Tucannon River Spring Chinook Salmon Hatchery Supplementation Program

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Introduction

Mitigation Goal

The Water Resources Act of 1976 authorized the establishment of the Lower Snake River Compensation Plan (LSRCP) to replace adult salmon and steelhead lost by construction and operation of the hydroelectric dams on the Lower Snake River. During the mitigation negotiations it was determined that 2,400 spring Chinook salmon annually escaped into the Tucannon River. The Tucannon River spring Chinook hatchery mitigation program was designed to escape 1,152 adults to the Tucannon River (replacement of the 48% loss attributed to the construction and operation of the dams), with the expectation that the remaining 1,248 adults would come from natural production. It was also assumed that 4,608 (4x escapement goal) Tucannon spring Chinook would be harvested below the project area (Here the "project area" is defined as above Ice Harbor Dam). Hatchery mitigation was to be accomplished by the annual release of 132,000 yearling smolts with an assumed SAR of 0.87%.

Management Objectives

The management objectives for the Tucannon River Spring Chinook population are: 1) Meet the LSRCP mitigation goal, 2) Restore and maintain fisheries (long-term goal – 2,400-3,400 hatchery and natural fish), 3) Restore and maintain the natural population (population viable threshold – at least 750 natural origin fish over a 10 year geometric mean), and 4) Minimize impacts of the hatchery fish on the natural population.

Monitoring and Evaluation Objectives

The monitoring and evaluation objectives are to: 1) Determine if the program is meeting its mitigation goals, 2) Monitor production, productivity, and life history characteristics of both the hatchery and natural components of the population, and 3) Evaluate hatchery rearing strategies so that we can maximize adult returns.

Location and Hatchery Facilities

The Tucannon River is located in southeastern Washington and flows into the Snake River between Lower Monumental and Little Goose Dams (**Figure 1**). Lyons Ferry Hatchery is located on the Snake River and is used for broodstock holding, spawning, egg incubation, and

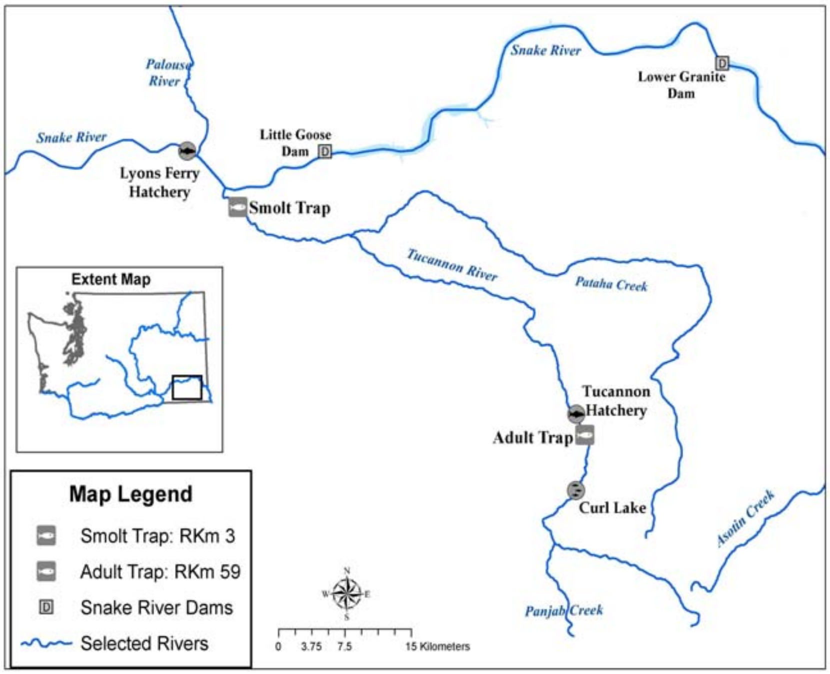

Figure 1. Location of the Tucannon River, and Lyons Ferry and Tucannon Fish Hatcheries within the Snake River basin in Washington State.

early juvenile rearing. The Tucannon Hatchery is used for broodstock collection at the adult trap, and juvenile rearing before release. Pre-smolts are transported to Curl Lake Acclimation Pond (AP) in February for acclimation and are volitionally released in April.

