Upper Grande Ronde River Spring Chinook Salmon Hatchery Program Review

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This program is a cooperative effort of the Oregon Department of Fish and Wildlife, the Confederated Tribes of the Umatilla Indian Reservation and the Nez Perce Tribe. The program is funded by the Bonneville Power Administration and administered by the United States Fish and Wildlife Service under the Lower Snake River Compensation Plan.

INTRODUCTION AND BACKGROUND

This paper provides background information, program development history, and an assessment of program performance for the Upper Grande Ronde River spring Chinook salmon *Oncorhynchus tshawytscha* hatchery program. We cover the time period from the initiation of the program in the mid-1990s to present. General background information and discussion of the now endemic hatchery programs were previously presented in Grande Ronde Basin Spring Chinook Salmon Hatchery Review: Introduction and the Early Years.

The Upper Grande Ronde River Spring Chinook hatchery program was initiated with the collection of wild parr for the captive broodstock program in 1995 due to the depressed status of this population (Figure 1). Adult trapping and smolt acclimation facilities were constructed to implement the program (Figure 2). The Upper Grande Ronde adult trapping and smolt acclimation facilities are operated by the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) and function as satellite facilities of Lookingglass Fish Hatchery (LFH). The LFH serves as the adult holding, spawning, incubation, and rearing facility for the program. Smolts are transported from LFH to the Upper Grande Ronde River acclimation ponds for a short period of acclimation prior to release. Annual adult mitigation, smolt production, and brood year specific smolt-to-adult return goals were developed for the Upper Grande Ronde program to represent 27.8% of the Grande Ronde basin goals (Table 1).

The implementation has been guided by nine priority management objectives: 1) Prevent extinction of Upper Grande Ronde River Chinook salmon population; 2) Establish adequate broodstock to meet annual production needs; 3) Establish an annual return of 1,617 hatchery fish to the compensation area; 4) Provide a demographic foundation to rebuild from after the key limiting factors and threats are addressed; 5) Maintain and enhance natural production while maintaining long term fitness; 6) Maintain genetic and life history characteristics of the natural population; 7) Operate the hatchery program so that the genetic and life history characteristics of hatchery fish mimic wild fish; 8) Re-establish historical tribal and recreational fisheries; 9) Maintain endemic wild populations of spring Chinook salmon in the Minam and Wenaha rivers – minimize straying.

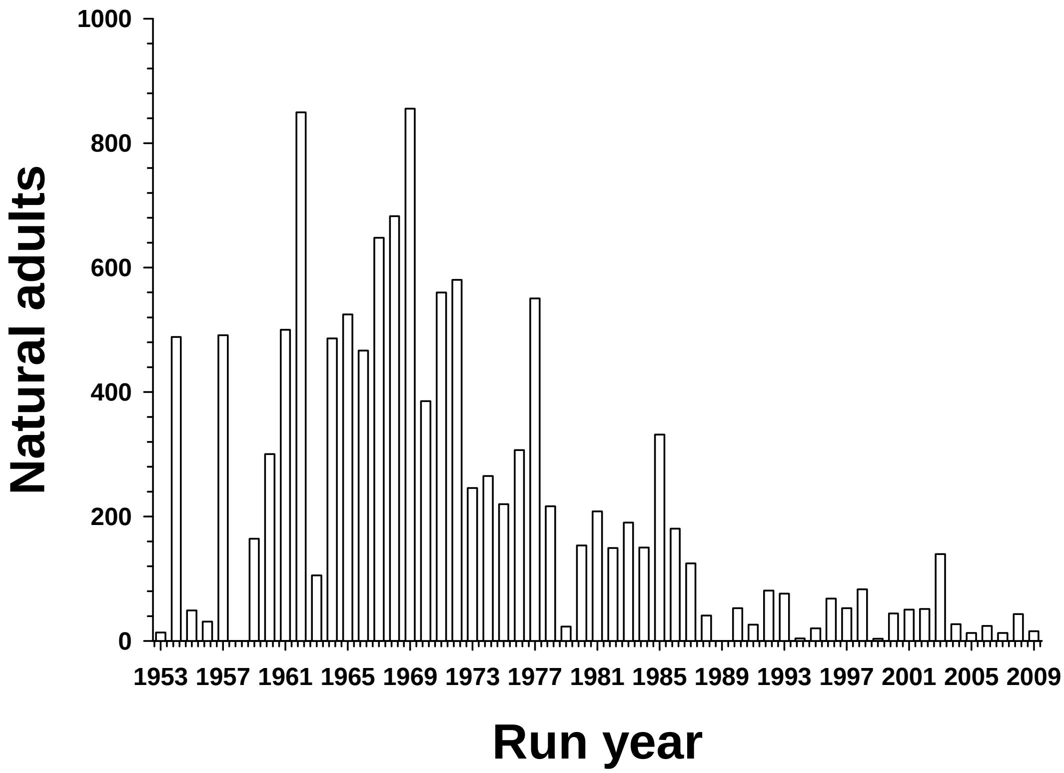

Figure 1. Natural-origin adult spawner abundance in the Upper Grande Ronde River spring Chinook salmon population.

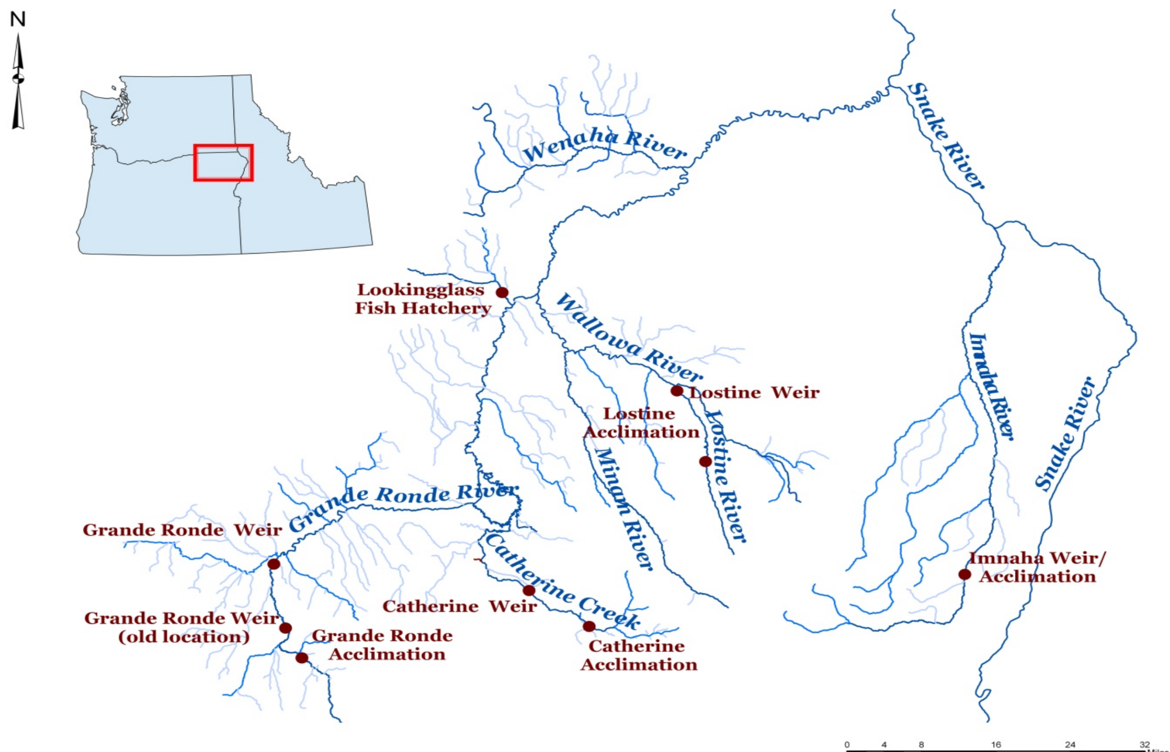

Figure 2. Map showing the location of the Upper Grande Ronde River Chinook salmon hatchery facilities.

