, it is very important at a project's initiation to describe the project assumptions, field and lab methods in adequate detail, as well as M&E data collection and analytical protocols. Some (or many of these) may change over the course of the project to adjust to environmental and biological variability encountered in dynamic salmon systems. Long-term evaluation of the project's goals and the efficacy of supplementation will be compromised (or impossible) without the development of detailed baseline data and protocols.

The rotary screw trap data on page 10 would be more usefully presented as the results of fish production and emigration from specific management actions – either smolt stocking or natural production from the release of adults the previous autumn. The initial rotary screw trap data indicates challenges and difficulties in actually operating the trap and producing estimates of watershed production. Some discussion of what is needed to resolve these problems is warranted. Finally it would be helpful to show the location of screw trap on a map. Are hatchery fish released above this area, and if so, are hatchery fish enumerated separately from naturally-produced salmon?

In many Idaho streams spring Chinook leave the spawning stream in three pulses – first spring YOY, fall parr, and the second spring smolts (yearlings). The explanation of how all this is going to be sorted out is not transparent. At what life-stage are there going to be production metrics used for evaluation: spring fingerlings, fall parr, yearling smolts? How are sponsors going to figure out which group actually produced most of the returning adults? This seems to be a point of important discussion in some Idaho spring Chinook systems. Are the sponsors going to try to convert fingerling and parr numbers into smolt equivalents for analysis and estimation of SARs etc?

Explanation of estimates of the numbers of individuals that passed the weir undetected, and spawned below the weir is needed (adult trapping, outplants, and redds; Table 3). What methods are used, and will the sizable numbers of fish spawning below the weir and passing undetected compromise analysis of the experiment. It is not evident how to account for the 381 fish return from the 2004 broodyear release of 135,934 smolts in 2006, since only 205 hatchery-origin adults are accounted for in table 3.

III. KEY FINDINGS

The Yankee Fork Chinook Salmon Supplementation Program appears to be its initiation phase (started in either 2006 or 2008). The project is linked with other ongoing Chinook supplementation and research projects in the geographic area.

Early data, which the sponsors discuss, showed a small run-timing shift for hatchery fish when compared with wild fish. Both show bimodal return peaks, with the hatchery-origin fish run shifted about two weeks later than the wild fish. The largest peak for wild fish occurred about mid-July, whereas the main peak for hatchery fish occurred during the first week of September. These life history differences may have adaptive and reproductive differences that will hopefully be elucidated by the parentage analysis and reproductive success studies.

Long-term goals of the project are also tied to a proposed expansion and improvement of the Crystal Springs Fish Hatchery. The Crystal Springs Fish Hatchery proposal also includes plans for constructing adult trapping and holding facility in Yankee Fork, as well as an improved weir. This project report did not describe any details of the weir and would have benefited if some of those details had been included.

Other missing details

Screw Trap: The data that was presented needs to be clarified. There needs to be a definition of fry versus parr (i.e., specific lengths or age of each life history). A time series of captured fish by life stage would help clarify the presentation given that sampling was intermittent over time and total abundance estimates could not be generated. Provide how many fish were PIT-tagged or stained for mark-recapture and the results of the mark-recapture efforts. Provide the length at age of fish over time. Indicate if the goals were reached. Given that problems were encountered (e.g., high water), describe how will sampling be improved so that objectives can be achieved

Smolt release: Provide the location and date of release, mean size at release and how those metrics compare with naturally produced smolts individuals.

Adult trapping: In text, please present annual values, rather than cumulative values since 2008. The sponsors might combine the adult trapping section with the spawning ground section and provide a comprehensive view of fish entering and spawning in the watershed.

Run Timing: Provide the year do these values represent (run timing graphs). It will be interesting to see if the timing pattern of natural and hatchery salmon continues in future years, and to evaluate whether supplementation affects timing characteristics.

Harvests: Please include a table of annual harvests of hatchery versus natural salmon.

Spawning Ground Surveys: Need to provide caption for Fig. 16. Continue to document hatchery versus natural origin spawners. The chart should also show the proportion of fish that are natural.

IV. OUTLOOK AND RECOMMENDATIONS

The Shoshone-Bannock Tribes' Yankee Fork program is in the initiation stage, and MOA supplementation project *Supplementation, Monitoring, and Evaluation Program (BPA project #2008-95-00)* and Crystal Springs Hatchery Master Plan are related to the LSRCP program.

The final Yankee Fork program should reflect and serve the conservation, harvest, and cultural traditions of the Shoshone-Bannock Tribes. Before determining the final program design, the recovery plan and ESA status of spring Chinook in the Yankee Fork needs to be established. The Interior Columbia River Technical Recovery Team (ICTRT) classifies the Yankee Fork as an independent population, but also concludes that genetic evidence suggests past introgression with Rapid River hatchery spring Chinook. In the period from 1980 to 2000 more than 2 million juvenile spring Chinook from Pahsimeroi and Sawtooth hatcheries were stocked into the Yankee Fork watershed. The ICTRT currently rates the Yankee Fork spring Chinook population at high risk of extinction; the population is not replacing itself (20 year geometric mean R/S is 0.80) and the geometric mean abundance of 13 spawners is far from the 500 recommended. Further, the ICTRT concludes that the upper Salmon River spring Chinook MPG can be recovered without the Yankee Fork achieving "viable" status (a natural population with 500 individuals and a Beverton-Holt productivity of 1.9).

If the Yankee Fork spring Chinook are a unique independent population the ISRP does not understand how a program based on salmon from a different independent population (Upper Salmon River mainstem (Sawtooth segregated hatchery stock)) can be consistent with conservation and recovery plan objectives. If the Yankee Fork spring Chinook are a mixture of Upper Salmon River spring Chinook stocks and not essential for delisting, the ISRP does not understand why a program with a substantial conservation objectives that requires rigorous supplementation protocols and M&E is desirable. Consequently, the ISRP wonders if a more realistic management strategy for the Yankee Fork would be to simply manage Yankee Fork spring Chinook as a terminal Tribal fishery designed to avoid interactions with other stocks in the area. That is, management of the Yankee Fork population should be designed and implemented so it does not impede the recovery of other Salmon River Chinook populations.

The Yankee Fork is a small-intermediate size watershed that could lend itself to this discrete management strategy. The combination of the watershed's size with the collection and sorting weirs at the Pole Flats and Five Mile locations, offer an opportunity to achieve harvest and cultural objectives while testing the potential for population expansion following habitat restoration.

Planning: A summary of the HSRG recommendations (sliding scale) for this program should be included, and a discussion of how the recommendations are being considered in the development of the program.

Monitoring and Evaluation: The investigators recognized the limitations of their brief investigation. They indicated the need for parentage studies as a means to evaluate supplementation efforts. However, they should also provide recommendations for improving monitoring of smolts and adults. Detailed tables and graphs should be developed for the project and these should be updated annually as new data are collected.

The Results section did not provide information on the "treatment and control" study that was identified in the study design.

The project report should provide more details, evaluation of the monitoring and findings, and recommendations for improvement in order to better achieve project objectives. The report should comment on observed status versus the production goals that were stated in the Introduction. If natural productivity is exceptionally low, what in-river modifications might be made to improve survival? There was no mention of habitat quality in the Yankee Fork and whether or not quality and quantity of habitat was affecting survival. Are there habitat projects in the watershed? If so, they should be integrated into this effort.

B. South Fork Salmon River

I. INTRODUCTION

The South Fork Salmon River (SFSR) summer Chinook salmon mitigation program was established to provide in-kind mitigation for summer run Chinook salmon losses associated with the four lower Snake River hydroelectric dams. The McCall Fish Hatchery is responsible for all the incubation and rearing for this program. The hatchery and the associated satellite facility were constructed in 1980.

The natural populations of Chinook salmon in the SFSR were listed as threatened in 1992 and the hatchery population was added to the listing in 2005. The ICTRT (2005) status assessment of the SFSR natural population indicates the population is not viable, is at a high risk for abundance and productivity, and is at moderate risk for spatial structure and diversity.

The LSRCP adult mitigation goal for the McCall Fish Hatchery is 8,000 adult Chinook salmon above Lower Granite Dam (LGD) and 32,000 adults available for downriver (Columbia and lower Snake rivers) commercial and sport harvest. The release goal is 1 million smolts and is based on a 0.80% smolt-to-adult survival rate applied to the LGD mitigation objective of 8,000 adults. All smolts are transported from the McCall Fish Hatchery and released directly into the upper SFSR at Knox Bridge (RKm 115).

Management Objectives for the SFSR Chinook salmon program are to meet the LSRCP adult mitigation objectives, to restore and maintain natural populations of Chinook salmon in the SFSR, to restore and maintain recreation and tribal Chinook salmon fisheries, and to minimize the impact of the McCall Fish Hatchery and SFSR Trap.

Monitoring and evaluation (M&E) objectives for the SFSR include monitoring production, productivity, and life history characteristics of hatchery and natural populations, and to evaluate broodstock and rearing strategies to increase and maximize adult returns. M&E activity on the SFSR is a cooperative effort between the Idaho Department of Fish and Game (IDFG) and the Nez Perce Tribe (NPT).

The broodstock history for the SFSR has been continually changing since the program's inception. This has made it impossible to estimate the contributions of the several founding stocks and difficult to evaluate the program. In recent years, the program has swung from focusing on segregated hatchery origin broodstock (1995-2009) to an integrated stepping-stone broodstock protocol, which was initiated in 2010.

<u>Management and Monitoring/Evaluation Objectives</u>. It is not clear how the actions in this program contribute to the objective "restore and maintain natural populations of Chinook salmon in the SFSR," or how the program is being implemented to "minimize the impact of the hatchery program on the natural Chinook populations in the SFSR." The sentences on monitoring and

evaluation do not identify the individual metrics that are being used to evaluate the various program objectives. Some are self-evident, e.g., adult abundance, harvest, etc, but other objectives are not, e.g., restore and maintain natural populations and minimize impacts. It would be helpful to identify how the information is being gathered. For example, are estimates of adult abundance determined from CWT data collected at LGD or the hatchery rack? Is there representative PIT-tagging and CWT-tagging?

Status of Natural Population. Additional specific details would enhance this section. The section states that the SFSR mainstem is part of a SFSR major population group that has four independent populations. Identify the ESU, the names and number of MPGs in the ESU, and then name the SFSR MPG independent populations and perhaps provide a map with their geographic distribution. There should be a description of where this hatchery program interacts with other spring Chinook populations, and the nature of the interaction. For example, genetic interactions may occur in tributaries where hatchery fish stray. It would be helpful to include a figure showing the trends in abundance of natural stocks and the viability assessment/recovery plan thresholds for viability.

II. DATA

The written and Power Point reports both presented many trend figures that were interesting. The results and performance of the SFSR program appear typical of many that we saw at the symposium – consistent problems in the early years with survival, within-hatchery mortality, and failure to reach program level goals for juvenile release numbers, while results for the last decade or so document programs that have addressed within-hatchery issues and are mostly reaching juvenile release numeric goals.

Adult returns. SFSR hatchery returning salmon have reached the program SAR goal of 0.80% in only 7 of 35 years (20%; Figure 6). SARs for ISS smolts in general are lower than those recorded for smolts produced by SFSR adults, but have also only reached the 0.80% goal about 20% of the years.

A description of how adults at LGD partitioned into the different Snake/Salmon river MPGs and independent populations would be useful. Are there hypotheses on how/why juvenile survival from release to LGD is greater for hatchery than wild smolts, yet SARs are lower for hatchery fish from smolt to adult?

Life history characteristics and age composition. It is not clear from the text and figures whether the age composition data is estimated for a “run” year or a “brood” year. Given the variation in survival from brood year to brood year, it seems that should be how age classes are reported, not on run years. As an aside, in the figure showing age composition (comparing 1-ocean to 2-ocean and 3-ocean fish), it would have been easier to see trends using a stacked bar graph than 3 separate line graphs.

III. KEY FINDINGS

Like many of the LSRCP hatcheries, the SFSR hatchery has made admirable progress over its roughly 30-year history toward solving in-hatchery production problems and achieving within-hatchery survival, and occasionally, production goals, depending upon broodstock availability. However, the mixed pedigree of the broodstock, the ever-changing broodstock management strategy, and the shifting nature of the supplementation strategy (from segregated to integrated stepping-stone over the last few years) creates uncertainty about what we can expect to learn from the SFSR supplementation experiment, as well as uncertainty about its future performance. A constantly shifting program becomes difficult to track and assess due to shifting goals and shifting data baselines.

While methods were not described, key metrics were presented in the report and presentation. It would be helpful if the data reporting were summarized as explicit statements reflecting the managers' self-evaluation of how well the program is achieving the objectives established.