Hatchery Operations and Results

Hatchery Spawning

The Tucannon River stock was derived from fish captured at the Tucannon Hatchery adult trap, thereby representing individuals that were endemic to the Tucannon River. The broodstock goal was to collect 100 adults for the production of 132,000 smolts annually from 1986-2005. This broodstock collection goal was achieved 50% of the time during that period. It was revised by the co-managers beginning with the 2006 brood year to adjust for lower than expected smolt to adult return survivals. The new goal is 170 adults (target - 50% natural origin) which are to be collected from throughout the run to meet the new smolt production/release goal of 225,000. The new broodstock collection goal has been met 40% of the time through 2010. Returning

Tucannon hatchery salmon are identified by a coded-wire tag in the snout or presence of a visible implant elastomer tag. A 2x2 factorial spawning matrix approach is utilized to increase effective population size and ensure the highest likelihood of fertilization.

Captive Brood Program Implementation

The Washington Department of Fish and Wildlife initiated a captive brood program in 1997 due to extremely low escapement in the mid 1990's (the total run in 1995 was estimated at 54 fish). The program began by collecting sac fry from the hatchery supplementation program from five (1997-2001) brood years (one generation) with additional sac fry collected from the 2002 BY in order to have extra males on hand to spawn. The project goal was to rear the captive salmon to adults, spawn them, rear their progeny, and release approximately 150,000 smolts annually into the Tucannon River between 2003-2007. This was expected to provide a return of about 300 adult fish to the Tucannon River of captive origin per year between 2005-2010. These smolts, in combination with the conventional hatchery supplementation program and natural production, were expected to produce 600-700 returning adult spring Chinook to the Tucannon River each year from 2005-2010.

Fish Health

Broodstock are given injections of erythromycin and oxytetracycline at trapping. Injections of erythromycin are given on monthly intervals before spawning. Spawned females are examined for Bacterial Kidney Disease (BKD) using the Enzyme Linked Immunosorbent Assay (ELISA) technique. However, unlike most other programs there is no culling or segregation of eggs based on ELISA results. This strategy has resulted in only two minor losses due to BKD in the last ten brood years (2000 and 2002 BY's). Broodstock mortality was high during the beginning of the program when fish were held at Tucannon Fish Hatchery (**Figure 2**). Beginning with the 1992 brood year, broodstock were held at Lyons Ferry Hatchery (LFH) and pre-spawn mortalities fell sharply due to lower water temperatures and pathogen free well water at LFH.

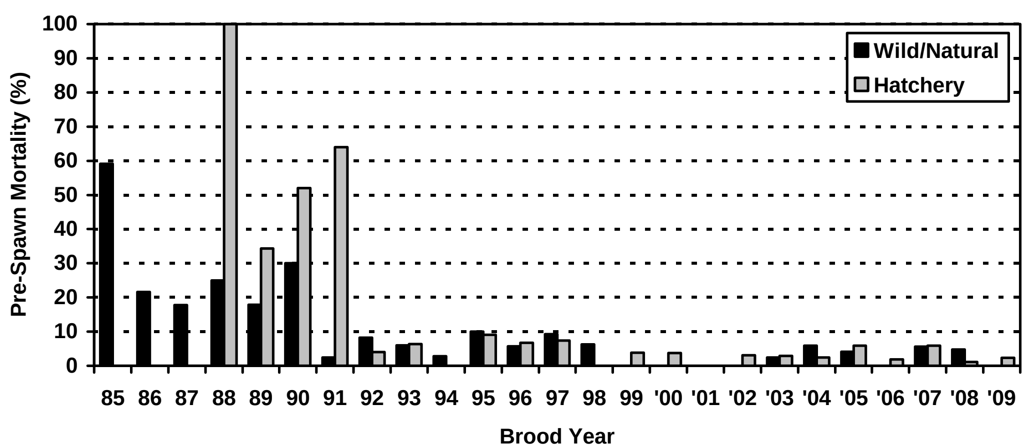

Figure 2. Pre-spawn mortalities (%) of wild/natural and hatchery origin Tucannon River spring Chinook salmon broodstock for the 1985 to 2009 brood years.

Rearing, Production, and Adult Returns

Only in three brood years out of the last 24 have we been below the 70% goal for eyed-egg to smolt survival (**Figure 3**).