Table 1. Lower Snake River Compensation Plan mitigation goals for Oregon's Upper Grande Ronde River spring Chinook salmon hatchery program. Adult and survival goals are expressed for returns to the compensation area.

Category	Goal
Annual smolt goal	250,000 smolts
Annual adult goal	1617 adults
Brood year specific smolt-to-adult return rate	0.65%

A comprehensive research, monitoring and evaluation program has been underway with the primary objectives to: 1) Document and assess fish culture and hatchery operation practices and performance; 2) Determine optimum rearing and release strategies; 3) Determine total catch and escapement, smolt survival, smolt-to-adult survival, and assess if adult production meets mitigation goals; 4) Compare recruits-per-spawner for hatchery and natural origin fish; 5) Assess response in natural population abundance and productivity (adult recruits-per-spawner, smolts-per-spawner) to supplementation; 6) Assess and compare life history characteristics (age structure, run timing, sex ratio, smolt migration, fecundity) of hatchery and natural fish; 7) Determine the success of maintaining genetic integrity of endemic wild spring Chinook salmon in the Minam and Wenaha rivers; 8) Assess success in restoring fisheries.

PROGRAM ASSESSMENT

When co-managers developed supplementation program strategies for the Grande Ronde River basin spring Chinook salmon populations they adopted a "spread the risk" strategy. The Upper Grande Ronde River population was the most severely depressed and the most aggressive hatchery intervention program was developed for this population. The sliding scale management framework for the Upper Grande Ronde River population is simple and places few constraints on proportions of hatchery fish in broodstock or spawning in nature. There are no limits on the proportion of broodstock that must be natural-origin or the proportion of natural spawners that are hatchery-origin. There are only two constraints in the sliding scale. 1) not to exceed collection of the 50% of the natural-origin adults for hatchery broodstock ,and 2) no retention of returning captive broodstock progeny for hatchery broodstock.

The Captive Broodstock Program served as the only source of broodstock for the 1998-2000 spawn years. From 2001-2004, captive broodstock adults and a small number of natural-origin adults were used for broodstock (spawned as separate groups). Conventional hatchery produced adults, captive broodstock, and natural-origin adults all contributed to production from 2005-2009, although natural-origin adult broodstock numbers were low (Table 2). Conventional hatchery adults and natural-origin adults have been spawned together and the captive broodstock have always been spawned separately. Offspring of the two groups are reared separately and uniquely marked for management purposes.

Table 2. Hatchery broodstock history for the Upper Grande Ronde River spring Chinook salmon hatchery program.

Spawn year	Number of females in broodstock		Percent natural origin adults in broodstock	Number of Captive Broodstock females
	Natural	Hatchery		
1998	0	0	0	4
1999	0	0	0	5
2000	0	0	0	188
2001	8	0	100	199
2002	17	0	100	56
2003	20	0	100	1
2004	7	0	93.3	1
2005	3	38	7.7	58
2006	12	71	17.7	5
2007	8	25	23.3	77
2008	5	8	36.0	109
2009	6	52	12.9	64

Few Upper Grande Ronde River stock hatchery fish spawned naturally from 1998-2003. Hatchery fish represented a high proportion of natural spawners (51.6-95.8%) from 2005-2009. Subsequently, the Proportionate Natural Influence (PNI) has been low for the past five years (Table 3).

Table 3. Vital statistics for natural spawning spring Chinook salmon in the Upper Grande Ronde River.

Spawn year	Total Number spawning in nature	Percent hatchery spawning in nature	Percent natural retained for broodstock	PNI
1998	88	0	4.3	
1999	4	0	0	
2000	51	0	3.8	
2001	56	0	27.3	
2002	60	5.0	47.2	0.913
2003	196	18.9	31.8	0.917
2004	638	94.8	32.7	0.512
2005	354	95.8	31.8	0.076
2006	62	51.6	48.3	0.253
2007	34	52.9	47.2	0.423
2008	465	84.9	11.4	0.090
2009	309	85.4	19.6	0.137

During the early years of broodstock collection a significant proportion of adults escaped the weir un-trapped. However, since 2001 a majority of adults were captured in most years (Figure 3).

Prespawning mortality at LFH has been highly variable ranging from 2-45%. Green egg-to-smolt survival has been consistently high, near 80% in all years (Figure 4). Smolt production has varied widely due to variable performance of the Captive Broodstock Program, as well as availability of natural origin and conventional hatchery adult returns. The smolt production goal of 250,000 has been met in only one year and many production years have been below 50% of the goal (Figure 5). Hatchery smolt survival to Lower Granite Dam is similar to the survival of Upper Grande Ronde River natural-origin smolts, however it is lower than survival of most of the other NE Oregon hatchery programs (Figure 6). The smolt migration pattern of hatchery fish is different than natural-origin smolts. Hatchery fish have a compressed distribution with a much earlier time of migration completion (Figure 7).

