Pre-Decisional WHITE PAPER

Snake River Basin Fall Chinook Salmon Production Program Marking Justification

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Background

Artificial (hatchery) production of fall chinook salmon in the Snake River Basin utilizes two primary hatchery facilities. Releases of subyearling and yearling fish occur at multiple locations and times; applying direct and acclimated techniques. The management goals for this hatchery production are multifaceted and adaptive. Co-mangers acknowledge two program components:

- ESA recovery/population sustainability/supplementation, and
- Mitigation/Harvest.

Marking fish supports multiple aspects of fisheries management; hatchery production, harvest management, monitoring and evaluations, and policy/permitting. No one single mark or level of marking will fulfill all program needs. The primary purposes for marking hatchery-origin Snake River Basin fall chinook salmon include; *broodstock composition management, quantification of escapement (abundance)/run reconstruction, harvest quantification, run prediction, and monitoring specific program/release effectiveness*. Past marking approaches have also supported a desire to exclude out-of-basin stray fall chinook from spawning areas upstream of Lower Granite Dam; "stray exclusion" is no longer a hard management constraint. A suite of marking options exists and new methods are regularly explored, as such, marking requirements and approaches should be considered dynamic. The recommendations made here provide general marking approach guidelines. The information presented here provides the basis for understanding and assessing the need for impacts of fish marking directly associated with Snake River Basin Fall Chinook Salmon.

Working Presumptions/Constraints:

1) Minimize the number of ad-clip/CWT marks applied based on management and financial obligations.

2) Exclusion of all out-of-basin strays at Lower Granite Dam is not an operational requirement.

3) Fall chinook salmon harvest monitoring in the ocean and Columbia River fisheries currently uses adipose fin clips to trigger CWT sampling.

4) Ongoing fall chinook salmon harvest in ocean and Columbia River is non-selective.

5) Trapping facilities at Lower Granite Dam are NOT sufficient to selectively trap all CWT fish given numbers of fall chinook salmon, coho salmon, and steelhead migrating simultaneously. A systematic subsampling approach similar to that pilot tested in 2003 will be operational in future years as well.

6) There is a statistical need for a sample size of at least 30 fish per evaluation release group at any given evaluation point (ocean and in-river harvest, Lower Granite Dam, Lyons Ferry Hatchery, etc.) to provide a minimum level of certainty to detect change over time. Based on De Libero (1986), 30 CWT'ed adult returns will provide a coefficient of variation of 28%. Each release group must have a unique CWT code to be individually identifiable and also have enough marked fish returning to a given evaluation point.

7) Existing Nez Perce Tribal Hatchery Biological Opinion requirement of uniquely marking 100% is flexible if supportive of comprehensive Snake River Basin management and assessment of recovery status.

8) Existing Lower Snake River Compensation Plan Biological Opinion requirement of uniquely marking 100% of on station releases is flexible if supportive of comprehensive Snake River Basin management and assessment of recovery status.

9) Existing Dicks' Legislative mandate to mark all hatchery produced fish is flexible if supportive of comprehensive Snake River Basin management and assessment of recovery status.

Management Objectives

Broodstock Composition Management – Control/manipulation of the hatchery:natural composition within hatchery broodstock is a basic aspect of most hatchery production programs. The desired composition is variable based on program goals and status of the natural population segment; ranging from full exclusion of hatchery origin fish to full exclusion of natural origin fish. Currently, Snake River fall chinook salmon hatchery broodstock is maintained from 100% hatchery origin fish, although some natural spawners were incorporated into the broodstock at Lyons Ferry Hatchery (LFH) in 2003. Fisheries comanagers have identified a range of 10-20% natural composition as the future target, provided the number of natural-origin fish in to the broodstock does not exceed 10% of the natural-origin escapement. If a level of (un)certainty with the actual rate of natural fish contribution is acceptable, it is possible to only mark a portion of the hatchery production and incorporate more unmarked fish in the brood in order to account for the unknown origin of specific fish. The recommended magnitude of natural contribution to overall production will vary by specific hatchery objectives and current population status.