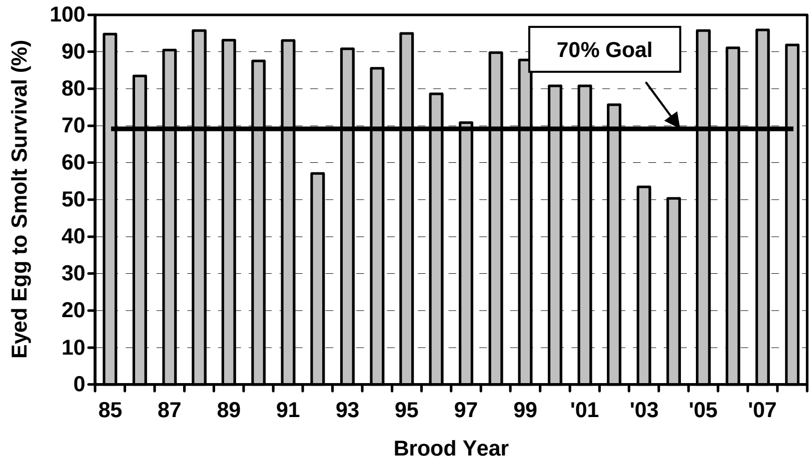

Figure 3. Eyed-egg to smolt survival for Tucannon River spring Chinook for the 1985 to 2008 brood years.

For various reasons we have not always met our smolt production goal (**Figure 4**). When the Tucannon River spring Chinook captive brood program was in place, it at least allowed us to meet our goal which otherwise would not have been met with just the conventional supplementation program alone. Beginning with the 2006 brood year, the tribal co-managers and WDFW agreed to increase the smolt production goal to 225,000 due to low hatchery origin smolt to adult returns.

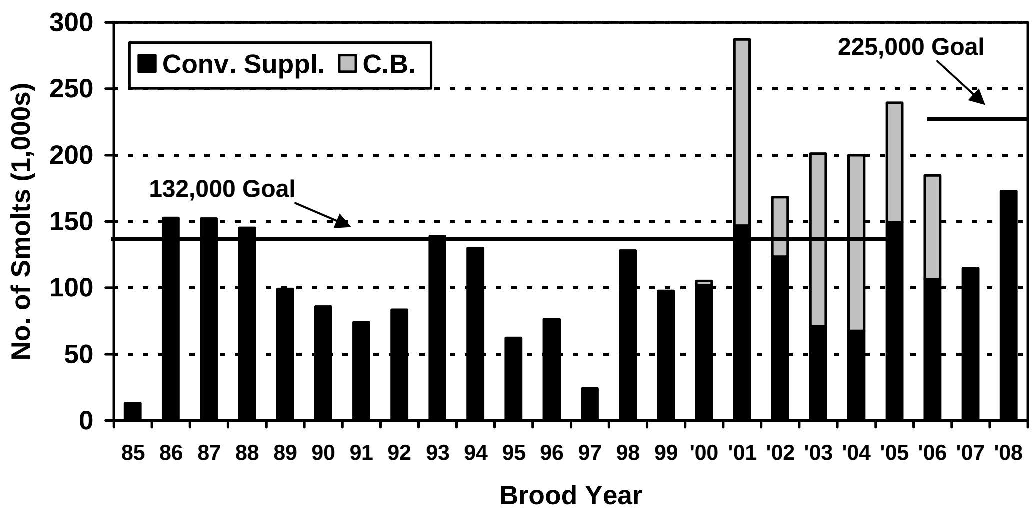

Figure 4. Number of smolts produced by brood year for both the conventional hatchery supplementation and captive brood programs.

Both the numbers and distribution of redds has varied over the years (**Figure 5**). During low runs in the mid 1990's the majority of fish were collected at the adult trap in an effort to save the