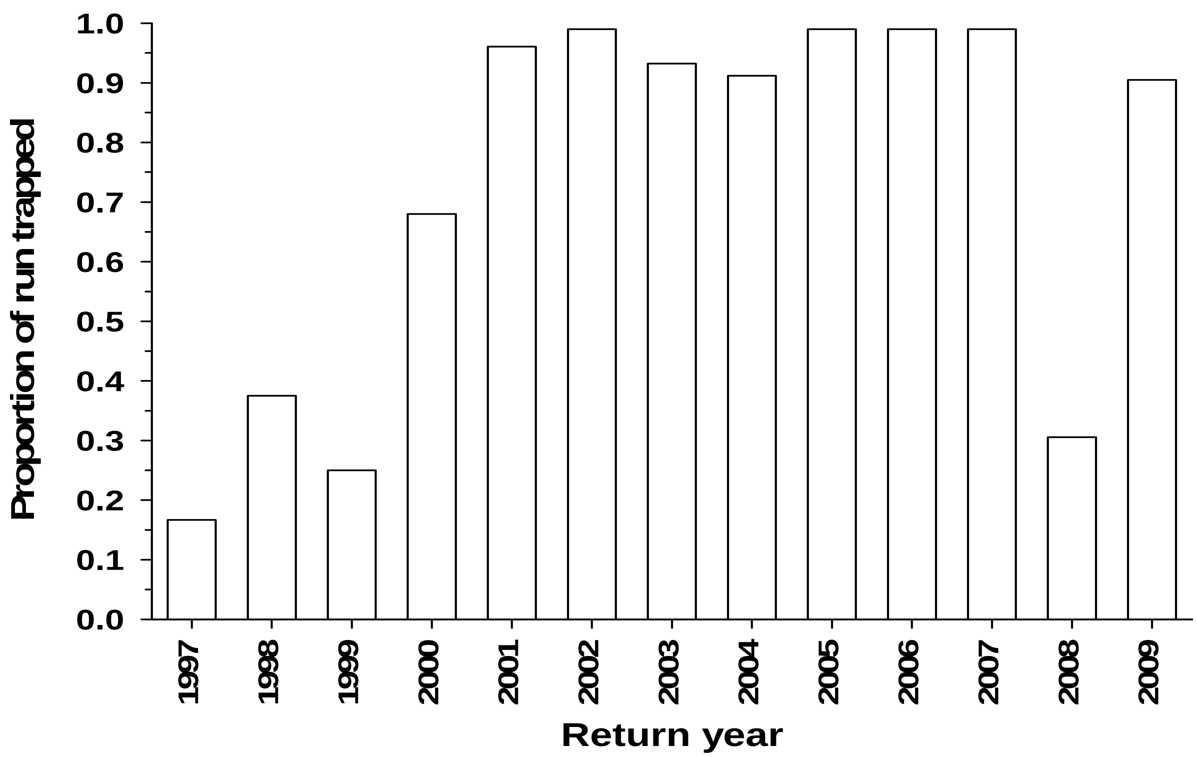

Figure 3. Estimated proportion of the Chinook salmon run trapped at Upper Grande Ronde River Weir., 1997-2009.

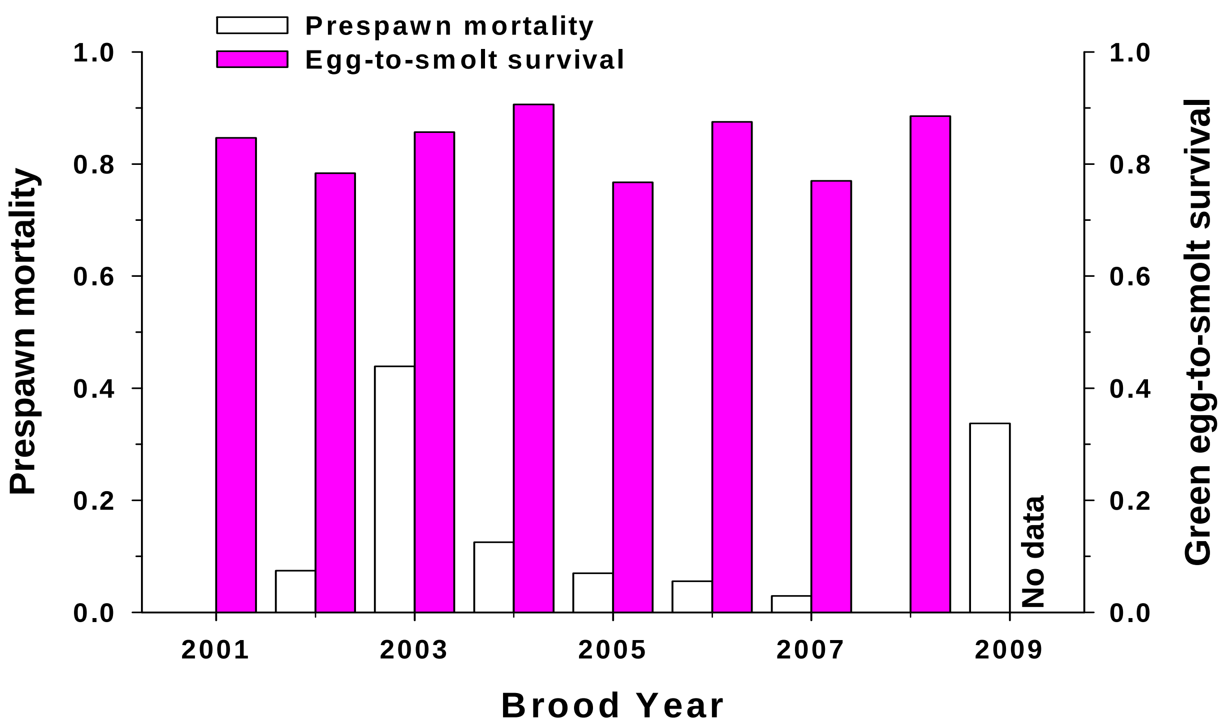

Figure 4. Prespawn mortality of broodstock collected at the Upper Grande Ronde River Weir and held at Lookingglass Fish Hatchery and green egg-to-smolt survival of their offspring, 2001-2009 brood years.

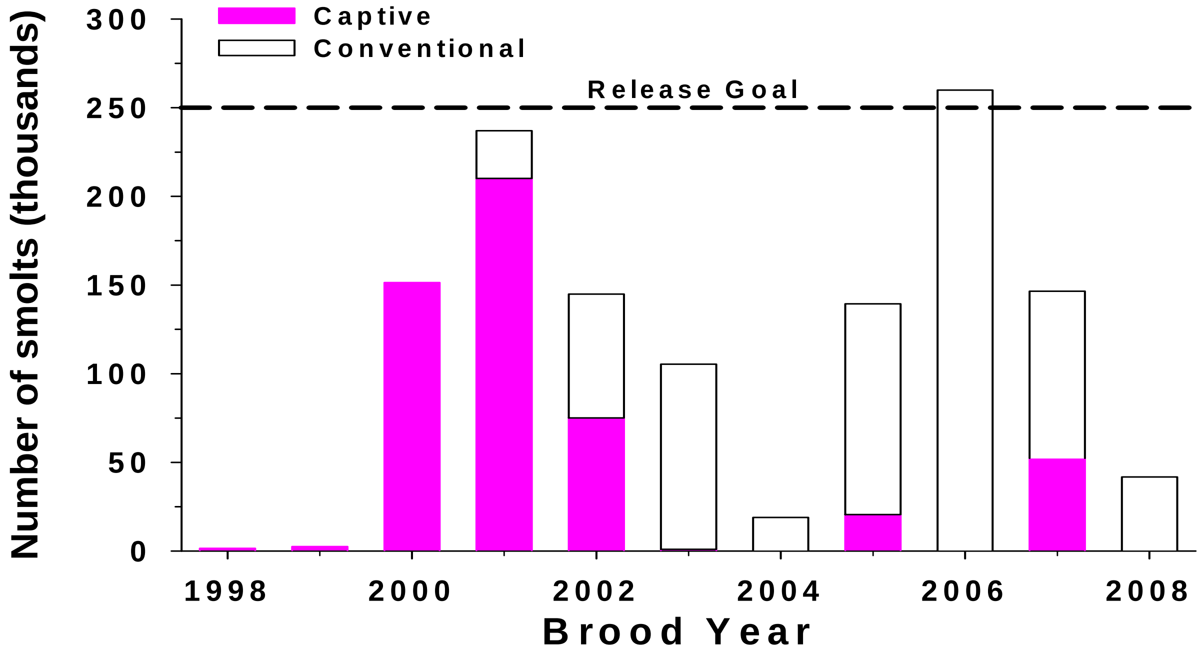

Figure 5. Chinook salmon smolt releases in the Upper Grande Ronde River, 1998-2008 brood years.