Smolt survival. Please comment on why survival of hatchery smolts to LGD is consistently higher than that of natural smolts given that survival to adult stage of hatchery smolts is consistently lower. Does high early survival of hatchery smolts reflect distance or size? This finding is opposite that of Upper Salmon River spring Chinook.

Smolt-to-adult survival of natural smolts is much higher than that of hatchery fish. If available add the adult return per spawner for natural spawner to the report. If it is not available summarize the information from the ICTRT viability assessment. Discuss if their habitat characteristics in the watershed that could be improved as a means to enhance spawner-to-smolt survival.

The presentation of life history data of hatchery and natural Chinook was helpful. Older age of maturation by natural Chinook is important because older fish produce more numerous and larger eggs and therefore contribute to higher adult returns per spawner. Are there any differences in mean length-at-age of hatchery versus natural Chinook (ANOVA test)? It is difficult to tell from graphs given the Y-axis scale.

Stray rate. Indicate if the reported values estimated the percentage of the hatchery return that stray to streams. Provide any information on the fraction of natural spawners that are hatchery strays. If there is natural spawning near the weir site, provide what fraction are hatchery fish.

IV. OUTLOOK AND RECOMMENDATIONS

The TRT concluded that the natural population was not viable. What is needed to make it viable? What is the annual return per spawner of natural Chinook? Can tributary habitat or mainstem river conditions be improved sufficiently to allow a viable natural population? Or is hatchery production essential in the next decade or so in order to maintain fish returning to this region? What is needed to meet the management objectives that were stated in the introductory comments? Are management objectives realistic or should they be re-evaluated?

The "Summary and Outlook for the Future" section of the written report describes in broad brush the future direction of the program including the implementation of Parental Based Tagging (PBT), which along with CWTs, will be used to monitor catch contribution and stock identification. This section should also include a brief summary of the findings from the USFWS hatchery review and the HSRG review, and how the program is addressing those findings.

The Summary section also describes the integrated stepping-stone approach to supplementation that includes maintaining two broodstocks (integrated and segregated). Returns from the integrated brood will be used to supplement the natural-origin population above the hatchery weir and produce the next generation of integrated broodstock. Weir and broodstock management will be based on a sliding scale approach. There is text indicating that this program will initiate supplementation above the existing weir. The management and monitoring of that program should be summarized.

While this may be a very pragmatic approach to managing the SFSR Chinook stock, it (coupled with the mixed artificial production history of the stock) is one that encompasses significant uncertainty with respect to rebuilding a natural population and the fitness effects of such a strategy. The detailed methods of this approach and consideration of the uncertainties associated with it are not addressed in the written document and deserve greater discussion and scrutiny. It is our recommendation that the SFSR plans that design the dual programs be reviewed by the ISRP or an equivalent body when it is available.

C. Upper Salmon River

I. INTRODUCTION

The natural population of Chinook salmon in the Upper Salmon River was listed as threatened in 1992, and the hatchery population was added to the listing in 2005. From 1991 to 2009, the estimated natural-origin adult abundance in the Upper Salmon River mainstem population has ranged from 18 to 1,431 fish. The Interior Columbia Technical Recovery Team (ICTRT) concluded that the USR natural population is not currently viable, is at a high risk for abundance and productivity measures, and is at moderate risk for spatial structure and diversity.

The Upper Salmon River (USR) spring Chinook salmon program was established in 1985 to provide in-kind mitigation for losses of spring run Chinook salmon associated with the construction and operation of the four lower Snake River hydroelectric dams. The Sawtooth Fish Hatchery is located on the Salmon River approximately seven miles upstream from the town of Stanley, Idaho. All adult trapping, spawning, incubation and rearing occurs at this facility. Currently, this facility is used to monitor adult abundance of the natural population and no broodstock is collected at this site.

The LSRCP adult mitigation goal for the USR spring Chinook program is 19,400 adult Chinook salmon above Lower Granite Dam (LGD) and 77,000 adults available for downriver sport and commercial harvest. The original release target of 2.3 million yearling smolts was based on an assumed 0.87% smolt-to-adult survival rate applied to the LGD mitigation objective; however, due to limitations with well water availability and ice thickness in outdoor rearing containers during the winter months, the actual facility capacity was adjusted down to 1.7 million yearling smolts. Currently, the release strategy is for 1.5 million smolts released directly into the Salmon River at Sawtooth Fish Hatchery and 200,000 smolts released into the Yankee Fork as part of the Shoshone Bannock Tribe supplementation program.

Initial broodstock for the USR program was collected at a temporary weir in the Upper Salmon River from 1981 to 1984. It was estimated that approximately 50% of the two-ocean broodstock collected in 1981 were from the release of Rapid River hatchery smolts in 1979. A similar proportion of the three-ocean returns in 1982 were assumed to be from the same hatchery release. Since 1983, all broodstock have been of USR origin. Because mass marking was not initiated until brood year 1991, the origin of adult returns (hatchery or natural) could not be distinguished until 1995.

The broodstock history and AP strategy for the USR has changed several times since the program's inception. This has made it impossible to estimate the contributions of the USR and Rapid River founding stocks and difficult to evaluate the program. Prior to 1995 the program was a de facto integration/supplementation program with both hatchery- and natural-origin adults incorporated into the broodstock and also released above the weir to spawn naturally. In recent years, the program has swung from focusing on segregated hatchery origin broodstock (1995-2009) to an integrated stepping-stone broodstock protocol, which was initiated in 2010.

Management and Monitoring/Evaluation Objectives. It is not clear how the actions in this program contribute to the objective “restore and maintain natural populations of Chinook salmon in the USR,” or how the program is being implemented to “minimize the impact of the hatchery program on the natural Chinook populations in the USR.” The sentences on monitoring and evaluation do not identify the individual metrics that are being used to evaluate the various program objectives. Some are self-evident (e.g., adult abundance, harvest) but other objectives are not (e.g., restore and maintain natural populations and minimize impacts). It would be helpful to identify how the information is being gathered. For example, are estimates of adult abundance determined from CWT data collected at LGD or the hatchery rack? Is there representative PIT tagging and CWT tagging?

A table summarizing the planning assumptions for this program would help. See table 1 in the Imnaha report for an example.

Broodstock History. This section notes that broodstock collected in 1981 (and 1982) likely included adults from Rapid River smolts released into the upper Salmon River in 1979. It appears to be appropriate and necessary to provide an expanded explanation of Chinook salmon smolt releases in the upper Salmon River in the years preceding the development of this program.

Status of Natural Population. Additional specific details would enhance this section. The section states that the USR mainstem is part of a USR major population group that has nine independent populations. The sponsors should identify the ESU, the names and number of MPGs in the ESU, and then name USR MPG independent populations, and provide a map with their geographic distributions. There should be a description of where the USR hatchery program interacts with other spring Chinook populations, and the nature of the interaction. For example, genetic interactions may occur in tributaries where hatchery fish stray. It would be helpful to include a figure showing the trends in abundance of natural stocks and the viability assessment/recovery plan thresholds for viability.

The USR written report contains adequate background information and project objectives, but the format should be standardized with that of the other spring Chinook hatchery reports. This summary was consistent with that presented for the South Fork Salmon, but it was quite different from the summary of the Yankee Fork investigation, which is relatively new.

II. DATA

Methods were not described, but key metrics were presented. Greater detail, or references to key documents where the methods are adequately described, would be of benefit to the report.

Hatchery survival and production. A comparison of the observed pre-spawning mortality, fecundity, egg take, and egg–to-smolt survival to the planning assumptions would improve the presentation.

Adult returns LGD. An explanation of how adults at LGD are partitioned into the different Snake/Salmon river MPGs and independent populations; whether they are these based on CWT or PIT tag data, and the precision of the estimates would improve the report. How robust are the estimates?

Life history characteristics. The figures showing age composition (comparing 1-ocean to 2-ocean and 3-ocean fish) should use a stacked bar graph rather than 3 separate line graphs.

III. KEY FINDINGS

Like many of the LSRCP hatcheries, the USR hatchery has made admirable progress over its 26-year history toward solving in-hatchery production problems and achieving within-hatchery survival, and occasionally, production goals, depending upon broodstock availability. The mixed pedigree of the broodstock and the shifting nature of the supplementation strategy (from segregated to integrated stepping-stone over the last few years) create uncertainty about what we can expect to learn from the USR hatchery program, as well as uncertainty about its future performance. A constantly shifting program becomes difficult to track and assess due to shifting goals and shifting data baselines.

Data Reporting. It would be helpful if the data reporting were summarized as explicit statements reflecting the managers' self-evaluation of how well the program is achieving the objectives established in the background.

Smolt Survivals. Why is release to LGD survival higher here for natural versus hatchery smolts, a pattern that is opposite that for the South Fork?

Survival of subyearling releases was determined to be too low. Can this information be applied to the natural Chinook; do natural Chinook also have high mortality? If so, what is needed to improve survival of natural Chinook while rearing in the watershed?

Adult Survival. Please provide adult return per spawner data for the natural component, if possible, and evaluate sustainability, including the degree to which survival must improve to provide sustainability and sustained harvest. Can sustainability of natural runs be achieved with ongoing actions to improve survival, or is "sustainability" totally dependent on highly favorable environmental conditions that are not likely to persist?

Adult timing. The high degree of synchrony of hatchery and natural Chinook return timing suggests that time cannot be used to reduce bycatch of natural Chinook. Harvests of hatchery Chinook were presented (Note: two Figure 10s were shown). How many natural Chinook were harvested?

Straying. Are the presented values the percentage of hatchery fish on the spawning grounds or fraction of hatchery return that were found in streams? If the former, it would be good to present information on the locations sampled and level of effort. If the former, it is surprising that only 0.59% of the spawners were hatchery origin given that hatchery fish tend to stray, harvest rates are low, and natural fish abundance is very low.

IV. OUTLOOK AND RECOMMENDATIONS

The TRT concluded that the natural population was not viable. The "Summary and Outlook for the Future" section of the written report describes in broad brush the future direction of the program including the implementation of Parental Based Tagging (PBT), which, along with CWTs, will be used to monitor catch contribution and stock identification. This section should also include a brief summary of the findings from the USFWS hatchery review and the HSRG review, and how the program is addressing those findings. The project sponsors also indicate that development of an HGMP is underway. It is our recommendation that the USR HGMP be reviewed by the ISRP or an equivalent body when it is available.

The Summary section also describes the integrated stepping-stone approach to supplementation that includes maintaining two broodstocks (integrated and segregated). Returns from the integrated brood will be used to supplement the natural-origin population above the hatchery weir and produce the next generation of integrated broodstock. Weir and broodstock management will be based on a sliding scale approach. There is text indicating that this program will initiate supplementation above the existing weir. The management and monitoring of that program should be summarized.

The program anticipates being split with a portion being conducted as a segregated program and a portion implemented as an integrated program. The integrated program will produce adults to supplement the natural population above the hatchery. As designed by the HSRG (2005) an integrated artificial production program requires a natural population that is above replacement. It is not clear to the ISRP that abundance and productivity of the natural population are sufficient to implement an integrated program. Given the response in natural abundance from other supplementation programs for spring Chinook it is not evident that additional natural adults will be produced to provide the foundation for an integrated program. These issues should be carefully discussed and considered in the summary section. It is our recommendation that the USR plans that design the dual programs be reviewed by the ISRP or an equivalent body when it is available.

Analysis of the hatchery and natural Chinook data should lead back to objectives. What is needed to achieve the objectives (or are objectives unreasonable given current conditions)? Are there habitat issues that need to be addressed? Where are the major bottlenecks for survival and which bottlenecks might be altered to improve survival. For example, if sufficient natural spawner data are available, one could calculate smolts per spawner and smolt survival to LGD. Are these values high or low, and can survival during these life stages be improved? Or is it essential that smolt survival through the hydropower system be improved. Low, moderate and high survival at sea should be considered when evaluating survival requirements during each life stage.

2. Clearwater and Tucannon

A. Clearwater

I. INTRODUCTION

The Clearwater Fish Hatchery near Ahsakha, Idaho and its three outlying facilities (Powell, Red River, and Crooked River) comprise the largest hatchery complex constructed by the Army Corp of Engineers under the LSRCP. Construction began in 1986 with the Red River satellite facility and ended in 1991 with the completion of the main Clearwater Hatchery. The three satellite facilities function variously for trapping, spawning, rearing, and acclimation. The Idaho Department of Fish and Game (IDFG) operates the hatchery.