The acceptable level of (un)certainty will dictate marked to unmarked ratio limits in hatchery production. We recommend a 95% C.I. of +/- 5% for the natural fish contribution desired precision target to hatchery broodstock composition. Precision of estimated natural fish

contribution to target contribution rate will be a function of relative abundance of unmarked hatchery origin fish and natural origin fish as estimated a) at Lower Granite Dam, b) from run predictions, or c) by collection site expansion of marked and unmarked release ratio to capture ratios.

Incorporation of natural fish into the broodstock from collection at Lower Granite Dam is a fairly straightforward expansion based on the assumption of equal capture rate of natural fish and unmarked hatchery fish to relative abundance as predicted to Lower Granite Dam. Current broodstock needs call for approximately 4,100 adults for LFH and 1,040 adults for NPTH, assuming a 1:1 sex ratio. Therefore, we would need 514 and 1,028 natural adults to achieve the 10% and 20% natural contribution rates to broodstock, respectively. This, in turn, requires a minimum of 5,140-10,280 (for 10% and 20% contribution rates, respectively) natural-origin adults in order to achieve this goal without exceeding 10% of the natural-origin spawning population. Currently natural adult returns are <u>not</u> high enough to meet this goal without exceeding the 10% of natural-origin spawning population threshold. In 2003, only 3,856 non-jack natural-origin adult fall chinook returned to Lower Granite Dam.

One issue we run into is that broodstock is also collected at Lyons Ferry Hatchery and Nez Perce Tribal Hatchery. As spatial fidelity has been demonstrated to be high, at least at the release stream scale, it is likely that the capture rate of natural and unmarked hatchery fish at these hatcheries will be skewed toward unmarked hatchery fish. As a result, all unmarked adults for broodstock will have to be collected at Lower Granite Dam and hauled to the hatcheries. In addition, marked adults will have to be collected at Lower Granite Dam for run reconstruction. Under the proposed Lower Granite trap sub-sampling protocol, all adult fall chinook salmon captured with CWTs will be retained at Lower Granite Dam and prioritized for broodstock utilization. If the number of known origin hatchery chinook salmon retained at Lower Granite Dam plus the hatcheries exceeds broodstock needs, acceptable uses for these excess fish will need to be identified given recovery of CWT information requires lethal sampling.

Given the importance of precise quantification (of at least post-spawn contribution) of natural fish in hatchery broodstock it is recommended that all (100%) hatchery production is marked by Oxytetracycline or thermal/chemical otolith methods (both require lethal sampling) to quantify actual hatchery:natural broodstock composition and to validate predicted/estimated post-spawn contribution. Scale Pattern Analysis would also allow partitioning of hatchery:natural composition, with limited precision. Scale Pattern Analysis can achieve 80% accuracy with the 20% uncertainty due to unreadable scales (Sneva and Connor, unpublished). The higher the unmarked hatchery fish to natural fish ratio is, the higher the uncertainty in meeting the target natural contribution rate will become. The ratio of unmarked hatchery fish to natural fish is a function of 1) abundance of natural fish returns relative to hatchery fish returns, 2) percent of unmarked hatchery fish released relative to overall hatchery production and 3) collection methods and any associated bias.

Quantification of Escapement (Abundance)/Run Reconstruction – Information on the actual abundance of adult fall chinook salmon returning to the Snake River annually is one of the cornerstone performance measures needed for effective fisheries management and recovery programs. Not only does this support direct assessment relative to management abundance