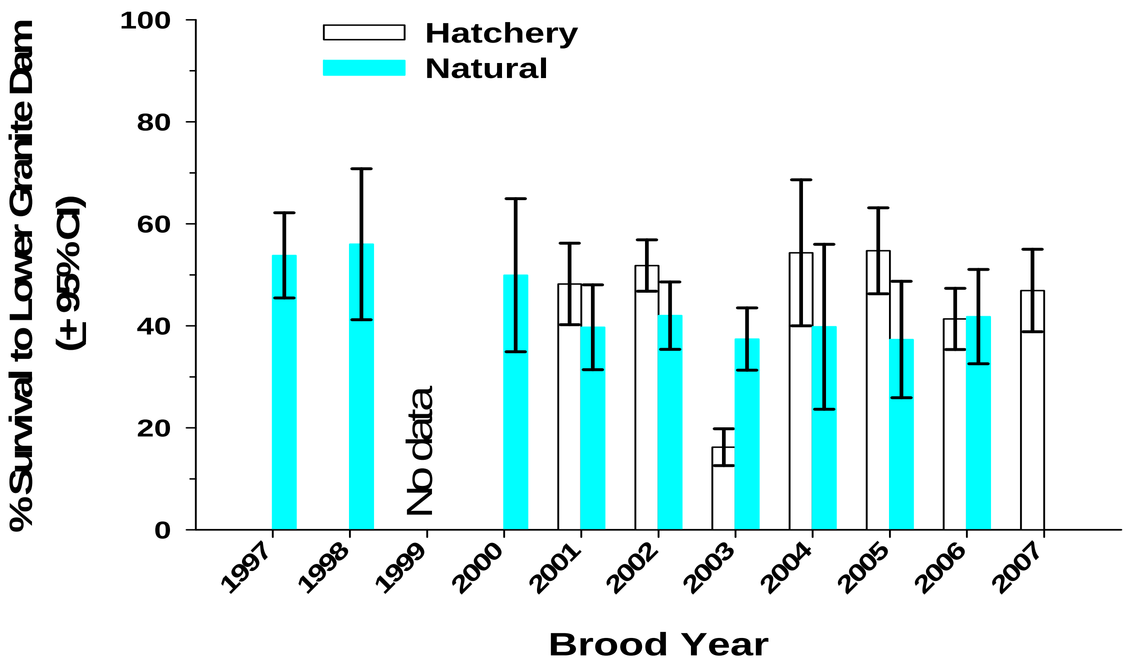

Figure 6. Upper Grande Ronde River spring Chinook salmon conventional hatchery and natural-origin smolt survival to Lower Granite Dam, 1997-2007 brood years.

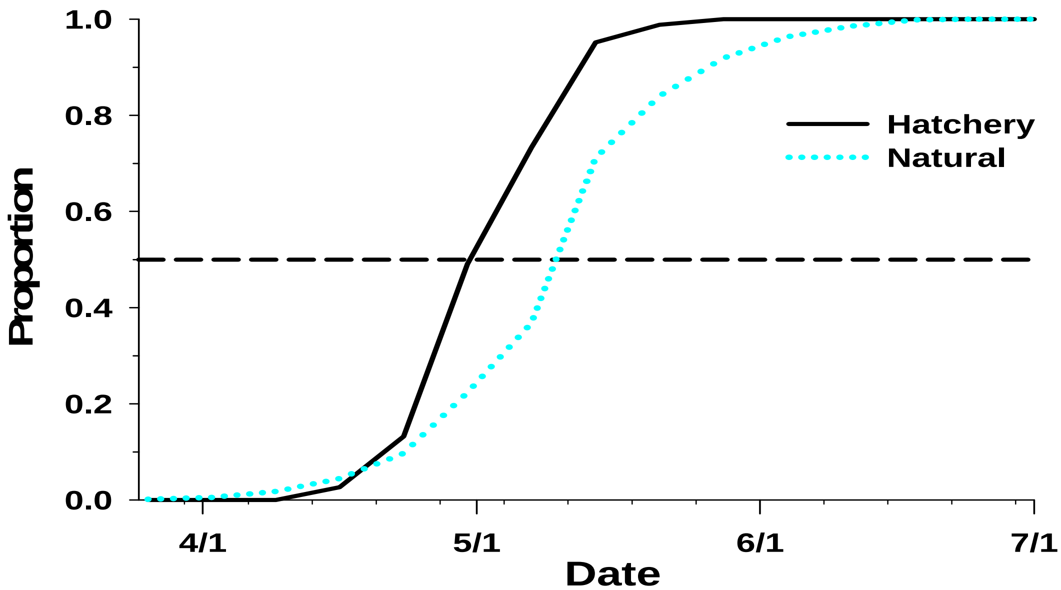

Figure 7. Migration timing at Lower Granite Dam of natural-origin and conventional hatchery-origin Upper Grande Ronde River smolts, mean at 2003-2009 migration years.

Adult returns to the compensation area have been well below the goal of 1617 (Figure 8). Two factors that have contributed to poor adult returns are: smolt production has been below the goal and smolt-to-adult return rates that have consistently been below the goal of 0.65% (Figure 9). We have not observed a consistent relationship between hatchery and natural SARs. Natural SARs are better in some years and poorer in others (Figure 10).

Upper Grande Ronde River Chinook salmon are exploited at low rates in ocean, Columbia River and tributary fisheries. On average, 87.1% of adults produced escape to the Upper Grande Ronde River (Table 4). Very low exploitation in mainstem Columbia River sport fisheries in recent years is a result of not fin marking the hatchery smolts and mark-selective sport fishery regulations that allow only marked hatchery fish to be retained. Most of the hatchery adults that return to the Upper Grande Ronde are used for broodstock or passed upstream to spawn naturally (Figure 11).