As described by IDFG, “The main hatchery consists of two separate incubation facilities, 24 outdoor raceways for steelhead rearing, 11 outdoor raceways for Chinook rearing, an adult holding and spawning area… [The hatchery] receives its water through a uniquely designed pipeline. Two pipelines pass through 25 feet of solid concrete in the middle of the Dworshak Dam. Water is carried 1.8 miles downstream where energy is dissipated through a hydroelectric plant. The water then continues through the two separate pipelines delivering water of two different temperatures to the rearing facility. The delivery of two separate water temperatures allows Clearwater Hatchery to raise spring Chinook salmon … at optimum rearing temperatures" (http://fishandgame.idaho.gov/fish/hatcheries/clearwater.cfm). Since the 1990s, the spring Chinook program has used locally adapted stocks. Since 2005, the program has moved primarily toward smolt releases because of low survival of parr.

II. DATA

Data presented to evaluate success consisted of broodstock performance (% prespawn mortality), in-hatchery survival, number released, percent (parr or smolt) survival to LGR, number of adult returns to the Lower Columbia River, number of adult returns to LGR, smolt-to-adult survival rate (SAS), smolt to adult return (SAR), and in-river state and tribal harvest. Life history data for assessing hatchery and wild differences include run timing, age composition, length-at-age, spawning timing, and fecundity. Known strays of adults were also assessed above and below LGR.

III. KEY FINDINGS

1. Fish performance in the hatchery is documented and appears to be adequate and consistent with standards of other rearing operations in the basin. There is demonstrated success at producing apparently healthy fish at release. There was little information presented to indicate if and how other aspects of smolt quality are being significantly improved upon or evaluated in the hatchery at this time.
2. The shift to native broodstock and to releases of full term smolts, rather than parr, has been justified based on post-release survival performance; however, the management change appears to have also resulted in increased production of jacks.
3. Although performance of fish in the hatchery is measured based on survival, and in-hatchery survival rates appear to be adequate to the smolt stage (generally 70% and above except for the South Fork in 2008), survival as measured by SASs and SARs is not. With low SAR and SAS results, the hatchery is not producing adult returns that meet its mitigation goals. The program is averaging 5% of mitigation goals to the mouth of the Columbia and a maximum success of only 18.5% of its mitigation goals.
4. Released smolts are showing erratic and low survival rates. Measures of these survival rates and other life history aspects (size, age at return, etc.) seem appropriate, although the information provided is not sufficient to provide much insight as to why overall survival is so low.
5. The ecological and genetic impacts of the programs on wild fish are shown primarily through comparisons of life history characteristics between hatchery and wild fish. Although in the presentation it was concluded that impacts to wild fish were not significant, we note that the percentage of jacks among hatchery fish returns has increased in BY 2002 and 2003, and that returns of jacks were higher in 2007, 2008, and 2009, and returns of 3 SW fish were lower.
6. Survival rates of smolts have declined from the mid-1990s as numbers of smolts released has increased. The causes of this undesirable pattern are not identified.
7. Evaluation of supplementation could be improved. In particular, it was not clarified why survival rates of wild smolts exceeded hatchery smolts in 1994-1996, but not in any recent years except 2007 (by a narrow margin). Has the quality (or size) of hatchery

smolts risen sufficiently or is there some unknown interaction of released fish and wild fish?

8. It is unclear why survival to Lower Granite Dam is only 60-70%, whereas it is higher for releases from Powell. What are the primary factors affecting survival of both the hatchery and wild smolts, and how well is that understood?
9. No information was provided on the possibility of residualization of precocious males (mini-jacks) from these increasingly large smolt releases and potential effects on wild fish. This issue may deserve study and discussion among LSRCP entities.

IV. OUTLOOK AND RECOMMENDATIONS

The low SARs indicate that existing approaches for rearing and releasing smolts do not result in fish capable of returning as adults to the Columbia River and Lower Granite Dam in numbers sufficient for meeting existing LSRCP mitigation goals. Under existing conditions, the long-term outlook for successfully meeting project area mitigation objectives is not favorable and appears unlikely. The overall mitigation goals of returning 59,500 fish to Columbia River mouth and 11,900 adults above Lower Granite do not appear achievable within the foreseeable future. No actions proposed seem to provide much likelihood of an improved outlook. The main benefit of the program as of 2010 has been to provide modest state recreational and tribal harvest fisheries, which, from any perspective beyond satisfying immediate harvest demands, do not seem justifiable unless it is shown that those fish, if not harvested and allowed to spawn, would result in reproductive success leading to a density dependent suppression of the natural production potential of the basin. The genetic and long-term fitness implications of the harvest are not evaluated. A science-based plan for deciding the most goal-oriented disposition of returning adults (harvest, allow to spawn naturally, broodstock, etc.) was not provided. A key question is how many fish should be used to meet longer-term mitigation goals before immediate harvest is pursued. At present, the only realistic prognosis for this program is to provide the modest fishery well below its mitigation goals.

In addition, it would be useful to have the information presented in terms of the Interior Columbia River Technical Recovery Team (ICTRT) goals and findings on VSPs, as well as HRSG review and recommendations, and a description of how the program releases are justified when the these recommendations are considered.

B. Dworshak

I. INTRODUCTION

Dworshak Hatchery is located at the confluence of the North Fork and the mainstem Clearwater River, Idaho, below Dworshak Dam. LSRCP spring Chinook salmon goals are 9,135 adults above LGD after an expected 36,500 combined harvest in ocean, Columbia River, and Lower Snake River fisheries (45,635 fish), and a production goal of 1.05 million smolts. Hatchery objectives are to provide recreational and tribal fish for harvest, return sufficient broodstock to meet annual production needs, minimize impacts to natural populations, and assist other programs in the Clearwater basin. The hatchery is not located in a natural spawning area.

II. DATA

Data presented to evaluate success consisted of broodstock performance (% prespawn mortality), , in-hatchery survival, number released, percent (parr or smolt) survival to LGR, number of adult returns to the LGD, number of adult returns to LGD, smolt-to-adult survival rate (SAS), smolt to adult return (SAR), and in-river state and tribal harvest. Life history data for assessing hatchery and wild differences include run timing, age composition, length-at-age, spawning timing, and fecundity, but without comparisons to wild fish for reference. Known strays of adults were also assessed above and below LGD.

III. KEY FINDINGS

1. Fish performance in the hatchery is well-documented and appears to be adequate.
2. The shift to native broodstock and to releases of full term smolts rather than parr has been justified. One result, however, has been an increase in the production of jacks.
3. Although performance of fish in the hatchery is measured based on survival, and in-hatchery survival rates appear to be adequate to the smolt stage (mean 83.2%), there was little information presented to indicate that other aspects of smolt quality are being significantly improved upon at the hatchery at this time.
4. Fish culture performance is within expected standards; however, survival as measured by SASs and SARs is not.
5. Released smolts are showing erratic and low survival rates. Measures of these survival rates and other life history aspects (size, age at return, etc.) seemed appropriate, although the information provided is not sufficient to provide much insight as to why overall survival is so low.
6. The ecological and genetic impacts of the programs on wild fish are not evaluated in the material provided. As in the Clearwater hatchery, we note that the percentage of jacks among hatchery fish returns has increased in 2007, 2008, and 2009 return years.
7. It is also clear that survival rates have declined from the mid-1990s. The causes of this undesirable pattern are not discussed.
8. The program is operating well below expectations in terms of mitigation goals. It has met or exceeded its upriver goal only in 2001; over the period 2005-2009 returns above LGD have not exceeded 45% of the goal of 9,135 fish. Return to the Columbia River has been less than 10% of total adult fish goals for the most two recent years.

IV. OUTLOOK AND RECOMMENDATIONS

Under existing conditions the long-term outlook for successfully meeting project area mitigation objectives is not favorable. It does not appear that overall goals are achievable within the foreseeable future. No actions proposed seem to provide much likelihood of an improved outlook. The main benefit of the program as of 2010 (and the prognosis) is to provide continued State recreational and Tribal harvest fisheries well below mitigation goals. A science-based plan for deciding the most goal-oriented disposition of returning adults (harvest, allow to spawn naturally, broodstock, etc.) was not provided. This analysis should be linked to LSRCP activities at the Clearwater hatchery. To an outside evaluator, the close proximity of the Clearwater and Dworshak LSRCP programs suggests that the programs should be combined and administered jointly with an overall goal-setting process. A key question is how many fish should be used to meet longer-term mitigation goals before immediate harvest is pursued.

C. Tucannon

I. INTRODUCTION

The Tucannon Hatchery functions jointly with Lyons Ferry Hatchery as a rearing facility. Fish for broodstock are trapped at the Tucannon Hatchery (excess fish marked and released above the trap), trucked to Lyons Ferry Hatchery and held until spawning. Rearing through the fingerling stage is at the Lyons Ferry Hatchery, when the fish are transported to the Tucannon Hatchery for rearing. Pre-smolts are moved to Curl Lake for acclimation before release as smolts.

It was estimated during mitigation negotiations that 2,400 Chinook salmon historically returned to the Tucannon River, and that the mitigation goal for the two Snake River dams below the river would consist of a goal of 1,152 returning adult fish. It was also assumed that 4,608 adult salmon (1,152 x 4) would be harvested below the project area. The expected SAS was 0.87%, so that 132,000 smolts would be needed for the program to meet LSRCP mitigation goals.

II. DATA

Data presented to evaluate success consisted of broodstock performance (% prespawn mortality), in-hatchery plus acclimation survival, number of smolts produced and released, redd counts above and below weir, percent of the run that is natural fish, hatchery origin and natural escapement to the Tucannon River, strays and recoveries in various downriver and ocean fisheries, run timing of hatchery and natural adults, smolt emigration timing, smolt-to-adult survival rate (SAS), smolt to adult return (SAR) by origin (natural, hatchery), percent survival of smolts versus fish size at release, and progeny per parent ratio (hatchery and natural). Comparisons of hatchery versus natural versus captive broodstock fish were made for several life history traits, including age composition, fecundity, egg size, and reproductive effort. Several correlative analyses were also conducted in an effort to assess density dependence and factors leading to the suppressed natural production.

III. KEY FINDINGS

1. Fish performance in the prespawn, hatchery, and presmolt acclimation phases was documented and appears to be adequate. It was all native broodstock; marked strays were removed from the system. Pre-spawn mortality of adults has been greatly reduced (<10%) by holding the fish at Lyons Ferry Hatchery. Eyed egg-to-smolt survival from 2005 to 2008 has exceeded 90%. The number of smolts produced has approached the 132,000 goal but is well below the revised 225,000 goal designed to meet mitigation losses at existing SAS rates. There was some information presented to indicate that smolt survival may improve by releasing larger smolts. Disease issues were not a major impediment.

2. Although fish culture performance was within expected standards, survival of hatchery fish as measured by SASs and SARs was not. Although SARs met the 0.87% goal in 1997, SARs over the most recent 5-year period has ranged from approximately 0.10-0.30%. Natural SARs were several times higher than hatchery SARs.

3. The program was operating well below expectations in terms of mitigation goals. At current mean survival rate of 0.21%, it would theoretically take more than 500,000 smolts to meet the mitigation goal of 1,152 fish.

4. Released smolts were showing erratic and low survival rates. Measures of these survival rates and other life history aspects (size, age at return, etc.) seems appropriate, although the information provided was not sufficient to provide much insight as to why overall survival was so low.

5. The ecological and genetic impacts of the programs on wild fish are shown primarily through comparisons of life history characteristics between hatchery and wild fish. The percentage of precocious males may reduce adult returns. Adult hatchery fish had a younger age composition and earlier migration timing than wild fish.

6. Information was provided on the possibility of residualization and male precocity from the increasingly large smolt releases and potential effects on wild fish. Residualization (mini-jacks) is an issue deserving more study. Effects of mini-jacks on SARs should be evaluated.

IV. OUTLOOK AND RECOMMENDATIONS

Under existing habitat conditions, the long-term outlook for successfully meeting project area mitigation objectives is not favorable. While fish culture performance was within standards expected for salmonids in general, the low SARs indicate that existing approaches for rearing and releasing smolts do not result in fish capable of returning as adults to the Columbia River and Lower Granite Dam in numbers sufficient for meeting existing LSRCP mitigation goals. Although releasing more and larger smolts may provide returns closer to goals, the much lower SARs for hatchery fish than wild fish are causes for concern (and even the wild fish are not replacing themselves in most years). Releasing larger smolts may also increase residualization of the incidence of min-jacks. The lack of adult replacement along with the bimodal (biseasonal) emigration timing of wild fish suggests that their historical life history may have involved some of the stock rearing to smolt size in the Tucannon River, but another segment, and perhaps the larger portion, emigrating early and rearing in the Snake River mainstem for several months or more prior to smoltification. The reduction in this life history (low survival in response to mainstem modifications) may be the cause of wild fish remaining below replacement in most years. Proposed instream habitat improvements may improve survival of natural fish to some extent. Field evaluation of potential density dependence should be included in the evaluation of this effort.