thresholds (i.e. minimum adult spawner escapement, ESA recovery target of 2,500 natural-origin spawners (NMFS 2000), hatchery broodstock requirements, and established harvest impact limits of 31.6%) but also is essential for deriving life stage specific survival and population trend matrices (i.e. smolt-to-adult survival rates, parent progeny ratio and lambda). The recommended primary assessment location for direct escapement monitoring is Lower Granite Dam. Given that Lower Granite Dam is functionally the final assessment site for representative sampling of adult returns, it also serves as the point where project/release specific performance is measured, except for Lyons Ferry Hatchery on-station releases. A "run reconstruction" approach to estimate annual escapement partitioned by natural-origin fish, hatchery-origin fish (release group specific), and out-of-basin strays has traditionally been used. This will continued to be employed due to the 1) inability to directly sample (identify origin and age class) all fish passing Lower Granite Dam, 2) need to expand counts for areas downstream of Lower Granite Dam, and 3) desire to avoid a mass marking approach for all fall chinook salmon hatchery production.

Draft precision targets for total escapement estimates to the Snake River Basin is a CV of 15%. The current run reconstruction goal is to track a 5% change in abundance with 95% certainty, however the current sampling approach at Lower Granite Dam is not adequate to fulfill this goal. In order to adequately describe the natural production status relative to ESA recovery goals a more rigorous target of a CV of 10% is recommend, while the targeted precision for hatchery escapement is a CV of 15%. At low natural abundance levels the ability to determine status with sufficient confidence will most likely be compromised. From an economic and tribal standpoint, it is desirable to mark as few fish as possible yet still achieve satisfactory certainty. Any type and a mixture of marks that are detectable support this task; with CWT's, adipose fin clips and visible implant elastomer tags traditionally being used. However, sampling methods vary through different activities and at different locations requiring use of different types of marks. Ideally the marks would be detectable at the time of quantification (i.e. passage at Lower Granite Dam).

Adult fish passage facilities at Lower Granite Dam include a fish counting window (with video capabilities), PIT tag detector, and a research trap. The research trap has the capability to selectively trap CWT'ed fish, PIT tagged fish, or sub-sample the entire run on proportional time basis. The trap structure and current level of staffing is not adequate to handle comprehensive trapping of all escapement or comprehensive trapping of all CWT'ed fish given the high returns of both CWT'ed chinook salmon and steelhead in recent years. To accommodate these facility limitations, Lower Granite Dam adult fish passage facilities were operated in a sub-sampling mode during 2003 migration period. Temperature criteria sometimes limit the ability to operate the trap. We have assumed that this general approach will continue to be employed in future years; and that the rate of sub-sampling would be adjusted annually to assure adequate collection of CWT tag fish for evaluation of individual release groups. It is possible that future returns of steelhead or natural fall chinook salmon could overwhelm trap capabilities with a sub-sampling rate inadequate for sufficient hatchery fall chinook salmon CWT recoveries. Under these conditions modifications to marking (increasing number or combining CWT groups) or trap facilities would be required. Similarly, if comprehensive trapping of all CWT'ed fish is reinstated in the future, adjustments to tagging rates or plans to release a portion of trapped fish would need to be developed.

Total escapement (hatchery and natural origin combined) of fall chinook salmon past Lower Granite Dam can be estimated via fish counting window observations. This estimate will serve as the primary in-season indicator of abundance and run timing. It will also serve as a validation measure for trap sub-sampling efficiency. Operations should target a census count, therefore 24-hour observations should continue/ be reinstated.

Run reconstruction from the Lower Granite Dam fish passage data will incorporate an expansion for returns to terminal areas downstream of Lower Granite Dam (i.e. Lyons Ferry Hatchery, harvest in the Snake River downstream of Lower Granite Dam and natural spawning in the Snake, Tucannon and Palouse Rivers). As such, estimates of total escapement to the Snake River Basin will included a summation of estimated escapement upstream of Lower Granite Dam, Lyons Ferry Hatchery Trap collections, estimated harvest between Ice Harbor Dam and Lower Granite Dam, harvest above Lower Granite Dam (counted as adults not reaching the spawning areas), natural spawners downstream of Lower Granite Dam (including the Tucannon and Palouse rivers).