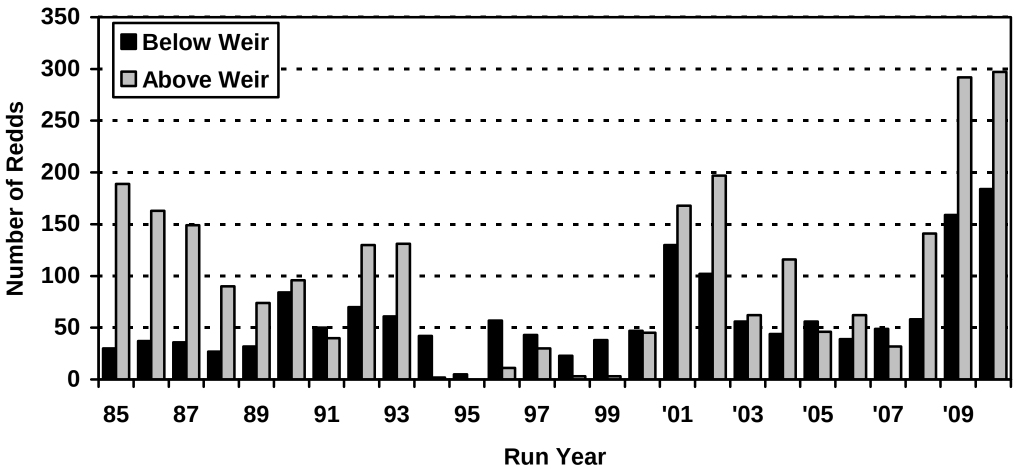

Figure 5. Number of spring Chinook redds above and below the adult trap on the Tucannon River for the 1985-2010 run years.

population from extinction due to early life history survival advantages in the hatchery. This action, combined with all smolts being released from the hatchery, led to a majority of natural spawning occurring below the hatchery weir. We have also documented trap avoidance based on radio telemetry studies and visual observation. Beginning with the 1997 brood year (released as smolts in 1999) we began using Curl Lake AP which is located above the adult trap. This appears to have improved the distribution of redds above the weir.

While we have come close in recent years we have not met the hatchery mitigation goal of 1,152 (**Figure 6**). We have had at least 750 natural origin fish [minimal viable population (MVP) abundance level] return to the Tucannon River in the last two years.

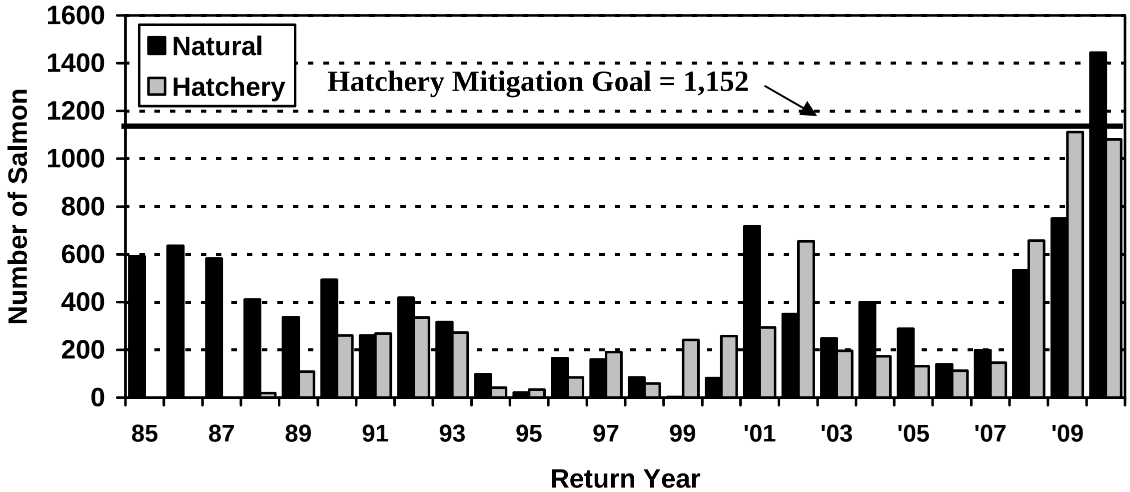

Figure 6. Escapement to the Tucannon River by origin for the 1985-2010 return years.

The majority of both the hatchery and natural components of the Tucannon River spring Chinook population return at age-4 (**Figure 7**). Hatchery rearing causes earlier maturation with more age-3 and fewer age-5 fish than the natural component of the population.

Natural origin precocial parr (age-0 and age-1) have been observed on the spawning grounds but are missed at the adult trap and during carcass recoveries so they are excluded from the spawner age composition graph. In the hatchery environment, males that mature at these ages are included in the monthly mortality counts since hatchery origin fish are not released until April (age-1+).