D. Genetic Analysis of Tucannon

I. INTRODUCTION

The Tucannon River is a tributary of the Snake River in southeastern Washington. In 1985, the spring Chinook supplementation program was initiated in the Tucannon River by capturing wild endemic adults and spawning them at the Tucannon River Hatchery. By 1989, the hatchery was integrating natural and hatchery-origin spring Chinook in the broodstock and both natural and hatchery-origin spring Chinook were naturally spawning in the river.

Spring Chinook in the Snake River basin (including the Tucannon River) were listed as Endangered in 1992 by NMFS; however, the status was changed to Threatened in 1995. Adult returns declined precipitously during the mid-1990s and a captive brood program was proposed by WDFW and the co-managers in addition to the supplementation program that began in 1985. The captive broodstock program began in 1997.

The hatchery programs in the Tucannon River (supplementation and captive brood) are being conducted with the possibility that artificial propagation may have negative effects on the genetic profile of spring Chinook in the Tucannon River. The genetic effects could result in fitness loss and reduced reproductive success.

This study used microsatellite DNA analysis to evaluate spring Chinook from three spawner groups (in-river spawners; supplementation spawners, and the captive brood program). Analyses of natural- and hatchery-origin fish were also used to determine the impacts of spawner group in addition to spawner origin. Analysis was conducted on collections from 1986, 1997 – 1998, and 2000 – 2008. The collection from 1986 was prior to the return of Chinook that were produced by the supplementation program and was therefore a collection of the wild endemic stock. Analysis of the 1986 collection provided a baseline measure of the genetic diversity of Tucannon River spring Chinook prior to the supplementation program and allowed evaluation of genetic changes over 12 years including the time of the captive brood program in the Tucannon River.

II. DATA

Data and methods were adequate for the questions being addressed in the project. A total of 2,545 samples were analyzed at 14 microsatellite loci (13 coastwide GAPS loci plus Ssa-197). Eight different groupings of samples were analyzed to determine if there were genetic differences among hatchery or natural-origin samples, in-river, or supplementation samples, and the captive brood, as long as for differences among brood years or collection years.

III. KEY FINDINGS

The results of the genetic analysis in the Tucannon River suggested that genetic diversity of spring Chinook salmon has not changed as a result of supplementation or the captive brood program. While the initial analysis showed many significant differences among the various Chinook samples from the different collections, variation occurred primarily around the year of collection and did not show patterns of change over time.

Analysis was conducted on the supplementation and in-river collections by collection year and by brood year to determine if genetic changes were a result of individuals from different brood years spawning together. Overall, there were no differences between the analysis of the collection years and brood years (one locus for one collection not in Hardy-Weinberg equilibrium and low number of loci comparisons with significant linkage disequilibrium).

Hatchery and natural-origin samples were also analyzed to determine if there were any genetic differences that resulted between individuals that had different origins. The results of the analysis by collection year and brood year did not reveal any patterns in the genetic differences among collections that could be attributed to differential survival of the genetic ancestries. The differences that were detected were from differences that occurred among the collection years.

Finally, the factorial correspondence plots of mean values for the temporal in-river and supplementation collections with the natural origin collection from 1986 showed that the collections were differentiated, but that the results for the collection from 1986 laid between the groups of the other temporal collections. The genetic diversity of these collections has therefore not been altered from the 1986 natural-origin collection but maintained a genetic difference that existed among years. This suggests that the supplementation and captive brood program have not homogenized any of the spawner groups because they remain grouped with the collections based on their spawner group or origin.

IV. OUTLOOK AND RECOMMENDATIONS

This study documented a thorough and systematic examination of the genetic profile of the natural-origin Chinook stock based on 1986 samples, prior to initiation of the supplementation or captive brood programs, and in-river, supplementation, and captive brood lines after the program's start. While the analyses documented many differences among the different groups, differences appeared to be primarily related to broodyear or year of collection and not to the genetic divergence of the three groups.

Consequently, from this point forward, a reduced genetic sampling program (reduced in scale, frequency, and perhaps relying on key genetic markers) should be sufficient to monitor the program and detect divergence among the three groups, should that start to occur.

Adult returns of Chinook salmon and smolt-to-adult return rates (SARs) to the Tucannon River appeared to be following the same patterns observed elsewhere in the Salmon and Clearwater systems. Programs appeared to be producing adequate numbers of smolts, but failed to return adequate numbers of adults. This study is of limited value in addressing the perplexing question of why recruitment of natural adults remains below replacement or why SARs are so much lower for hatchery fish than natural fish.

3. Grande Ronde

A. Grande Ronde Spring Chinook Captive

I. INTRODUCTION

The introduction and background information clearly defined the stock status and history, and the experimental approach where parr were collected as captive broodstock (three streams). Success will be determined by a positive change in natural origin returns. That stage has not yet been reached. Natural origin abundance declined to zero in some of the tributaries prior to the study – no reason was given, where there should have been. Trends in Chinook abundance indicated a clear delineation of the 1976/1977 and 1989 ocean regime shifts as likely causes in the trends in abundance (this was not discussed). Nine management objectives were tabled which related to the captive brood stock (CBS) work. 2010 was the last year of CBS; the work transfers now to a Safety Net Program (not well defined or referenced, and should be).

The Captive Brood Program in the Grande Ronde subbasin was designed to increase survival of hatchery-spawned parr to adulthood by retaining the fish in captivity through maturation and spawning instead of releasing them through the hydrosystem, thereby assuring that sufficient fish would be available ("return") for broodstock for transitional development of a conventional hatchery program. It was designed to prevent extinction of the Catherine Creek, Upper Grande Ronde, and Lostine populations. Other objectives were to maintain genetic diversity of the artificially propagated fish and of the indigenous wild fish in the Minam and Wenaha Rivers. The approach was used to develop and refine these methods for rapid recovery in situations where extinction is imminent and until causes of the precipitous natural declines can be identified.

II. DATA

Appropriate data for these analyses has been collected and reported, including metrics on numbers, size, sex ratio, fecundity, and recruitment. It is not clear if genetic analyses will be included. Methods were not described in detail but summary reports provided a description of methods, which may also be found elsewhere (a reference is required).

III. KEY FINDINGS

Issues, both prophylactic and husbandry, related to collection of parr as brood stock and following through to adults, spawning and release of CBS smolts, then adult returns were addressed. Of particular note were BKD (impact was not excessive), lower fecundity (small size by 35%), and early-maturing males. This lower fecundity (57% of expected for age-4 and 40% of expected for age-5) led to fewer than projected numbers of smolts. Thus, smolt goals (150,000) were rarely obtained, and subsequent adult returns rarely exceeded the goal of 150 adults/stream. There was much lower recruits-per-spawner in CBS (1.5) than conventional hatchery returns (14.3). F1 fish showed an overall lower than expected percentage of older fish. F1 fertility and eyed egg-smolt survival were slightly lower than expected, but the main problem was a much lower SAR than assumed (0.1% versus 0.35%). Overall, fish performance was documented and appeared adequate.

The program, with its combination of captive brood plus conventional hatchery, is operating well below expectations in terms of mitigation goals. Adult returns to Catherine Creek and the Upper Grande Ronde have not reached half of overall return goals in any brood years since 1998; in most years the return rate is a third or less of LSRCP goals. It does not appear that overall goals are achievable within the foreseeable future.

While their fish culture performance were within standards expected for salmonids in general, the low SARs indicated that existing approaches for rearing and releasing smolts did not result in fish capable of returning as adults to the Columbia River and Lower Granite Dam in numbers sufficient for meeting existing LSRCP mitigation goals. Released smolts showed erratic and low survival rates. Measures of these survival rates and other life history aspects (size, age at return, etc.) seemed appropriate, although the information provided was not sufficient to give much insight as to why overall survival of natural, conventional hatchery, and captive derived smolts was so low. The ecological and genetic impacts of the programs on wild fish were not evaluated in the material provided. Please refer to programmatic comments for these issues.

More detailed comment:

Table 1. Please provide SD or SE along with mean survival and an indication of the number of years that data is available. Growth was 35% smaller — was this for same age of fish, or does this value reflect earlier age at maturation?

Table 2. The low fecundity in the captive fish, especially among the older age fish is an interesting finding. There was no mention of whether eggs were smaller or larger than natural or conventional hatchery fish.

There was good comparison of smolt-to-LGD survival among natural, CBS and CHP smolts. It appears survival was very low (~40%), and it is not clear from the report(s) why was survival of fish from the Lostine River was higher than from Catherine and Upper Grande Ronde.

IV. OUTLOOK AND RECOMMENDATIONS

This work must follow through to F2 to determine if CBS returns spawn successfully and contribute to smolt yield and adult return, as they acknowledge. The test that is needed is a comparison of NOR vs. CBS relative reproductive success through F2 and beyond. It is not clear that this is covered (requires genetic samples), although there is recognition of the need to measure through to F2. Here, as in all LSRCP projects, there is more emphasis required on the limits to production outside of the subbasin, including ocean effects and harvest.

Although this program did not meet smolt production objectives, overall it functioned as intended to stave off extirpation and get to the point where the conventional program could replace it. Its effectiveness in producing sufficient naturally produced adults (150) is not yet clear in the Upper Grande Ronde, but successes in Catherine Creek and the Lostine River suggest that meeting this goal is within range.

Lower fecundity of captive fish might be addressed with better understanding of factors affecting growth of captive-reared versus fish in nature. The fecundity issue by itself seems like a problem that perhaps could be effectively addressed with a more productive feeding regimen.

Although the captive program has functioned with some success at the original stages or the rebuilding process, the long-term prognosis of meeting LSRCP mitigation objectives remains less clear.

B. Grande Ronde early years

I. INTRODUCTION

A brief, well-written introduction to the issues of Chinook in the Grande Ronde basin was provided. This is background historical material for related projects (detail provided in these elsewhere) and defines the monitoring and evaluation, which seems very much in order and capable of assessing problems and successes associated with the initial development of the Lookingglass Hatchery and Rapid River broodstock.

Of note, the assumed harvest rate (80%, i.e., 4:1 catch to escapement ratio) prior to construction of dams seems much too high, at least on a long-term sustainable basis, even in a pristine watershed. This assumption and associated production goals were thus unrealistic.

II. DATA

The history of releases, returns, and survivals of spring Chinook salmon broodstock sources used in the Grande Ronde basin was well represented in graphs and tables for the spring Chinook hatchery program, 1978-1997 brood years. Shifts in the program and rearing strategy shifts away from parr and broodstock changes were well documented.

III. KEY FINDINGS

Recruits-per-spawner for all three populations were above 0.5 in only two of the eight years; a consensus was reached to move to native brood stock, including wild fish refugia and captive brood stock experiments.

Conclusions were succinctly presented, for example:

- Prior supplementation failed as indicated by low natural origin abundance.
- Extinction risk was high based on population growth rate trends, low abundance of natural origin spawners, and low productivity.
- There was significant genetic differentiation between hatchery and natural populations and between the Minam, Wenaha, Upper Grande Ronde, Lostine, and Catherine Creek natural populations.
- Hatchery programs using endemic broodstock should be initiated immediately in Catherine Creek, the Upper Grande Ronde, and Lostine river populations.
- Given the uncertainties associated with use of artificial propagation to enhance natural production, they suggest a diversified approach (lower to higher risk) and maintain the Minam and Wenaha river basins as wild-fish management areas.

A long history of non-local Chinook brood stock is reported. If there are samples available to evaluate how genetic characteristics of the natural stock may have changed over time, perhaps from tissue remaining on scale samples, this should be explored. Of interest is the question of similarity or difference among the natural stock, the present hatchery stock, and the Rapid River stock.

Fig. 7. Please define how the stray rates were calculated, or provide reference to these methods. Can hatchery practices be improved to improve homing and to reduce straying?

IV. OUTLOOK AND RECOMMENDATIONS

As they noted: "Preliminary results of the new hatchery programs are presented in separate papers. The true measure of success of these programs will be determined by the response of the natural populations, smolt survival, adult returns, and the ability to restore and sustain tribal and sport fisheries in the future."

This is a multi-agency project that seems well coordinated with an established monitoring and evaluation framework that has been effectively utilized towards appropriate adaptations, and should continue.

Under existing habitat conditions the long-term outlook for successfully meeting project area mitigation objectives does not appear favorable. Adult returns have not exceeded one-fourth of the goals for the basin (5,820). Although releasing more smolts may provide returns closer to goals, the much lower SARs for hatchery fish than wild fish are causes for concern.

C. Upper Grande Ronde Supplementation

I. INTRODUCTION

Objectives were clearly laid out. History and data trends were presented and interpreted. This was a good background description and listing of program objectives, including research and monitoring objectives. The program would benefit from having a habitat component so that habitat issues could be evaluated and addressed as needed to improve salmon survival rather than simply relying upon supplementation and hatchery production. These runs are severely depressed and all approaches for recovering the populations should be considered.