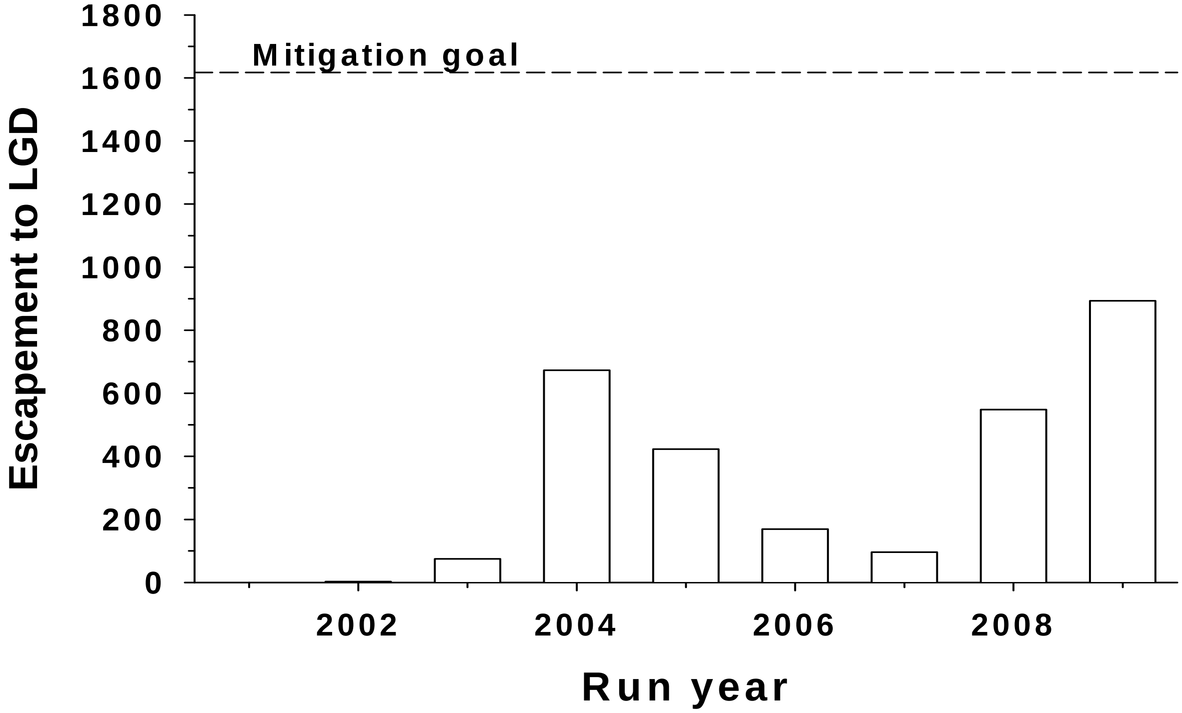

Figure 8. Adult returns to the LSRCP compensation area for Upper Grande Ronde River hatchery Chinook salmon, includes conventional and captive broodstock F_1 returns.

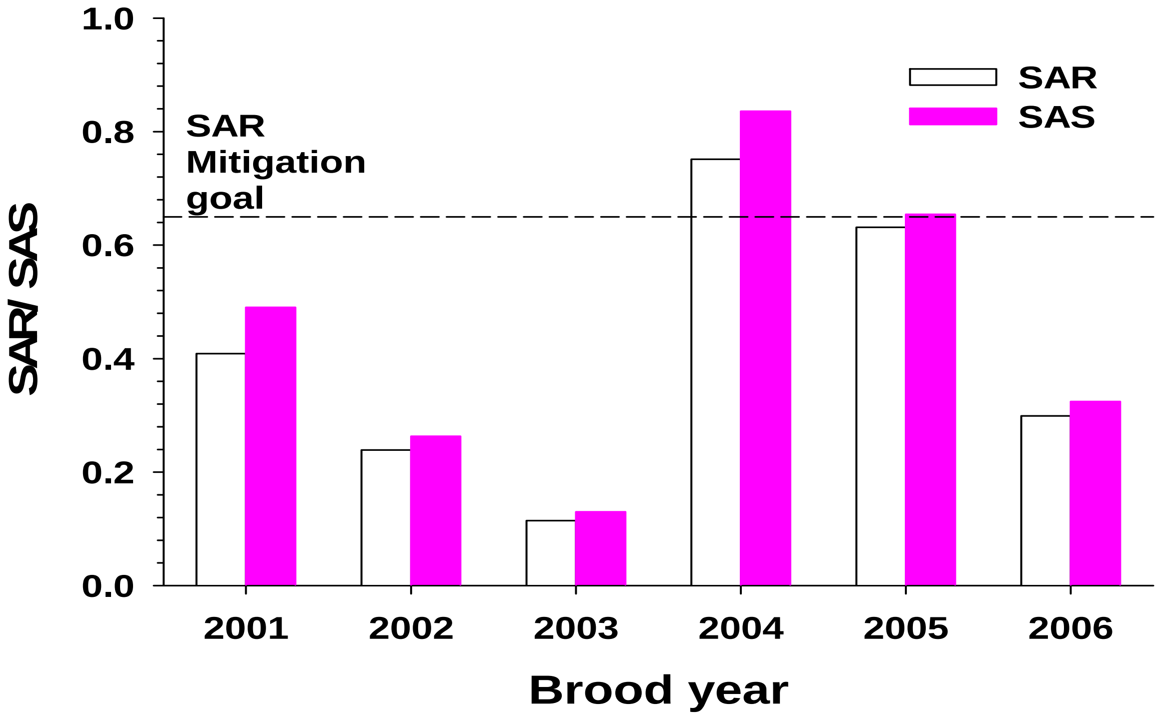

Figure 9. Smolt-to-adult survival (SAS) and return (SAR) rates for Upper Grande Ronde River conventional hatchery Chinook salmon, 2001-2006 brood years. Note: the 2005 and 2006 brood years include only ages 3 and 4 and age 3 returns, respectively.