Quantification of abundance of naturally produced escapement under a partial marking strategy is based on quantifying total escapement, accounting for the hatchery produced component (marked and unmarked) and subtracting it out from the total. This requires the ability to quantify hatchery origin adult abundance for each release group at Lower Granite Dam, which is the priority evaluation site for all yearling and sub-yearling release groups upstream of Lower Granite Dam, as well as harvest and spawning in the Tucannon River, Palouse River and Snake River below Lower Granite Dam. Lower Granite Dam also serves in combination with ladder/trap at Lyons Ferry Hatchery as the evaluation point for Lyons Ferry Hatchery on station release groups.

Harvest Quantification - Harvest of fall chinook salmon in both ocean and in-river fisheries are currently non-selective for origin of fish. Harvest sampling programs typically target a sampling rate of 20%. Though these fisheries are non-selective, CWT sampling within this 20% is selective, triggered by an adipose fin clip mark. As such, to estimate rate of harvest exploitation, we must adipose fin clip and CWT adequate numbers within hatchery release groups. A double mark index approach will be used as a validation measure to differentially assess performance of adipose fin clipped and non-clipped fish. The need for adipose fin clips in support of harvest monitoring could be eliminated with the implementation of electronic sampling of all ocean and in-river harvest rather than just those fish with adipose fin clips.

If selective harvest management is instigated either in the Columbia River or Snake River downstream of Lower Granite Dam, marking approaches would require adjustment to account for differential survival of adipose fin clip and non-marked fish. An alternative approach using harvest evaluation groups [representatively marked adipose fin clip and CWT across multiple release groups within a production strategy (i.e. subyearlings upstream of Lower Granite Dam)] could be implemented. This would enable harvest contribution estimation and not impact run reconstruction while reducing the overall amount of adipose fin clips.

Run Prediction - Run prediction or forecasting for fall chinook salmon is currently handled by the *U.S. v Oregon* Technical Advisory Committee (TAC). Run predictions are generated for an

aggregated group of upriver bright fall chinook salmon, which comprises all areas upstream of McNary dam including the Snake River Basin escapement. TAC is also responsible for forecasting Snake River Basin natural returns separately; however this prediction has not been produced in recent years. It is anticipated that Snake River natural forecasts to Lower Monumental Dam or Ice Harbor Dam (depending on open harvest areas) will be generated in the future. This committee applies data from co-managers on the run reconstruction from the previous years escapement. TAC's methods for fall chinook salmon return forecasts is adjusted annually. Generally the initial run predictions are made using smolt stocking numbers from the previous year, adult return numbers by age from the previous year, and mean brood year age at return. Hatchery jack estimates are based on the number of smolts released the previous year and on average return rate. We estimate age 4 and age 5 returns from previous year returns of age 3 and age 4 fish and mean conversion rates developed from mean brood year age at return.

In-season run size adjustments are formally made for upriver brights and Mid Columbia brights as well as Spring Creek Hatchery fish. These are based on actual Bonneville counts and harvest monitoring results of age class and origin. Currently it is not possible to update the Snake River Fall Chinook return at Bonneville Dam. It may be possible in the future based on PIT tags or other data, but techniques would need to be agreed to by the co-managers. For example, if 10 four-year-old, PIT tagged, Snake River fall chinook have passed Bonneville or Lower Granite Dam by the time that 50% of the run would normally have passed, we would expect 20 four-year-old, PIT tagged, Snake River fall chinook salmon to pass Bonneville or Lower Granite Dam for the year. If 10% of the release group was PIT tagged then we would expand that 20 fish projection to 200 four-year-old, Snake River fall chinook salmon entering the Snake River Basin for the season. We will be able to calculate historical conversion rates of PIT tags detected at Bonneville Dam to PIT tags detected at the Lower Granite Dam to determine expected loss for that reach of river and apply that loss to the projections based on Bonneville PIT tag detections. To implement this approach representative groups of fish across all release groups would be required to be tagged and handled representatively (passage route) to non-PIT tagged fish during their juvenile emigration.