II. DATA

No specific comments

III. KEY FINDINGS

In summary:

1. Goals for smolt production have not been met because of low numbers of adult fish.
2. Adult returns are less than 50% of goals.
3. A strong relationship was found between number of spawners and smolts per spawner.
4. Age structure of hatchery adults shifted toward younger fish compared to natural spawners
5. Mean smolt survival to LGR was lower than desired for both hatchery and natural fish. The causes were not explored.

Density dependent relationships at these low spawner abundances suggests habitat capacity issues exist. Fig. 15 suggests strong density-dependence: a sharp decline in smolts per spawner with increasing spawner abundance. This relationship should be followed carefully in the coming years. The report mentioned that EDT analysis did not predict density dependence at these low numbers. However, EDT is usually based on “expert” opinion. These data indicate additional effort is needed to evaluate habitat quantity and quality in the watershed. Is the decline in smolts per spawner associated with reduced growth of smolts, suggesting food limitation? Or is the decline related to early emigration of fry and fingerlings, suggesting limited habitat availability? These data highlight the need to include a habitat component in the Program, rather than simply relying on hatchery supplementation to “fix” the problem. Supplementation is only a short-term solution to be used when abundance is extremely low.

Return per spawner of natural Chinook is exceptionally low. What fraction of this low ratio is related to smolts per spawner versus adults per smolt? If low productivity is indicated by low smolts per spawner, what measures might be taken to improve habitat? What is the size of smolts (and earlier fingerling migrants)? What is the timing of juveniles leaving the watershed? Is it associated with return per spawner?

IV. OUTLOOK AND RECOMMENDATIONS

It was concluded that there was no benefit apparent to natural smolt migration abundance or smolts per spawner (see slides 34 and 35, and recommendations listed in slide 36).

This, and Catherine Creek, are comprehensive research programs with appropriate monitoring and adaptations as required that are managed effectively, with good reporting, and require continuation. Out-of-basin comments apply, and reasons for low survival of smolts to LGD warrants further research, along with further exploration of freshwater capacity.

Based on the evidence presented, the supplementation program has not been successful and shows little sign of leading to increased abundance of natural fish. The decline in smolts per spawners as the number of spawners (mostly hatchery fish) has increased suggests that habitat in the river for this species is limited even at the low densities of fish present and that recovery is predicated on increasing instream productivity (see programmatic comments). The causes of this apparent density relationship are not explored. It is also of concern that inasmuch as the number of hatchery-reared fish allowed to move above the weir is not limited, that the remaining wild fish may have been compromised to no benefit.

The summary noted high pre-spawning mortality associated with the weir. Please report this annual mortality. Are these mortalities included as successful returns when calculating return per spawner and SAR? Has habitat degradation led to increased water temperature? Can anything be done to reduce high water temperature? Are cool water refuges available for spawners?

The ISRP was pleased to see that the summary section stating that research has been initiated to better understand habitat characteristics that are affecting Chinook productivity. However, it would have been worthwhile to present the sampling approach for these studies so they could be considered in our review. It is good that the program realizes that hatchery supplementation is not the solution to the problem, rather factors affecting low survival of natural salmon must be identified and fixed if the natural run is to persist and eventually provide harvest.

D. Catherine Creek Supplementation

I. INTRODUCTION

We compliment the presenters on excellent work. There was good background description and listing of program objectives, including research and monitoring objectives. The program would benefit from having a habitat component so that habitat issues could be evaluated and addressed as needed to improve salmon survival rather than simply relying upon supplementation and hatchery production. These runs are severely depressed and all approaches for recovering the populations should be considered. Factors such as limited overwinter habitat have the ability to generate density dependent responses (Van Dyke et al. 2009[14]). The relation between fish responses and habitat issues should be explored more closely.

III. KEY FINDINGS

In summary:

1. Goals for smolt production were close to being met.
2. Adult returns were less than 50% of goals.
3. A strong inverse relationship was found between number of spawners and smolts per spawner. Also a strong inverse relationship between percent hatchery fish and smolts per spawner.
4. Age structure of hatchery adults was shifted toward younger fish compared to natural spawners.
5. Mean smolt survival to LGR was much lower than desired for both hatchery and natural fish. The causes were not explored.

Smolt-to-LGD survival was lower in Catherine Creek compared with all other stocks, and this needs further exploration. The report mentions that timing of hatchery smolts is somewhat earlier than natural smolts. Are hatchery smolts larger than natural smolts? It would be good to compare length frequency distributions of hatchery and natural smolts in Catherine Creek and in other watershed. Are some fish migrating downstream as subyearlings in fall and winter? If so,

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14 Erick S. Van Dyke, D.L. Scarnecchia, B. C. Jonasson, and R. W. Carmichael. 2009. Relationship of winter concealment habitat quality on pool use by juvenile spring Chinook salmon in the Grande Ronde River Basin, Oregon USA. Hybrobiologia 625:27-42.

these findings should be described. How does early emigration affect survival rates? Are early emigrants less successful after accounting for their younger age compared with smolts?

What percentage of propagated releases are visually marked or tagged?

Straying into the Minam and Wenaha rivers declined significantly after switching from non-local to local broodstock. Is broodstock the sole reason for lower straying? Methods to reduce straying are important.

The ratio of recruits per spawner of natural Chinook is well below 1, indicating that the natural run is declining. Continued natural spawning by hatchery fish perhaps keeps the natural run from perishing. On the other hand, a number of studies indicate interbreeding of hatchery and natural spawners leads to reduced fitness of the natural stock. Is Catherine Creek a situation where interbreeding of hatchery and wild fish reduces survival of the spawning fish but continued introduction of hatchery fish into the spawning areas maintains the less-fit natural population? This is an important question that should be addressed soon.

Fig. 16 suggests strong density-dependence: a sharp decline in smolts per spawner with increasing spawner abundance. This relationship should be followed carefully in the coming years. Density dependent relationships at these low spawner abundances suggests habitat capacity issues. These data indicate additional effort is needed to evaluate habitat quantity and quality in the watershed. Is the decline in smolts per spawner associated with reduced growth of smolts, suggesting food limitation? Or is the decline related to early emigration of fry and fingerlings, suggesting limited habitat availability? These data highlight the need to include a habitat component to the Program, rather than simply relying on hatchery supplementation to “fix” the problem. It is also possible that interbreeding of hatchery and wild salmon has lowered the survival of natural spawners (e.g., Fig. 17). An experimental approach may be necessary to evaluate whether smolts per spawner declines with increasing contributions of hatchery spawners.

Fig. 18. Please report age composition for male and female salmon because females tend to be older on average and these larger fish carry more eggs. If hatchery females carry fewer eggs, on average, to what extent does this influence the smolts per spawner relationship in Fig. 16? What influence does average female age have on Fig. 16? Is fecundity at age available for this stock?

Fig. 21. Hatchery strays have been quite low in the Minam and Wenaha rivers since 2002. How does survival of smolts from these two systems (to LGD and overall) compare with that of Catherine Creek and Upper Grande Ronde where supplementation is high? Do these two river show strong density-dependence relationships? Is the ratio of recruits per spawner greater than 1? It is important to monitor, evaluate, and compare these rivers where supplementation has been much less. How do these populations persist when so few hatchery fish spawn in the rivers? Is habitat quality better? If so, and the natural population is sustainable, then a key step for rebuilding populations in Upper Grande Ronde and Catherine Creek would seem to be habitat rehabilitation. What efforts are being made to address habitat issues in the basin and how does the hatchery supplementation program integrate and coordinate their actions with habitat efforts? Alternatively, these populations are limited largely by survival from smolt-to-adult. These life stage survival limits require further attention.

IV. OUTLOOK AND RECOMMENDATIONS

Based on the evidence presented, the supplementation program has not been successful and shows little sign of leading to increased abundance of natural fish. The decline in smolts per spawners as the number of spawners (mostly hatchery fish) has increased suggests that habitat in the river for this species is very limited even at the low densities of fish present, and that recovery is predicated on increasing instream production. The potential for sufficiently increasing instream production is not clear. The causes of this apparent density relationship were not explored, and should be. Based on data presented, there is a serious supplementation bottleneck in this system that must be circumvented before gains will be made.

The report should have provided more information on efforts to evaluate the effect of habitat conditions on Chinook productivity. More complete monitoring and evaluation of Minam and Wenaha rivers is needed because these rivers have received few hatchery fish since 2002. Is productivity also low in these two rivers? Although data were not presented, it appears that productivity is likely much higher in the Minam and Wenaha rivers simply because the populations are persisting without supplementation. More complete monitoring (e.g., spawner and smolt production) of these two rivers and comparisons with existing supplementation projects and habitat efforts may help evaluate key factors affecting survival of these populations in the Grande Ronde basin.

4. Lostine and Imnaha

A. Lostine Supplementation

I. INTRODUCTION

The introduction is clear in explaining the project relationship with the LSRCP, the watershed characteristics, and the use of artificial production technologies to increase adult spring Chinook abundance first by efforts to develop a Captive Brood Program to protect the stock from extirpation, and then shifting to a conventional hatchery program designed ultimately through supplementation to increase the number of natural spawners to 1,716.

Suggestions for additions and clarification in the report follow:

1. Program Overview: Provide the year(s) different artificial production activities began in the Lostine River. 1995 is mentioned, but it is not clear whether that is a first year of brood stock collection, release of smolts, capture of parr for the captive rearing, etc.
2. There is a short-term goal of returning 250 adults from the hatchery program (page 2). The anticipated disposition of those fish in terms of natural spawning, retention for broodstock, and harvest should be provided. The report is not clear on whether there was anticipation that some natural production would also be taking place during this time-period. How was the transition from short-term abundance of 250 individuals to the mid-term abundance of 500 hypothesized to proceed?
3. Page 3. “The benefits that were expected with supplementation were higher egg-to-smolt survival and harvest opportunities.” The higher egg-to-smolt survival is a measure of within hatchery performance of the program, and yield to harvest would be a measure of benefit after fish are released. Were there benefits anticipated from the natural spawning of an increased total abundance of adults as a consequence of the hatchery program? The background section reads as though there are conservation justifications for beginning the program, but the sentence on benefits does not seem to explicitly include any.

II. DATA

There is a good presentation of SARs, SASs, spawner abundance, natural smolts per spawner, recruits per spawner results to date, including graphs.

Suggestions for additions and clarification in the report follow:

1. Figure 11. Natural smolts per spawner. This relationship should be expanded to consider smolts-per-spawner as a function of the number of female spawners. This would give a preliminary consideration of density dependence in this tributary population. Is there evidence of sufficient smolt rearing capacity in the Lostine River to anticipate restoration? Is return year on figure 10 equivalent to brood year on figure 11? If so, inspection suggests the years of increased total spawning abundance (2001 – 2005) produced fewer smolts per spawner than years with fewer adults (2000 and 2004).
2. Figure 12. Adult recruits per spawner. It is not clear whether this is female to female or total adult abundance to total adult abundance. The critical relationship would be egg to egg, but female to female would be sufficient. Adult recruits per spawner appear to be fewer in years with more adults spawning. This river system may already be exhibiting density dependence.
3. Provide a summary of the percent hatchery and natural adults in the broodstock and in the spawning escapement for each brood year, and PNI for the program. Also, indicate the operating parameters for the program and whether the program has been able to meet that guidance.
4. An analysis evaluating the supplementation similar to the Imnaha program analysis is required.

III. KEY FINDINGS

The midterm escapement goal was reached for hatchery fish. Smolt release targets were not reached in the first four years due to a lack of sufficient number of broodstock – reached by 2005. Recruits per spawner for wild spring Chinook has been less than one since the 2001 brood year.

While there was a substantial survival difference between wild and hatchery smolts, there was no difference in adult size-at-age (what about within sex?) nor in spawning location. Stray rates of hatchery fish appeared low (3%) and disease issues were few and seemed minor.

Natural fish survived at higher rates than both hatchery groups except in 2002. The number of adult returns was increased, allowing a harvest. It is not clear if wild fish were harvested incidentally or otherwise in the tribal, sport, or other fisheries.

IV. OUTLOOK AND RECOMMENDATIONS

A summary of the HSRG recommendations and program managers' actions in response to those recommendations should be added.

No analyses of natural production in response to the supplementation treatment (hatchery-origin adults spawning in the Lostine River) and this is required to assess benefits. There is no evidence of an increase in wild adult abundance that can be associated with supplementation. There is possibly a decline, but cannot separate ocean effects from supplementation effects in the analysis. Need to explore RRS, as well as mortality evident in the smolt migration to LGD and beyond – the key limit to population viability that likely cannot be fixed with a hatchery. Harvest issues may also require further exploration if wild stock are included.