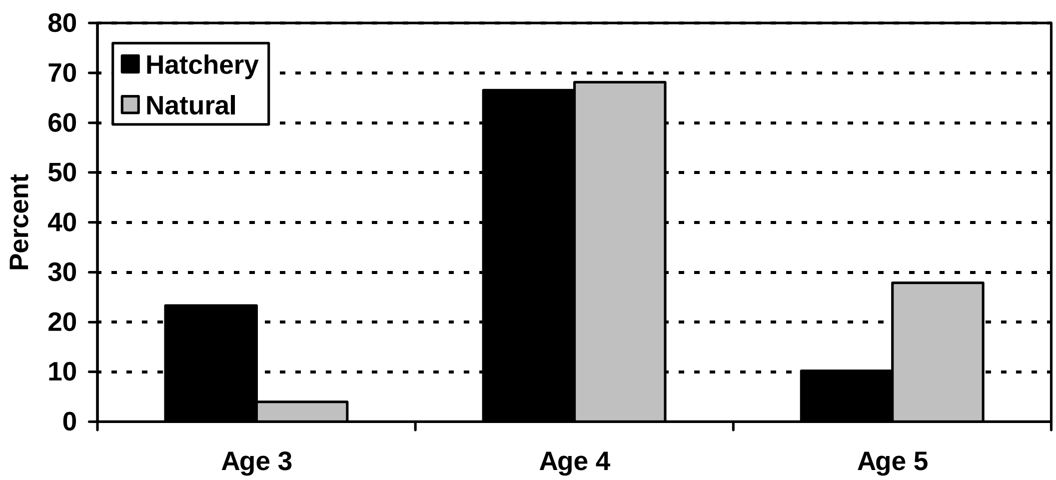

Figure 7. Age composition of hatchery and natural origin Tucannon River spring Chinook for the 1985-2009 run years.

Fecundity

Natural origin Tucannon River spring Chinook females were significantly ($P < 0.05$) more fecund than hatchery origin females for both age-4 and age-5 (**Table 1**).

Table 1. Mean number of eggs per female by age for natural and hatchery origin Tucannon River spring Chinook broodstock, 1990-2009 return years.

	Age 4		Age 5	
	Natural	Hatchery	Natural	Hatchery
Mean Fecundity	3,485	3,092	4,405	3,671
(S.D.)	(640.3)	(658.1)	(883.4)	(767.6)

Strays

Hatchery strays from other systems are found in the Tucannon River which we have been able to remove at the adult trap when they are fin clipped. Umatilla River spring Chinook have historically comprised the majority of the strays. However, the numbers of strays are typically below the 5% stray proportion deemed acceptable by NOAA Fisheries. We cannot remove strays that may spawn below the adult trap/weir, only document their abundance based on carcass recoveries during spawning ground surveys.

Coded-Wire Tag Recoveries

The majority of Tucannon River spring Chinook coded-wire tags are recovered in the Tucannon River (**Figure 8**). With the exception of a couple of brood years, few fish have been captured in

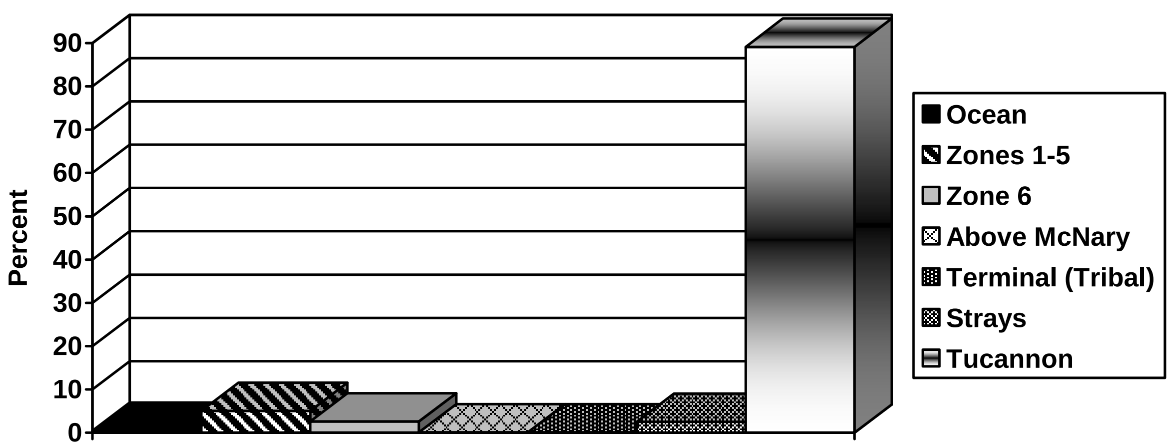

Figure 8. Coded-wire tag recoveries of Tucannon River spring Chinook salmon from the 1985 to 2006 brood year hatchery releases.

fisheries. It is important to point out however, that due to historic low runs we stopped adipose fin clipping beginning with the 2000 brood year in order to maximize escapement back to the Tucannon River. If only adipose clipped fish are scanned for wire in these fisheries, than this would under-represent the contribution of Tucannon River spring Chinook in the catch.