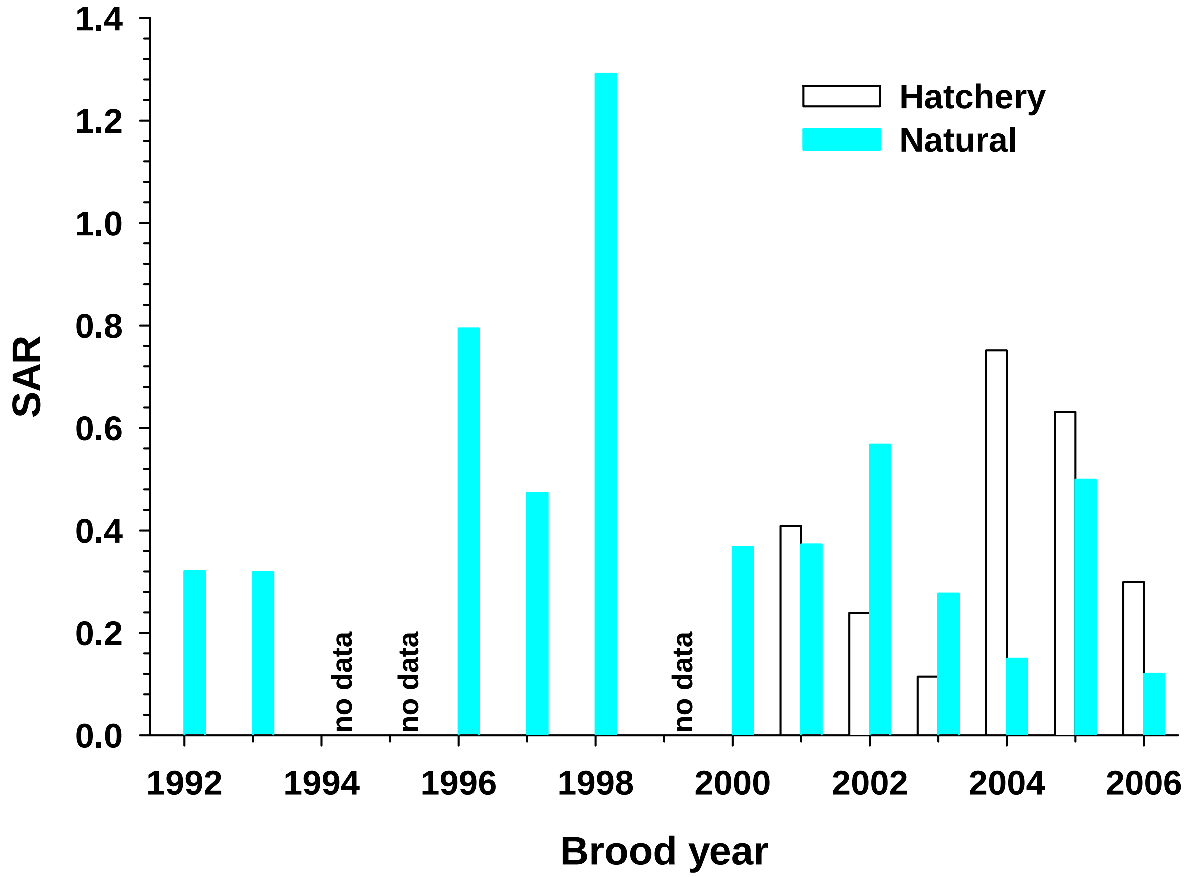

Figure 10. Conventional hatchery and natural-origin smolt-to-adult return (SAR) for Upper Grande Ronde River spring Chinook salmon, 1996-2006 brood years. Note: the 2005 and 2006 brood years include only ages 3 and 4 and age 3 returns, respectively.

Total adult spawners in nature have varied widely since hatchery adults have returned. In 2004 there were over 500 natural spawners, however, in 2007 there were less than 20 spawners. Hatchery fish have comprised a majority of the spawners in recent years (Figure 12). The hatchery program is providing a significant full life cycle survival advantage over naturally spawned fish. The R/S for hatchery fish has exceeded 1.0 for all recent brood years while natural R/S has been a small fraction of 1.0 in all years (Figure 13). Natural smolt production has varied considerably and has not increased significantly since we started supplementation (Figure 14). Smolts produced per adult spawner appears depressed for years when significant numbers of hatchery fish spawned naturally (Figure 15).

We found a significant negative relationship between adult spawner abundance and smolts-per-spawner. Smolts-per-spawner decreased at substantially lower spawner abundance levels than what we had assumed based on prior Ecosystem Diagnosis Treatment analyses and recent historical escapements (Figure 16). We did not find any relationship between percent hatchery-origin adults in nature and smolts-per-spawner. However, we have only three years in the data series where hatchery fish were a significant component of the adult spawners (Figure 17).

Table 4. Catch and escapement distribution (%) of Upper Grande Ronde River spring Chinook salmon. Data are for captive and conventional broodstock fish combined.

	Brood Year				
	2001[a]	2002[b]	2003[c]	2004[d]	Mean
Ocean	0.7	2.2	0.0	0.0	0.7
Columbia River Harvest					
Tribal	0.0	0.0	0.0	3.2	0.8
Sport	11.9	0.0	0.0	0.0	3.0
Commercial Net	3.3	0.0	0.0	0.0	0.8
Snake River					
Stray below LGD	0.0	0.5	0.0	0.0	0.1
Stray above LGD	4.1	6.5	12.0	7.1	7.4
Sport above LGD	0.0	0.0	0.0	0.0	0.0
Tribal above LGD	0.0	0.0	0.0	0.0	0.0
Escapement to River	80.0	90.8	88.0	89.7	87.1

[a] *> 99% released with AD CWT*
[b] *> 99% CWT only, no fin clips*
[c] *50% CWT only, no fin clips*
[d] *95% CWT only, no fin clips*

We have not observed a difference in age-at-return for hatchery-origin and natural-origin fish, however the sample size for natural-origin age is small (Figure 18). This is the only spring Chinook hatchery program in NE Oregon where we have not seen earlier age-at-return for hatchery fish. Adult migration timing at the Upper Grande Ronde River weir is similar for hatchery and natural-origin fish (Figure 19). We assess and compare spawning distribution of natural and hatchery-origin adults based on location of female carcass recoveries. We have observed a difference in spawning distribution between hatchery and natural-origin females. The range in spawning is similar, however hatchery female distribution is concentrated further upstream than natural females, near the acclamation/release location (Figure 20).

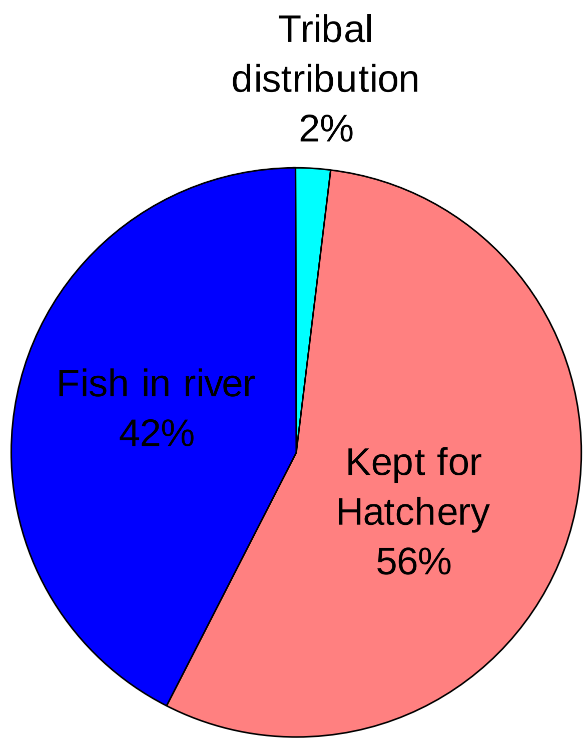

Figure 11. Escapement disposition of Upper Grande Ronde River hatchery spring Chinook salmon from the 2001-2004 brood years. Data include captive and conventional fish.