The main benefits to the Lostine River program have been the returns of sufficient fish to provide some Tribal harvest opportunities in the river and some below LGR. There was no information provided to indicate that the program is meeting LSRCP goals for rebuilding natural runs. Recruitment of natural fish remains well below LSRCP targets.

B. Imnaha Supplementation

This report is well prepared and should serve as a format for other reports/programs that involve supplementation and reintroduction efforts.

I. INTRODUCTION

No specific ISRP comments or suggestions.

II. DATA

No specific ISRP comments or suggestions.

III. KEY FINDINGS

1. Pre-spawn mortality and hatchery egg to smolt survival were within acceptable limits.
2. Smolt production was near or exceeding goals in most years; smolt survival goals to LGR were high compared to other Grande Ronde and nearby areas.
3. SARs sufficient for hatchery fish returning to provide tribal and sport fisheries. Even with the observed SARs, SASs was not sufficient to provide the LSRCP goals for ocean and lower Columbia River harvest.
4. No observed trend in abundance of natural spawners since supplementation began; natural recruits per spawner remains low. Natural fish production decreasing since supplementation began. BACI analysis suggests that supplementation has not improved adult abundance.

A final conclusion on the effect of the program on natural adult abundance and productivity is not provided. Arriving at reasonable inference on the program's effects on these vital statistics is an important next step. This information would contribute to evaluating the programs effect on the viability of the natural population. The results that are presented are not encouraging and do not appear to provide empirical justification for expanded supplementation of spring Chinook.

IV. OUTLOOK AND RECOMMENDATIONS

A section summarizing the HSRG and USFWS hatchery review findings and how they are reflected in project management would improve the presentation.

The analysis begs the question of whether hatchery production should be scaled to meet harvest needs only, and at the least, to the productive capacity of the system for freshwater rearing, since there is no evidence that wild production benefits from supplementation.

The Imnaha hatchery program *per se* has been more effective in meeting many of the interim goals of the LSRCP than most other spring Chinook programs. Most of the other systems in the

LSRCP have not even been able to meet hatchery production objectives, and some have resorted to captive brood programs. Unfortunately, the analysis to date also reveals that the supplementation efforts have not resulted in an increase in abundance of natural spawners. This is cause for concern about the prognosis of the entire supplementation strategy. Although several causes for the failure of the hatchery program to have been hypothesized, the specific causes remain unidentified for this system. Until these causes are indentified, the prognosis for the program meeting LSRCP objectives is not good.

C. Size at release Imnaha

I. INTRODUCTION

The Imnaha River has historically supported spring Chinook salmon with documented larger size and later age at maturity than neighboring stocks. One key objective of the LSRCP is to develop a program where returns of hatchery fish and natural supplemented fish mimic the age composition of the original wild population. The shift toward younger age at maturity and the desire to optimize size at release led to an evaluation of optimal size(s) at release.

The Imnaha supplementation program has three objectives that pertain to the investigation in this report – minimize impacts of the hatchery program on resident stocks; maintain the genetic and life-history characteristics of natural Chinook salmon populations in the Imnaha River; and operate the hatchery program so that genetic and life-history characteristics mimic those of wild Chinook.

Age composition in hatchery-origin spring Chinook salmon is typically different from the natural populations from which they were derived. Age of maturation is usually earlier (younger) in hatchery-origin salmon – resulting in more three-year old females and fewer five-year old females compared to the natural counterpart.

The introduction does not provide an explanation for why there is an objective of having a hatchery program that mimics the life-history characteristics of the natural population. The objective of maintaining the genetic and life-history characteristics of the natural population are not explained either, but are largely self-evident: as a first principle, long-term viability of the natural population is presumed to require maintaining the evolutionary potential of the population. Superimposing a hatchery program on the population will influence the state of the evolutionary potential, and conducting the program in such a way that it does not critically compromise the potential for future evolution is important. One way to limit deleterious effects is believed to be maintaining genetic similarity between the hatchery and natural population.

It is less self-evident why life-history characteristics of the hatchery population should mimic the natural population. Some characteristics, like run- and spawn-timing are likely essential for reproduction in the hatchery and natural environment, so these are very important. Similarly, characteristics like precocious male maturation, mini-jacks, and jacks, might strongly influence the total biological yield from the hatchery exercise. While the observation of earlier age of maturation is interesting and worthy of study, it is not explained how this alteration affects the dynamics of either the hatchery program or the natural population.

An essential issue is whether the age structure difference is being accompanied by underlying genetic modification of the hatchery population, and to what extent the natural population may be modified by interbreeding between natural-origin and hatchery-origin adults, both in the hatchery and in the natural settings. The experimental design employed in these investigations is unable to provide insight into this important issue. It would be helpful to briefly elaborate on these concepts in the introduction.

II. DATA

Data measured included juvenile survival to Lower Granite Dam, age composition and survival of adults, SARs, SASs, and returns per 10 kg of smolts produced.

Smolts were divided into two size groups, large and small. However, page 4 text does not actually describe how groups of large and small smolts were established and does not describe how CWT groups are established. How CWT data was used is explained adequately.

III. KEY FINDINGS

1. Releasing larger smolts did not confer any advantage over releasing smaller smolts under existing habitat and transportation schemes.
2. Size of smolt did not seem to be a factor influencing the age at maturity of the adults.
3. For reasons of space and cost releasing more, smaller smolts results in a greater return of adult fish per weight of smolts produced.

The ISRP has no concerns with the interpretation of the data or analysis.

IV. OUTLOOK AND RECOMMENDATIONS

A statement was provided on spreading the risk by releasing both large and small smolts. Based on their evaluation, their conclusion to not raise just larger smolts but to raise a broader range of smolts to spread the risk seemed appropriate. It is not evident how hatchery practices are modified to produce a specific mix of large and small smolts or how managers are integrating the findings into specific actions. It would be useful to indicate whether this research is being continued.

The ISRP encourages the authors to submit the findings for publication. This may require additional replication (see Bilton et al. 1982[15]).

D. Reintroduction of Spring Chinook Salmon in Lookingglass Creek: Analysis of Three Stocks Over Time

I. INTRODUCTION

This was a well-prepared report that defined the issues, objectives, methods, and results for work involving re-introduction of spring Chinook. Adult returns were from smolt releases that were progeny from Catherine Creek captive broodstock (collected as parr), a stock that is likely more closely related to the extirpated population than the Rapid River hatchery stock used previously. Three comparisons of numerous population metrics were possible, including natural production from endemic stock (1963 to 1974), production from Rapid River broodstock (1992 to 2000), and, since 2001, Catherine Creek captive broodstock. Metrics for comparison were

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15 Bilton, H. T., D. F. Alderdice, and J. T. Schnute (1982). Influence of time and size at release of juvenile coho salmon (*Oncorhynchus kisutch*) on returns at maturity. *Canadian Journal of Fisheries and Aquatic Sciences* 29: 426-447.

appropriate and included a full list: adult returns at the weir, spawning, parr, tissue samples for genetic analyses, parr to LGD survival, total outmigrants, outmigrants/redd by season, juvenile growth, survival, migration timing, progeny/parent ratios, and smolt/adult ratios. These results were nicely summarized in graphs and tables. The authors acknowledged that results were preliminary and that differences may have been also due to environmental conditions in the ocean (note that difference in freshwater conditions may also accompany regime shifts).

Reintroduction of spring Chinook to Lookingglass Creek to establish a self-sustaining viable population was the long-term objective. The success will be a function of the productivity and capacity of the freshwater environment, which was stated as healthy and unaltered over the study period. Specific comments:

1. Figure 1: the percent of redds in different streams in the two time periods needs to reflect hatchery-origin adults in the later time period. The implication of the figure is that LGC had the second greatest redd counts in the 1965 – 1981 time period, but not in the 1982 – 1991 period. And that this reduction represents loss to the entire system. However, if many of the redds in other locations are from hatchery fish spawning in unproductive habitat that do not yield progeny, the redd count observation is less useful in establishing what might be expected in the current environment.
2. Abundance and productivity of the "endemic" stock during the 1960 – 1980 time period is more appropriately considered a "reference" rather than a control. In this particular data collection, two things are being evaluated: first is the potential of the environment in Lookingglass Creek to provide conditions for survival of adults to spawning, adequate spawning gravel, and conditions for juvenile rearing and growth; second is the performance of the Catherine Creek stock in this specific environment. The two elements are confounded experimentally.

II. DATA

While data collection from weirs and surveys was summarized and data to date was analyzed, the ISRP provides suggestions below that are intended improve an otherwise nicely-prepared report.

Paragraph 2 page 5. Provide a table or figure with the numbers of hatchery and wild fish released above the weir for each year. This would clarify the first sentence that states that 56-66% of the fish have been natural-origin in later periods.

Neither figure 2 or figure 4 identified the "Units" in Lookingglass Creek. Please identify these in figure 2 and present the data in figure 4. Reference to figure 4 should be to figure 5. Please elaborate and explain the statement: "Differences in release time and location for upstream spawners can affect redd distribution."

Provide the actual estimates of different classes of outmigrants that are discussed qualitatively on page 7 following figure 5. The comparison of smolt per redd across eras should be adjusted by spawner density. Rather than smolt per redd, develop a regression of smolts per redd or smolts per female, as a function of spawner (or female) abundance. This will facilitate establishing whether contemporary capacity is similar to capacity in the 1960s and 70s.

Provide the actual data used to estimate the recruits per spawner. It would be useful to identify for each broodyear the numbers of fish released to spawn, their composition (natural and hatchery), the outmigrant production from that spawning (parr and smolts), and subsequent natural adult production. Are the recruits per spawner female to female? The Catherine Creek

F1 appears greater than one. If this is the case across multiple year-classes, the stock should rebuild without long-term supplementation.

III. KEY FINDINGS

The critical issue is whether the empirical data from the natural spawning of Catherine Creek adults suggests that habitat and environmental conditions in Lookingglass Creek are sufficient for reintroduction and reestablishing a self-sustaining population. Outmigrants/redd from the captive brood and supplementation experiment nearly matched previous endemic values, suggesting a well-designed reintroduction might lead to reestablishment of a self-sustaining natural population. However, a look at the total spawners, comparing endemic versus Catherine Creek brood, suggests high numbers of spawners did not always yield high numbers of outmigrants. In other words, density dependence may be occurring at relatively low spawner density, and/or this value has changed over time. Regardless, a closer look at the time-stratified recruitment is required, a factor which may confound this analysis. Beyond the limits of the freshwater environment, and resulting a further lowering of parent:progeny ratios to values barely above replacement, SARs by 2004-5 were ~1.5%, indicating a limit in the ocean life stage.

IV. OUTLOOK AND RECOMMENDATIONS

The conclusion section should identify whether this program was reviewed by the HSRG or the USFWS hatchery review, and if it was, state how the program implementation reflects the recommendations of the reviews, or how it will do so in the future. The HSRG suggested the ESA status as extinct, but that the productivity and capacity of the habitat was 3 and 200, respectively. This suggests there is uncertainty about these estimates, since this report suggests 1.5 and 500. A review is required. They also suggest productivity could increase from 1.3 to 2.8 without hatchery fish, thus a viable population may result in the longer term. Projections into the impact of climate change may also be useful in planning around these values.

Given the marginal nature of the recruitment in its current state, it is perhaps premature to suggest that there seems real potential for successful re-introduction with the captive brood supplementation. There will be need to adapt to a sliding-scale broodstock approach, which remains experimental. Continued hatchery production may provide tribal harvest, but this should be carefully managed such that “wild” production is not compromised. Continued and careful monitoring and broodstock selection will be necessary to confirm the development of a self-sustaining population.

Limits to production are also evident below LGD, and are likely oceanic – SARs are lower than anticipated and currently limit returns. Despite relatively high yield of outmigrants, suggesting near capacity production of juveniles from the unaltered habitat (the outmigrant capacity is unclear at this point, and requires further analysis), adult returns remain low, and recruits per spawner are marginal, and only slightly >1. Sources of mortality below LGD should be explored more thoroughly.

Although the comparisons used in this study may prove instructive, the issue of three “treatments” that did not occur not over the same time period poses some major problems for interpretation. No evidence was provided that supplementation with the Catherine Creek stock will result in any different responses than seen elsewhere in the Grande Ronde and Imnaha basins. The main issue in question seems to be how much of an increase or decrease in natural production can be seen with the captive brood approach compared to previous endemic values and use of hatchery brood fish, and that information was not presented in a convincing manner, nor could it be, due to the differences in time period. The important point is that there are now some natural-origin fish returning from which brood stock can be selected, and the program can move on using the sliding scale.

Comments on Appendix 1. Draft Lookingglass Creek spring Chinook salmon management plan.