Run Timing

The cumulative percentage of arrival timing of natural and hatchery origin fish shows nearly identical run timing to approximately the 60% mark (**Figure 9**). After that point it appears that the natural origin fish arrive at a slower rate than the hatchery origin fish. Similar trends have been observed in other basins.

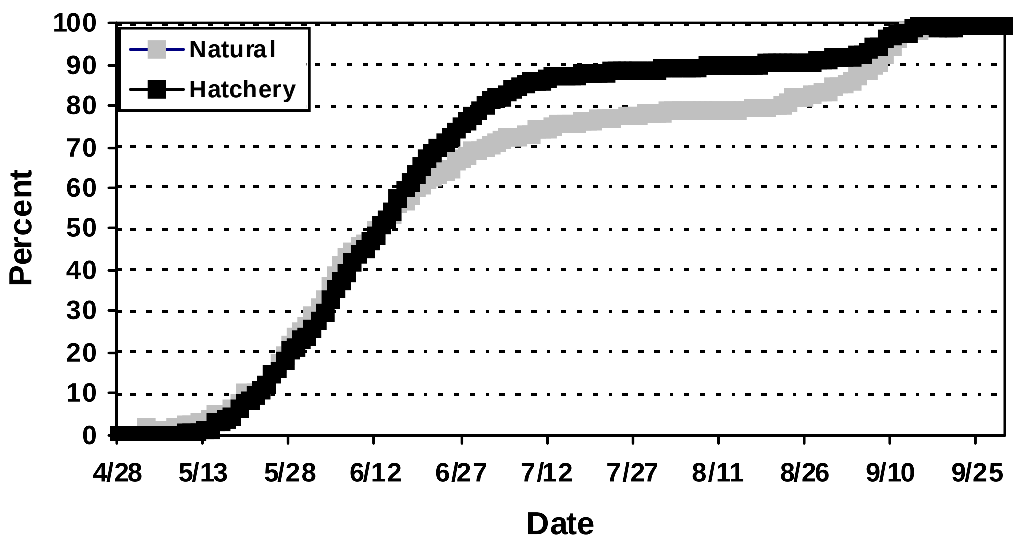

Figure 9. Mean percent of total run captured by date at the Tucannon Fish Hatchery adult trap on the Tucannon River for both natural and hatchery origin Tucannon River spring Chinook salmon, 1993-2009.

The program has never met the LSRCP hatchery origin smolt-to-adult return (SAR) goal of 0.87% (**Figure 10**). We are short of the goal even when all known recoveries are included in the smolt-to-adult survival (SAS).

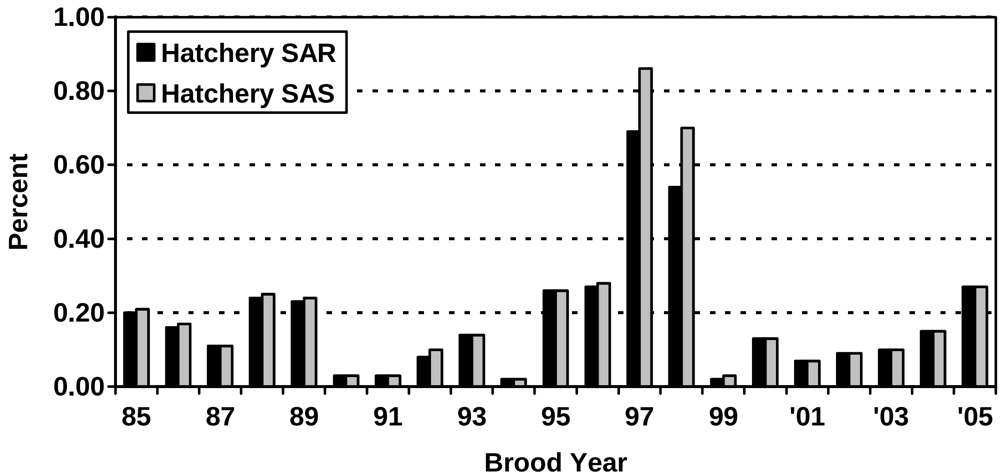

Figure 10. Comparison of hatchery origin smolt-to-adult return (SAR) and smolt-to-adult survival (SAS) for the 1985 to 2005 brood years (jacks excluded).