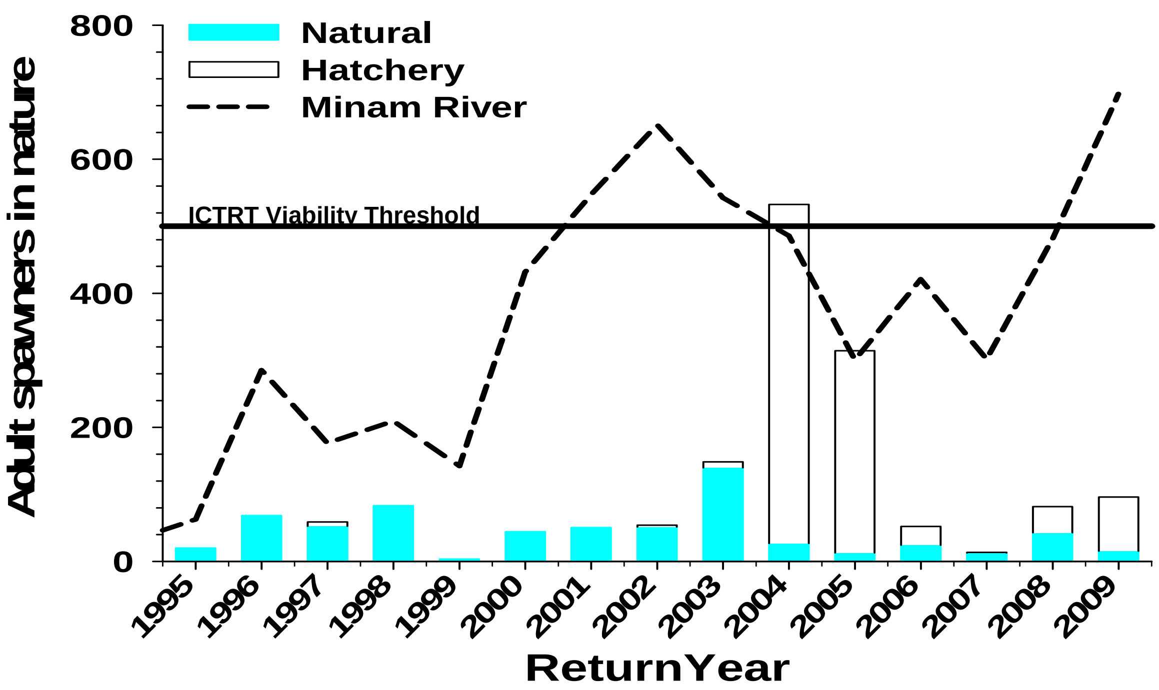

Figure 12. Adult spawner abundance in the Upper Grande Ronde River and Minam River populations. Spawners include natural-origin and all hatchery-origin fish.

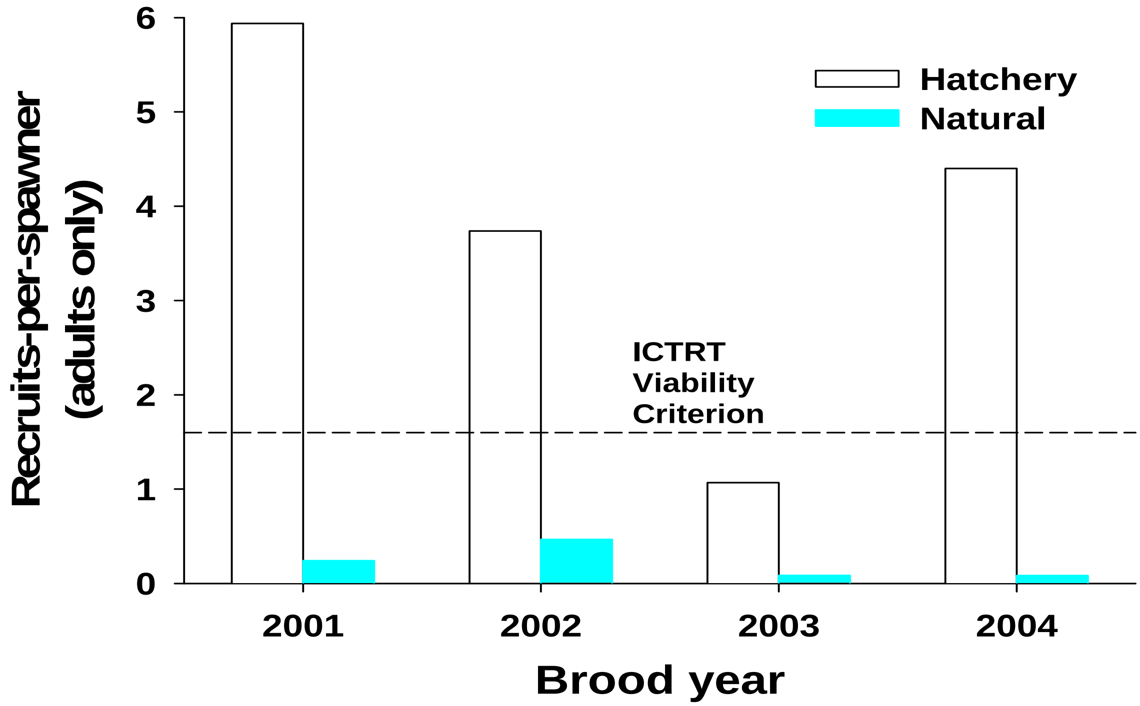

Figure 13. Upper Grande Ronde River Chinook salmon recruits-per-spawner (jacks omitted) for hatchery spawned adults and natural spawning hatchery and natural-origin adults, 2001-2004 brood years.

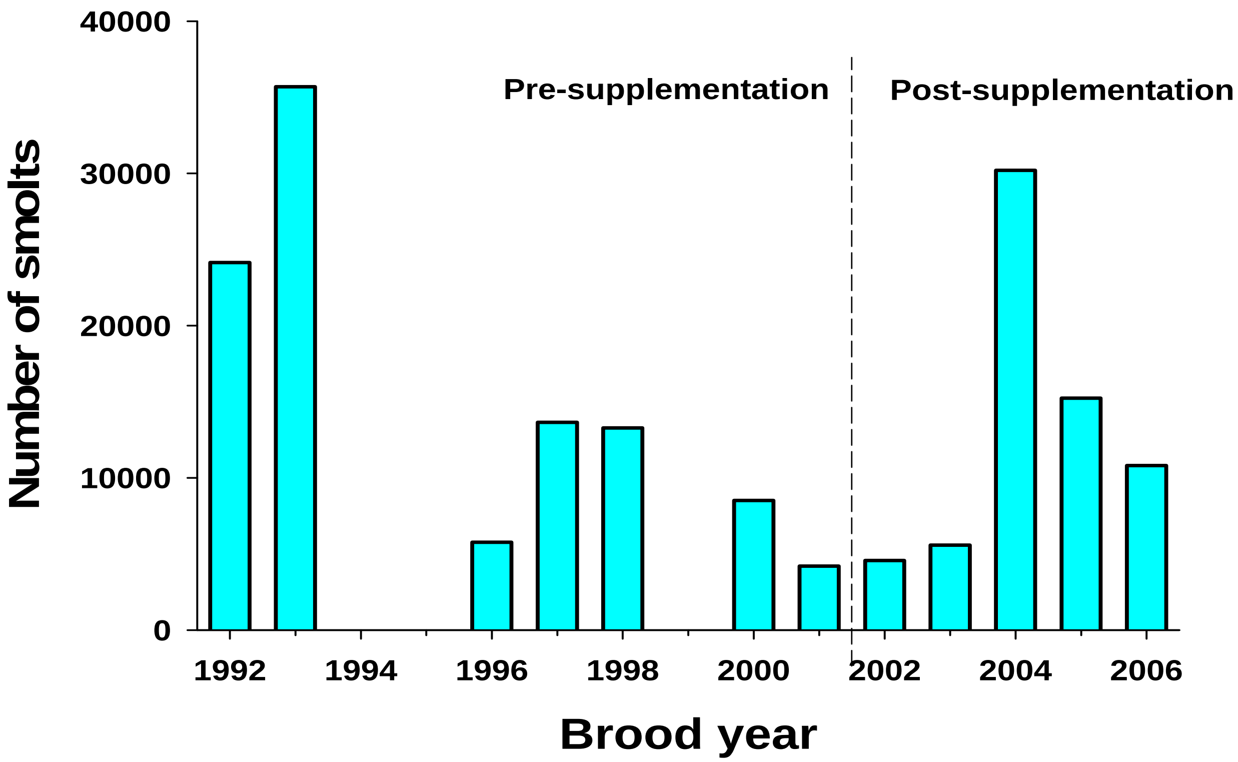

Figure 14. Upper Grande Ronde River Chinook salmon natural-origin smolt abundance, 1992-2006 brood years, no estimates for 1994, 1995, and 1999.