Adult return goals. The statement that restoration of a genetically-independent Lookingglass Creek spring Chinook population to viable status is not necessary to achieve viable status of the Grande Ronde Major Population Group should be attributed to a reference or identified as an assumption of the management plan. Discuss whether restoration of Lookingglass Creek with Catherine Creek Independent Population spring Chinook makes any difference in the status of the Grande Ronde MPG.

Juvenile production and releases. The rationale for the release numbers in Lookingglass Creek should be based on habitat capacity and harvest goals, but we did not see this. Please provide a revised estimate of the estimated productive capacity of Lookingglass Creek and explain how it is reflected in the natural and hatchery management.

Weir Management. Table 2, defining the pass or keep disposition of returning adults, should reflect the HSRG recommendations (or explain otherwise), and identify whether the fish kept or passed are hatchery or natural origin. Please indicate if this is the case. Do the fish that are recycled into lower Lookingglass Creek spawn, and if so, how would this complicate the assessment of the reintroduction program? We assume it does not – please correct if otherwise.

Broodstock management. There are several biological uncertainties embedded in the program, and it would be beneficial to explicitly identify them and develop management guidance for addressing them in a short- and long-term adaptive management effort. The extent to which wild fish need to be parents in a broodstock for reintroduction is unknown. Whether the 30% guideline is too large or way too small is uncertain. The proportion of a natural population (either absolutely or at different levels of abundance) that can be removed to provide broodstock without compromising the viability of the population is not well investigated by the fisheries biology community. The 25% guidance may be too liberal, especially in years with small natural abundance. Finally, the strategy of backfilling a shortage of natural-origin adults with hatchery-origin adults to maintain a target smolt production level has poorly investigated consequences for reintroduction success and for the primary biological characteristics of the integrated hatchery/natural population. Backfilling will likely slow down adaptation to the natural environmental conditions by having hatchery-adapted parents predominating in both the hatchery environment and the natural spawning aggregate. The current state of the science to deal with these uncertainties is via the HSRG review and recommendations. Please state how these recommendations will be incorporated into future plans.

5. General Topics and Program Roll-Up

A. Benefits of Culling for Bacterial Kidney Disease (BKD)

Culling female Chinook salmon with high ELISA optical density scores (ELISA ODs) together with segregation of eggs and progeny from high ELISA OD females when culling is not demographically advisable has been satisfyingly successful in reducing Bacterial Kidney Disease as an impediment to hatchery production of healthy Chinook salmon smolts. Despite historical failures in developing vaccines and less than complete control of this intracellular bacteria with antibiotic, this application of ELISA-based detection of the pathogen (coupled with culling or segregation of the offspring of infested females has had worthwhile success in reducing incidence of the disease. In their report article the authors properly address the report on genetic effects (or lack thereof) of this culling (Hard et al. 2006[16]); Hard's recent personal communication (J Hard 14 Apr 2011) is a little less sanguine, he retains some apprehension about the long-term effects on genetic variation for resistance to BKD following exposure to the causative bacteria *Renibacterium salmoninarum (Rs)*. "The high heritability for resistance to Rs and the high frequency of returning adults with high ELISA titers suggest [that]: adults with high titers that survive to return to the hatchery may in fact be highly resistant to the disease; eliminating them from broodstock might erode resistance in the population over the long term. This risk is what needs to be weighed against the risk of an epizootic in the hatchery in the shorter term." But given the unavoidable enhancement of stressors and thus the disease in hatcheries, even if there are deleterious evolutionary effects, the benefits of this practice probably outweigh them, particularly if they allow diminished use of antibiotics in the future. The report of this project is a peer-reviewed publication (NAJFM 30:940–955, 2010), which is an indication of the quality and importance of the work and a credit to the project team.

Some basic questions are suggested by the project review. One is why a useful vaccine against *Rs* has been developed for Atlantic salmon when efforts for Pacific salmon have been frustrated. Another question is whether, despite the negative finding of Hard et al. (2006), the culling of very-high-titer females (which were not allowed in their experiments) may in the long term erode resistance in cultured stocks (pers comm J Hard 14 Apr 2011.). He indicates that USGS and NOAA are pursuing genomic research on *Rs* resistant and susceptible Chinook.

A very useful addition to this report would be a summary of the LSRCP overall fish health program including a description of routine fish health monitoring, how epizootics are reported and managed, and how the program relates to responsible government agencies.

B. Bacterial Kidney Disease Study: Natural vs. Hatchery

The project team compared *Rs* prevalence over years (measured by ELISA) in four groups of stocks: captive broodstocks, supplementation broodstocks, natural populations receiving offspring of captive or supplementation broodstocks, and wilderness natural populations. They find no evidence that hatchery releases have caused an increase of *Rs* in natural populations which reduces concern that supplementation might increase disease risk for natural populations, but they wisely promise continued monitoring. In fish health/disease discussions, people often do not distinguish between the prevalence of the causative agent of a disease (e.g., ELISA detection of *Rs*, the agent causing BKD) and the prevalence of the disease. In this report, the two are conflated "we examine[d] the prevalence of BKD, based on...ELISA OD..." when actually the report is on the prevalence of *Rs.* It's a useful distinction in a discussion of a disease like BKD: *Rs* is widely prevalent in nature, BKD isn't. The problem of concern is the likely amplification of *Rs* in a captive broodstock program and the effect of the increased *Rs* infestation on natural populations into which the offspring of captive broodstocks are introduced.

16 Hard, J. J., D. Elliot, R. Pascho, D. Chase, J Winton, and D. Campton. 2006. ELISA-based segregation for control of bacterial kidney disease in Chinook salmon (*Oncorhynchus tshawytscha*). Canadian Journal of Fisheries and Aquatic Sciences 63:2793-2808.

If the result is an increase of Rs in natural populations over the level naturally present, it might make the populations more susceptible to BKD in a stressful environment. It's comforting that no increased prevalence has been found, but it is important to realize that little is known about the occurrence of BKD in natural populations.

Again, it would be useful to summarize the fish health program of the LSRCP.

C. Study: Use of PIT-Tags as a Tool to Monitor Adult Chinook Returns

PIT tags provide a critical tool for evaluating stock specific survival to each life stage, age composition, in-season estimates of abundance, and survival rates associated with specific projects such as transporting salmon in barges around dams. This brief paper indicated that shedding of PIT tags by salmon may be remarkably greater than previously believed, thereby introducing bias in critical metrics that rely upon PIT tags. For example, using double-tagged fish, the authors estimate that 12.5% of jack Chinook salmon (n = 8 fish total) and 30.6% of Chinook spending two years at sea shed their PIT tag (n = 36 fish). These preliminary findings suggest older salmon have a higher rate of tag loss.

The value of this paper would be greatly enhanced if it reviewed all available literature in an effort to determine PIT tag shed rates for each age class of salmon. What factors contribute to tag loss? Are there methods to minimize tag loss? Continued research into tag loss is critical because many decisions in the Basin are based on PIT tag data. High and variable tag loss could introduce significant error in survival rate estimates, leading to the misinterpretation of data from hydrosystem and supplementation experiments, and from harvest management.

D. Program Roll-Up

This roll-up was a good summary, but additional analyses could and should be performed. A synthesis of findings across all watersheds is essential for review and adaptive management of this program. Detailed comparisons of individual programs can provide answers to questions that individual reports cannot.

Program goals from 1975 have not been achieved. The original planning assumption that the affected natural populations would remain viable and produce approximately 50% of the pre-dam abundance was erroneously optimistic. The hatchery mitigation goals assumed a sustained harvest rate (80%) that is unrealistic even for a productive Chinook population in a pristine habitat. Assumed SAR values (0.87%) were also unrealistic based on observed values and current conditions in fresh and marine waters.

A major concern is the apparent lower-than-anticipated production capability of natural salmonids in most of the LSRCP systems. Evidence of density dependence (e.g., reduced Imnaha recruits per spawner versus total spawners in nature) has occurred at lower numbers of spawners than forseen at the beginning of the program. Indications of density effects have arisen despite pristine habitat in many tributaries, and considerable habitat improvement work in others.

Although disease is not a major problem in hatcheries, it may be worthwhile to use genomic technology to identify whether disease may significantly contribute to mortality of returning adults (Miller et al. 2011). See Science paper by Kristi Miller, CDFO, in 2011 (Fraser sockeye study).[17]

Additional research is needed to identify factors contributing to high mortality during the smolt-to-LGD stage and from LGD to the ocean. A good time series has been developed but further analyses are warranted using all stocks. Distance is just one of many variables to be considered. Other variables for consideration include: (1) food availability, (2) predator abundance including exotic species, (3) agricultural crop acreage in drainages (and associated pesticide use), and (4) wastewater treatment plants (WWTPs) discharges of various products into watersheds. Although many of these rives are relatively small, WWTPs even with small discharges may have an adverse effect because the river flow is also small and provides less ability to dilute the discharged contaminants (flame retardants, pharmaceuticals, personal care products, etc).

Age at return: Reduced age at return (and size) of hatchery fish and lower fecundity lead to reduced productivity of populations that are supplemented with hatchery fish. Some attempt to model or measure this outcome is recommended.

Mini-jacks: LSRCP managers suggested that few mini-jacks were produced in the hatcheries, whereas NMFS scientists estimated high numbers of mini-jacks (e.g., 52% in Lookingglass Hatchery, 2006 and 2007).[18] This discrepancy should be evaluated. Please see mini-jack comment above in Grande Ronde section.

SAR and R/S data for hatchery and natural fish should be used to evaluate factors in freshwater that might lead to high mortality of natural Chinook. A comprehensive examination of habitat and factors affecting productivity of natural salmon is needed.

Stray rates. Most program reports were not adequate with regard to discussions of stray rates. It is difficult to monitor strays in all areas, therefore counts will be biased low. Nonetheless, how stray rates for each program are estimated, how they may be deficient, and what is needed to improve them, needs development. The Collaborative System Monitoring Evaluation Program (CSMEP) conducted initial surveys and analysis of hatchery stray rates in the Snake River system and bringing this information into the LSRCP is important.

The shedding of PIT-tags, especially among older Chinook, is a critical observation that was not mentioned in the roll-up (see comment above in 5C). PIT tags are a key tool for monitoring and evaluation of many programs. Additional review and research is needed to determine if shed rates are, for example, 30% for Chinook spending two winters at sea versus 12% for Chinook spending only one winter. The presentations and reports are insufficient for an evaluation of the rigor and robustness of the counts of fish (slide 31). Data quality is a project-by-project, metric-by-metric exercise that would require a financial-audit-like analysis of the data for each project.

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17 Genomic Signatures Predict Migration and Spawning Failure in Wild Canadian Salmon. Kristina M. Miller and others. Science 14 January 2011: 214-217. [DOI:10.1126/science.1196901]

18 Larsen, Donald A., Beckman, Brian R. and Cooper, Kathleen A. (2010) Examining the Conflict between Smolting and Precocious Male Maturation in Spring (Stream-Type) Chinook Salmon. Transactions of the American Fisheries Society, 139: 2, 564 — 578. First published on: 09 January 2011

The regional monitoring coordination for anadromous salmon has just begun to address these challenges.

The most successful portion of the program has been the raising of smolts for release; there has been return in sufficient numbers in a few systems to provide modest tribal and non-tribal recreational fisheries. Very little evidence is presented of supplementation benefits and any positive effects of these higher returns in producing more natural fish. The consistently lower SARs for hatchery fish than natural fish also argues that even though fish health is good, physical performance of hatchery fish in the hydrosystem, estuary, and ocean (from release to return) remains lower than for wild (natural) fish

The basis for concluding that natural-origin abundance can be increased is not justified. Whether or not genetic and life-history resources can be preserved is an open question. There have been no described extirpations of local natural-origin populations, but no clear evidence that population status was positively affected by the hatchery programs. The success in establishing a hatchery program using a local tributary broodstock that is self-sustaining is evidence that these programs could prevent extinction of the lineage. It is not evidence that they could prevent extirpation from the natural environment. In many locations, it appears there is now a hatchery spring Chinook population with some natural production from feral hatchery fish.

The importance of tributaries for rearing habitat of anadromous salmonids in large river systems is well known. The importance of lower river and mainstem rearing habitats later in their life cycle for fish that originated from tributaries is less well understood and appreciated. If combinations of growth and survivorship are such that higher fitness is obtainable from a migratory, anadromous life history, and genetic capability is present, anadromy can be adaptive and evolve. The same argument, minus the high costs of osmoregulatory change, can be made for a potamodromous (i.e., in-river migratory) life history. In this life history, Snake River spring Chinook spawn in upper, typically unproductive tributaries (often in granitic geologies), and move progressively downriver prior to smoltification to take advantage of increasingly productive freshwater habitats. In terms of productivity, the most historically productive freshwater habitats for salmonids were these mainstem and lower river “transitional” habitats. In the historical condition, density dependence *within* the tributary may still have occurred, but the overflow (well-documented emigration) of fish would have found higher quality habitat downriver in the transitional habitat. This hypothesis is consistent with the documented low success rates associated with parr releases from hatcheries, and the shift to exclusively smolts, released into tributary habitats. Consistently higher productivity downriver would have resulted in an adaptive, life history evolution toward progressive movements through transitional habitats prior to smoltification.