Natural origin smolt-to-adult returns have consistently been higher than hatchery origin returns (**Figure 11**). Based on the current mean hatchery origin SAR of 0.21% it would take a hatchery program of over 500,000 smolts to meet the mitigation goal of 1,152 hatchery fish. After discussions with the tribal co-managers it was decided to increase the smolt goal from 132,000

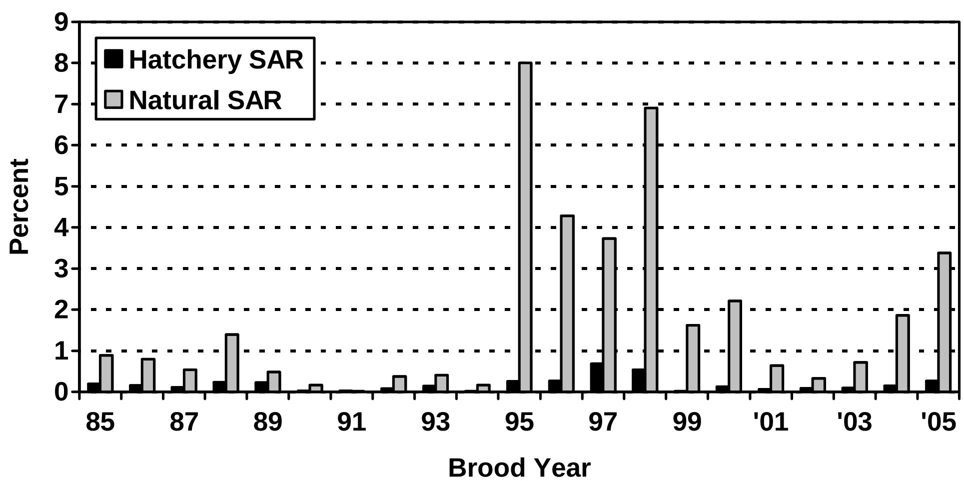

Figure 11. Comparison of smolt-to-adult returns of hatchery and natural origin Tucannon River spring Chinook for the 1985 to 2005 brood years (jacks excluded).

to 225,000 beginning with the 2006 brood year. It was felt that while for some years the increased goal wouldn't be met – we would hope to make the original 132,000 goal at a minimum. The program is currently examining size at release as a possible means to improve SAR survival rates.

Captive Brood Program Results

The captive brood program had problems with low fecundity, high egg losses, and progeny to parent ratios that were less than natural origin fish. Therefore, the program was discontinued as originally planned after one generation.

Genetics

Microsatellite DNA analysis was conducted to determine if there have been any changes to the genetic diversity of spring Chinook in the Tucannon River from before the hatchery program began (1986) to 1997-1998 and 2000-2008 samples of natural, conventional hatchery, and captive brood origin fish. The results showed that the genetic diversity of spring Chinook in the Tucannon River has not significantly changed as a result of the supplementation or captive brood programs. This study is more adequately described in Todd Kassler's report which is included in these proceedings

Adult PIT Tag Returns

Fifty-five adults originally PIT tagged as juveniles (1995-2008 tag years) have been detected returning to the Columbia River System. Of those, about 24% swam past the Tucannon River and were detected at Lower Granite Dam. This behavior does not appear to be a hatchery effect since both hatchery and natural origin fish bypassed the Tucannon River at nearly the same rate (23.5% for hatchery origin and 23.8% for natural origin). This information is based on a small sample size but we have seen the same bypassing issue with the Tucannon River steelhead which have had much larger numbers of PIT tagged fish. WDFW is increasing PIT tag numbers (up to 25,000 for the 2009 BY) to further study this issue.

Progeny to Parent Ratio

Examining progeny to parent ratios shows that natural origin fish have been above replacement in only six of the last 21 brood years (**Figure 12**). This is in comparison to the hatchery origin fish which are typically above replacement. That the natural origin fish are typically not replacing themselves is the most pressing question for this population since extinction is inevitable for a population should this situation continue. Preliminary WDFW evidence suggests that density-dependent factors (larger runs = smaller smolts = lower survival) below carrying capacity (based on Ricker and Beverton-Holt stock-recruit functions) may play an important role.