Program/release Effectiveness - Multiple groups have stressed the importance of monitoring natural resource status and results of management projects (Botkin et al. 2000; McElhany et al. 2000; Hesse and Cramer 2000). Monitoring and evaluation (M&E) activities are intended to address project uncertainty and to provide feedback to managers on program effectiveness (CRITFC 1995, Steward 1996, NPPC 1999). Uncertainty is a function not only of unpredictability and ecosystem randomness but also of our state of knowledge and scientific understanding. This feedback consists of collecting information describing status (abundance), distribution, condition, and trends of biological and environmental variables of interest. A suite of population status monitoring, small-scale studies, and controlled setting experiments are needed to address evaluation requirements as identified in the Snake River Fall Chinook Salmon Monitoring and Evaluation Program (July 17, 2002 DRAFT). Key performance measures and management questions were developed through review of ongoing fisheries evaluation programs, co-manager meetings in the Snake River Basin, and broader-spectrum monitoring and evaluation literature. They relate directly to the status of the natural population and performance of fall chinook salmon hatchery programs. The ESA listing status is a dynamic factor that may influence M&E requirements as species are added to or removed from the listing.

The need to quantify specific program/release performance is addressed through differential marking of individual release groups within the program as a whole. Marking strategies provide a measure of program/release effectiveness at several levels, with a number of the smolt-to-adult level evaluations inherent in the aspects currently supported by CWT and adipose fin clips as described in previous sections. Estimates of life stage specific survival rates are a critical component in the monitoring of release groups and in the evaluation of that performance in relation to program assumptions, model parameters, and performance standards.There is a need to monitor survival of juveniles through the lower Snake River hydro system to provide continuous baseline data to evaluate future passage management actions. We will PIT tag all release groups above Lower Granite Dam in sufficient numbers to obtain survival estimates with a 95% C.I. of +/- 5% for hatchery produced fall chinook salmon from release to McNary Dam. Based on several years of survival estimates for yearling fall chinook salmon released from the Pittsburg Landing, Big Canyon and Captain John Rapids acclimation facilities, PIT tagging 2,500-3,000 fish per yearling release group is sufficient to meet this requirement (need to do further calculations for sample size requirements for different groups).

Releasing groups of PIT tagged fish will also provide juvenile survival estimates with high levels of confidence (95% C.I. of +/- 2.5%) to Lower Granite Dam. We can then estimate overall hatchery produced smolt abundance at Lower Granite Dam by expanding release group specific survival to release group size. From there we can estimate natural smolt production from Fish Passage Center overall smolt estimates and subtract out the hatchery component. Smolt-to-adult (SAR) survival for hatchery and natural fall chinook salmon can then be estimated for natural produced fish from Lower Granite Dam to Lower Granite Dam and for hatchery produced fish from release to Lower Granite Dam. This is done simply by calculating survival based on group specific smolt abundance estimates at Lower Granite Dam (from PIT tag release groups) and group specific adult abundance estimates at Lower Granite Dam (from run reconstruction).

Recommended Actions

Recommended actions toward meeting program goals are listed below and Table 1 contains a recommended marking plan.

1) Mark 200,000 fish in each release group with CWT and AD clip. Combine groups where appropriate.

2) Utilize scale pattern analysis or application of an internal mass mark that is detectable with lethal sampling to support post-spawn quantification (validation) of unmarked hatchery to natural fish ratios used in broodstock development.

3) Reinitiate TAC forecasted run predictions for natural and hatchery fall chinook at Lower Monumental Dam each year.

4) Initiate full-scale electronic sampling of ocean and in-river harvest to eliminate need for adipose fin clips and double index groups.

5) PIT tag a minimum of 2,500 fish from each release group to provide continuous baseline data to evaluate future passage management actions. PIT tagging also have a potential

role in future in-season run adjustments if applied in sufficient quantity and representatively transported during juvenile emigration.