However, mainstem impoundments, introductions of non-native, lentic-oriented species, and warmer waters have greatly reduced the amount of this transitional habitat favored by salmonids. Similar density dependence may occur in estuaries as numbers of smolts released increases. Potential natural production (as measured by adult returns) of the existing spring Chinook stocks based on historical stock sizes, and their use in defining appropriate LSRCP targets, may thus be substantially overestimated. This suggest a re-analysis of the capacity of the current freshwater environment may be in order, along with current life-stage survivals throughout the life cycle, and that LSRCP targets should be adjusted accordingly.

APPENDIX 2. LSRCP RESPONSE TO ISRP REPORT 2011-14

The Lower Snake River Compensation Plan (LSRCP) thanks the Northwest Power and Conservation Council (NPCC) for their interest in the LSRCP Program, and the Independent Science Review Panel (ISRP) for their recently completed Program Review and Report of the Lower Snake River Compensation Plan's Spring Chinook Program (ISRP Report). We support the ISRP conclusion that the symposium format used to facilitate LSRCP cooperator review and independent retrospective evaluation of LSRCP accomplishments worked well and we remain committed to implement this process for the steelhead and fall Chinook program components.

We interpret ISRP's statement that "Overall, the performance and practices within the hatchery were acceptable and met stated goals" to mean the LSRCP program fulfills the Congressional mandate that projects must be based on sound scientific principles, benefit wildlife, have clearly defined objectives and outcomes, and have adequate provisions for monitoring and evaluation of results. LSRPC believes the LSRCP program provides benefits to treaty and non-treaty fisheries, benefits to Snake Basin spring Chinook salmon populations, has clearly defined objectives, and is adequately monitoring and evaluating the results. We feel the symposium and associated reports helped identify areas which can be improved. We are committed to modifying the program in ways that move us closer to achieving LSRCP goals while enhancing or incurring only minimum impacts to ESA listed fish.

Comments in the ISRP Report have been incorporated into the final reports for the LSRCP 2011 Spring Chinook Program Review where appropriate. Comments in the ISRP Report have been and will continue to be useful as LSRCP develops the Steelhead Program Review for scheduled for March 19 and 20, 2012. LSRCP has incorporated ISRP comments on individual programs into the final reports for those individual programs, and the ISRP Report and this response are included with the final Spring Chinook Program Proceedings on the LSRCP website at http://www.fws.gov/lsnakecomplan/Reports/HGMPreports.htm.

Since the November 2010 LSRCP Spring/Summer Chinook Program Review, Draft Hatchery Genetic Management Plans have been produced by program Cooperators and submitted to NOAA, and are available on the LSRCP website. It is unfortunate that these documents were not available at the time of the Program Review because they address in detail many of the comments and recommendations made in the ISRP report. Information in HGMPs addresses many of the ISRP comments and recommendations on original program goals and subsequent cooperator management goals, program change over time, broodstock goals, harvest goals and harvest levels, parent-progeny ratios, and response to hatchery reform (HSRG and USFWS Hatchery Review) recommendations, and will not be specifically addressed.

While planning and organizing the review, LSRCP and Cooperators spent a significant amount of time standardizing format presentations for the individual programs for both oral presentations and written reports. As ISRP observed at the review overall program objectives were established initially in the COE Special Report. Subsequent to the establishment of program objectives, each cooperator incorporated additional objectives into individual programs. As a result, each program is quite different. The roll-up was our initial effort at standardizing reporting of metrics. We felt that the roll-up was effective, however, understand that it can be improved. We have begun the process of incorporating ISRP suggestions and a modified Table 1 (from the ISRP Report) into the planning of the Steelhead Program Review Process. We plan to have a fully filled out Table 1, specific to the steelhead program, available at the beginning of the Steelhead Program Review. We are hopeful that will lead to improved standardization of metric reporting and a more useful roll-up.

ISRP commented that LSRCP primary mitigation goals established in the COE Special Report were based on overly optimistic survival assumptions. In the COE Special Report mitigation goals were based on an assumed 0.87% survival from smolt release back to the project area as adult, and that for each adult returning to the project area, four would be harvested in fisheries downstream of the project area. This equates to a smolt-to-adult survival of 4.35%. This smolt-to-adult survival is within the 2-6% survival range established by the NPCC as being necessary to restore fish populations affected by development of the hydrosystem. If the COE 0.87% survival to the project area is optimistic, then so is the NPCC goal. The reality of existing conditions does not invalidate the original program goals or mitigation obligation.

In their report, ISRP spent significant time on issues related to impacts of hatchery produced fish on naturally produced fish populations. LSRCP recognizes that this is an important issue. Since the beginning of the program, the LSRCP has focused on accounting for adults produced by the program. Much (but not all) of the work evaluating the impacts of hatchery releases on natural populations has been direct funded by BPA through the NPCC's Fish and Wildlife Program. Perhaps this was not made as clear as it could have been at the LSRCP Program review. For example, Idaho Supplementation Studies (ISS) funded through the Fish and Wildlife Program has been evaluating supplementation effects since the early 1990's. Many of the programs being evaluated by ISS use LSRCP produced fish. ISS did not report at the LSRCP Program Review. On the other hand, the Relative Reproductive Success study reported on by NOAA at the LSRCP review is not funded by LSRCP. The 'spider web' of interconnected studies evaluating effects of LSRCP produced fish and multiple funding sources caused difficulty in deciding what to include and what to exclude in the LSRCP review. The common thread between the presentations was juveniles produced and adults returned.

ISRP recommended that the BACI (Before/After/Control Impact) analysis be used to evaluate supplementation effects. LSRCP agrees that the BACI approach is useful. Where appropriate, we will incorporate BACI analysis into LSRCP evaluation. Conducting BACI analysis will require additional coordination with the NPCC Fish and Wildlife Program, BPA, and perhaps others who fund the evaluation of impacts of LSRCP produced fish on naturally produced fish.

ISRP commented that fresh water carrying capacity needed to be evaluated periodically to minimize effects of density dependence. Addressing carrying capacity issues has both ESA and US v. OR fish management implications and will require participation by NOAA, US v. OR parties, BPA, and NPCC. The impact of hatchery releases on listed natural populations is addressed as part of the development of Hatchery Genetic Management Plans and the ESA Hatchery permitting process.

ISRP recommended that LSRCP and managers take action to rapidly establish natural populations that are viable. Much work is being done to supplement natural populations. However, as ISRP notes in several locations in their report, efforts to increase naturally spawning population size must not lead to decreased productivity of those populations. Work will continue to accomplish this, but how to do that is currently not clear.

LSRCP was disappointed at the lack of emphasis of harvest and harvest opportunity provided by the LSRCP program in the ISRP Report. The LSRCP was developed to replace fish lost as a result of the hydrosystem. Over 80% of the adults that were to be provided were specifically for harvest. At the time of the previous LSRCP review ocean conditions were so poor program emphasis had shifted to increase abundance of ESA listed populations to prevent local extinctions, and little harvest opportunity was being provided. Since then ocean productivity has improved, adult returns (particularly hatchery origin adults) have increased and reasonably consistent annual sport and tribal harvest opportunity is being provided. We believe that the LSRCP Program has taken significant steps toward achieving LSRCP Program goals. While adult return goals remain far from being met, in-hatchery survival goals are being met currently, broodstock and smolt production goals are close to being met in recent years, and harvest opportunity, particularly above the project area, has increased in the last 10 years. LSRCP acknowledges that, natural populations are not currently viable.

ISRP Findings, Conclusions, and Recommendations

1. Review and approach and LSRCP Report Comments (pp.10-11)

LSRCP plans a similar format for the upcoming Steelhead and Fall Chinook Program Reviews. Planning is underway and efforts are being made to strengthen weaknesses and fill gaps noted by ISRP from the Spring Chinook Program Review. One of the obvious improvements will be preparation of a table similar to Table 1 from the Spring Chinook Review. We intend to use that table to guide preparation of the roll-up/summary presentation. Preparation of a peer reviewed article is under discussion with no decision at this point.

2. How are the project fish performing in the hatchery? (pp. 11-12)

ISRP notes that smolt release goals have never met the original LSRCP objectives. There are three reasons for that. First, few facilities currently have a release size goal of 15 fish per pound. Desire to increase SAR, precosity, mimicking the size of natural fish, and water temperature of hatchery water are all factors influencing hatchery manager decisions to adopt size of release goals different from 15 smolts per pound. Second, real world limitations at some hatcheries prevented achieving smolt production goals. For example, raceway ice cover over winter at Sawtooth Fish hatchery reduces rearing area and mandated a reduction in the hatchery production goal from 2.3 million to 1.3 million (subsequently increased to 1.7 million); inadequate water supply at Clearwater Fish Hatchery prevents operating the hatchery at full production. Clearwater Hatchery increased Chinook production at the expense of steelhead production, which meant leaving steelhead raceways dry because adequate water has never been available to operate the hatchery at full production. Third, broodstock availability has limited production at some facilities some years. For example, Sawtooth Fish Hatchery often struggles to return enough adults to achieve full production; ODFW management objective changes at Lookingglass Hatchery from Rapid River and Carson stock to endemic stock for releases in Lostine, Upper Grande Ronde, and Catherine Creek required rebuilding broodstock sources. While original goals have not been met, LSRCP believes significant progress has been made toward providing adequate brood at each facility to achieve egg and smolt production goals. Changes noted above suggest the need for additional metrics to monitor individual hatchery production goals.

ISRP noted the lack of a summary of differences between hatcheries and years. LSRCP became aware of this shortcoming while putting the roll-up presentation together. We found that the complexity of the program and changes to the program during the last 12 years makes difficult making meaningful comparisons across hatcheries. LSRCP efforts will continue to develop meaningful metrics to compare hatcheries over time.

3. How well are project fish performing once released? (pp. 12-13)

ISRP suggested that better understanding of smolt survival to Lower Granite Dam could lead to increased adult return. LSRCP notes that the number of PIT tagged fish has increased significantly in recent years. LSRCP cooperators currently Pit tag ~140,000 annually to better understand smolt survival to Lower Granite Dam and to the adult stage. Significant effort is on-going elsewhere in the NPCC Fish and Wildlife Program to install additional Pit Tag detection arrays and to analyze smolt survival (e.g., CSS study) in the Snake River (and Tucannon River) basin to better understand Chinook life cycle survival.

4. What are demographic, ecological, and genetic impacts of programs on wild fish?

ISRP noted that there is "an absence of empirical evidence from the ongoing projects to assign a conservation objective other than preventing extinction". As noted above in 1998, following the last LSRCP Program, ocean productivity had crashed and preventing extinction of local stocks was high priority. Captive broodstock programs were implemented in cooperation with NPCC to increase the number of returning adults to prevent local extinctions. Subsequently, ocean productivity has improved and the number returning adults has increased. HGMPs address management of hatchery origin adults in hatchery and natural production.

5. How are programs being modified and problems achieving objectives being addressed?

Responses to specific hatchery reform (HSRG and USFWS Hatchery Reform) recommendations are contained in HGMPs referenced above.

ISRP suggested additional emphasis be put on evaluating smolt survival from release to the ocean. As noted above, significant effort to evaluate smolt survival within the Columbia Basin is currently occurring. In addition to studies mentioned above, studies the effect of pinnepeds, terns, introduced and native fish on smolts occur. Study on tributary and estuary rearing conditions also occur. LSRCP will coordinate with BPA and NPCC on additional study in these areas as gaps in current information are identified.

Conclusions and Recommendations

1. Develop realistic harvest mitigation levels that might be attainable at some time in the future.

The smolt survival-to-adult goals (4.35%) that underlies the LSRCP Program is consistent with the NPCC goal of 2-6%. If this goal is unrealistic, the entire Columbia River basin adult return goal should be reevaluated also. The reality of existing conditions does not invalidate the original program goals or mitigation obligation.

2. Take action necessary to rapidly establish natural populations that are viable.

Following the previous Program Review in 1998, actions were taken to prevent extinction. Those efforts were generally successful, and extinction was avoided. Now, efforts need to turn to natural population recovery. NOAA is currently in the process of developing hatchery production permits that incorporate attempts to rebuild natural production based on recently submitted HGMPs. Those permits will incorporate natural population protection and rebuilding efforts as approved for the LSRCP Program.