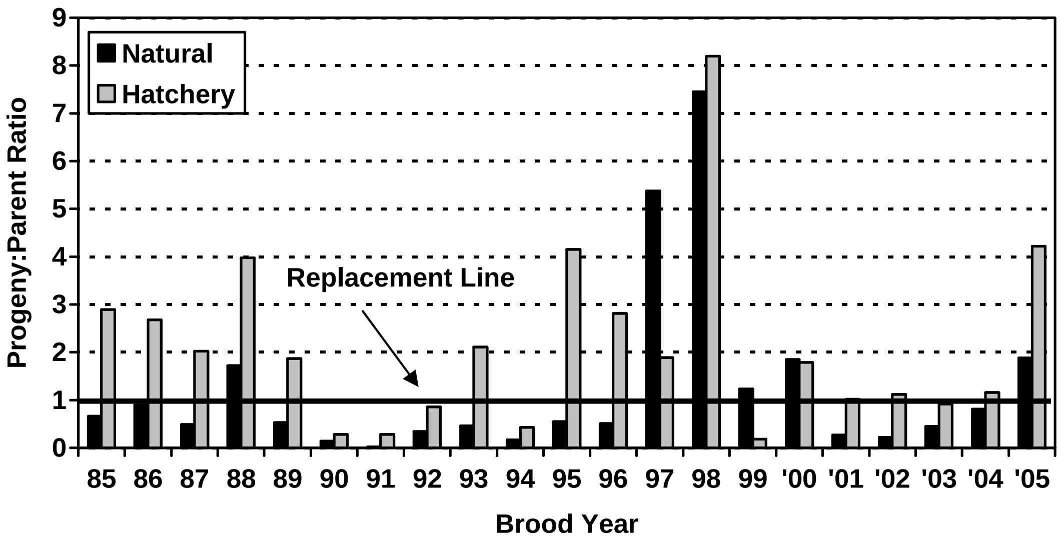

Figure 12. Progeny to parent ratios (with replacement line) for natural and hatchery origin Tucannon River spring Chinook for the 1985-2005 brood years.

<u>Hatchery Reviews</u>

The Tucannon River spring Chinook hatchery supplementation program underwent a hatchery scientific review process during 2009 and 2010. The Hatchery Scientific Review Group (HSRG) and Hatchery Review Team (HRT) made recommendations to improve the Tucannon spring Chinook hatchery program.

The HSRG recommended that the population be managed as a Primary Population because it is the only extant population within the Lower Snake River MPG, and therefore it is required to meet highly viable status under ESA recovery plans. The HSRG suggested that WDFW and the tribal co-managers develop a sliding scale management approach so that in low abundance years, more of the appropriate stock is allowed to reach the spawning grounds. The HSRG also recommended that the straying of Tucannon spring Chinook above Lower Granite Dam be further investigated.

The HRT provided numerous suggestions including changing the size and nature of the program, rethinking the prophylactic use of medicated feed for bacterial kidney disease, and possible changes to hatchery facilities used in the program.

Full responses to the HSRG and HRT comments are found in the Tucannon River Endemic Stock Spring Chinook Hatchery and Genetic Management Plan (HGMP) and are available at the LSRCP website (http://www.fws.gov/lsnakecomplan/Reports/HGMPreports.htm). These recommendations are being discussed between WDFW and the tribal co-managers. A series of alternatives have been devised under the HGMP for consideration by the co-managers, however the existing program was agreed upon under the 2008-2017 U.S. v. Oregon agreement and any changes will need to be addressed in that forum.

Summary

The assumptions made at the beginning of the mitigation program have not been realized and the program has failed to meet expected returns to the Lower Snake area. In addition the mean progeny to parent ratio of in-river spawners is below replacement. However, the failure of the hatchery program to restore the population may be beyond the control of the program due to potential density-dependent factors.

We continue to look for hatchery production methods to maximize hatchery fish survival (SAR's) in order to reach the mitigation goal. However, more research is needed to identify the underlying reasons for the failure of the natural population to replace itself and correct them if possible. The reasons for the population decline, which was the incentive for the LSRCP hatchery program, have apparently not been alleviated. A self-sustaining reference population of spring Chinook would be beneficial in identifying possible causes and directing necessary corrections.

Acknowledgments

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