6) Any harvest in downstream of Lower Granite Dam in the Snake River basin should be non-selective. Implementation of selective harvest management in areas downstream of Lower Granite Dam requires a shift in marking approaches 3 years prior to fisheries initiation.

7) Employ a sub-sampling protocol at Lower Granite Dam. Sub-sampling in 2003 was a pilot trial to assess feasibility, we assume long term application. The rate of sub-sampling should be adjusted annually to assure adequate collection of CWT tag groups for evaluation of individual release groups, which may require modifications to the Lower Granite adult trap to be feasible.

8) Conduct/reinstate continuous fish ladder counts (including nighttime video sampling) for both fall chinook salmon and steelhead in order to validate sub-sampling efficiencies.

9) Retain approximately 1,200 marked fish annually during Lower Granite Dam sub-sampling for run reconstruction needs. These fish require lethal sampling and ideally will be incorporated into broodstock requirements.

10) All natural-origin and unmarked hatchery-origin fish for broodstock will be collected at Lower Granite Dam and transported to LFH and NPTH.

11) Assess feasibility of current capabilities of Lower Granite adult trap to meet collection needs under current conditions and under a range of possible future conditions.

Table 1. Snake River fall chinook production agreement for the Lower Snake River Compensation Plan at Lyons Ferry Hatchery, the Fall Chinook Acclimation Program, the Idaho Power Program and the Nez Perce Tribal Hatchery. [1]

Production Priority	Rearing Facility	Release Number	Release Location	Life Stage	Marks
Tier 1 assumes rearing of 1.9 million subyearlings at Lyons Ferry Hatchery and 1.0 million eggs for the IPC program.					
1	Lyons Ferry	450,000	On-station	1+	200K CWT, AD 250K CWT
2	Lyons Ferry	450,000	Pittsburg Landing Big Canyon Captain John Rapids	1+	200K CWT, AD (Proportionally applied)
3	Lyons Ferry	200,000	On-station	0+	200K CWT, AD
4	Lyons Ferry	1,000,000	Big Canyon Captain John Rapids	0+	200K CWT, AD Proportionally applied
5	IPC [2]	200,000	Pittsburg Landing	0+	200K CWT, AD
6	IPC	200,000	Hells Canyon Dam	0+	200K CWT, AD
7	IPC	200,000	Pittsburg Landing	0+	Combine with # 5
8	Lyons Ferry	400,000	Direct Release (Captain John Rapids?)	0+	200K CWT, AD
9	Lyons Ferry	200,000	Grande Ronde	0+	200K CWT, AD
10	IPC	400,000	Hells Canyon Dam	0+	400K AD
11	Lyons Ferry	100,000	Grande Ronde	0+	100K CWT, AD
Tier 2 assumes rearing of up to 2.6 million subyearlings at Lyons Ferry Hatchery					
12	Lyons Ferry	300,000	Grande Ronde or Captain John Rapids	0+	Combine with # 9 and 11
13	Lyons Ferry	400,000 [3]	Pittsburg Landing	0+	400K AD
NPTH Tier independent of Lyons Ferry Production					

NPTH 1	NPTH	1,000,000	On-station North Lapwai Valley	0+	200K CWT and 100K CWT, AD at each location
NPTH 2	NPTH	400,000 [4]	Cedar Flats Lukes Gulch	0+	100K CWT and 100K CWT, AD at each location
TOTALS	**Tier 1+NPTH 5,200,000** **Tier 2+NPTH 5,900,000**			**2,100,000 CWT, AD 400,000 - 800,000 AD 850,000 CWT only 1,850,000 - 2,150,000 No Marks 0 VIE**	

[1] All programs except the IPC program are funded by Bonneville Power Administration.
[2] IPC program may be implemented at IPC Oxbow Hatchery and/or other hatcheries, such as Umatilla Hatchery.
[3] These would replace subyearlings released by IPC, and all IPC releases would occur at Hells Canyon Dam.
[4] Early spawning component of NPTH program.