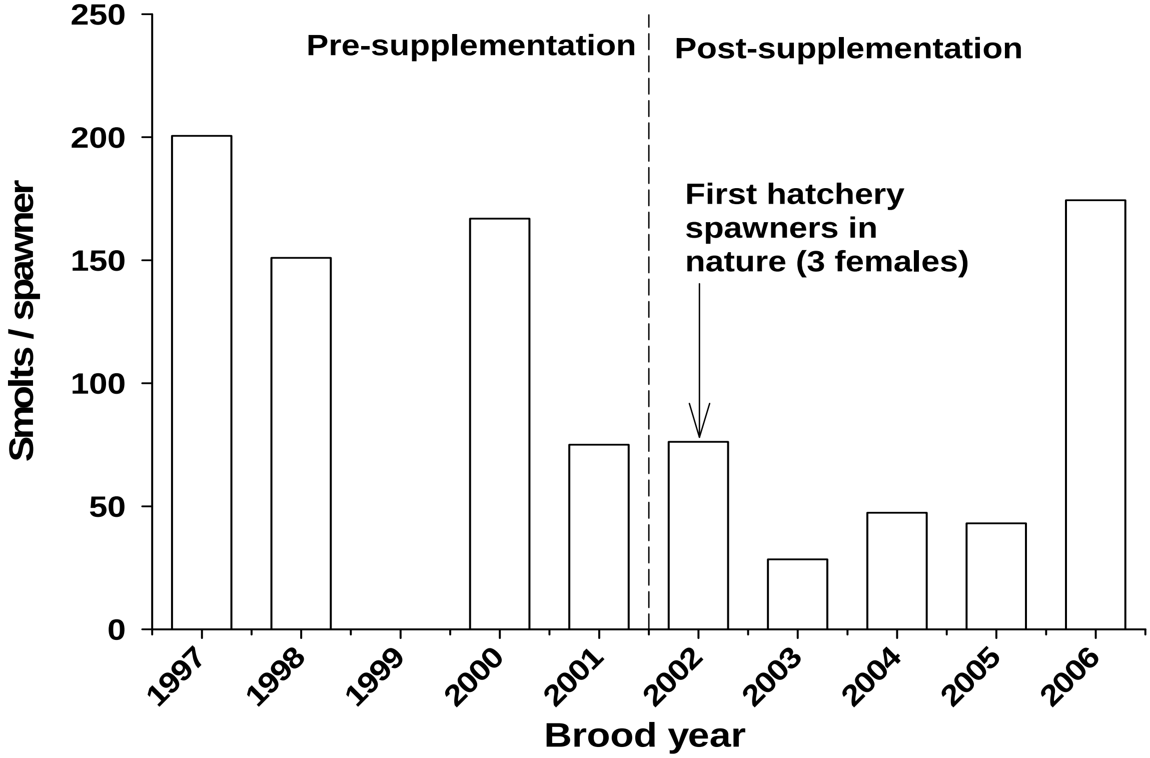

Figure 15. Upper Grande Ronde River Chinook salmon naturally produced smolts-per-spawner, 1997-2006 brood years.

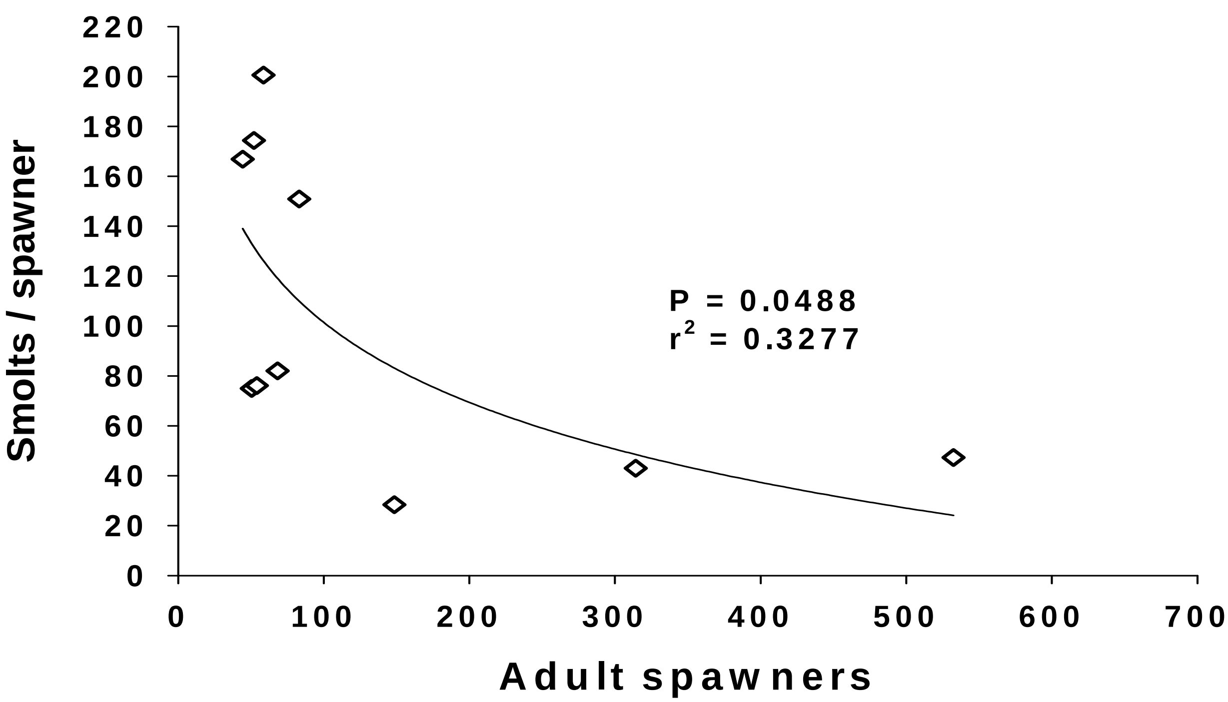

Figure 16. Relationship between adult spawner abundance and smolts-per spawner for the Upper Grande Ronde River spring Chinook salmon, 1996-2006 brood years (no data for 1999).

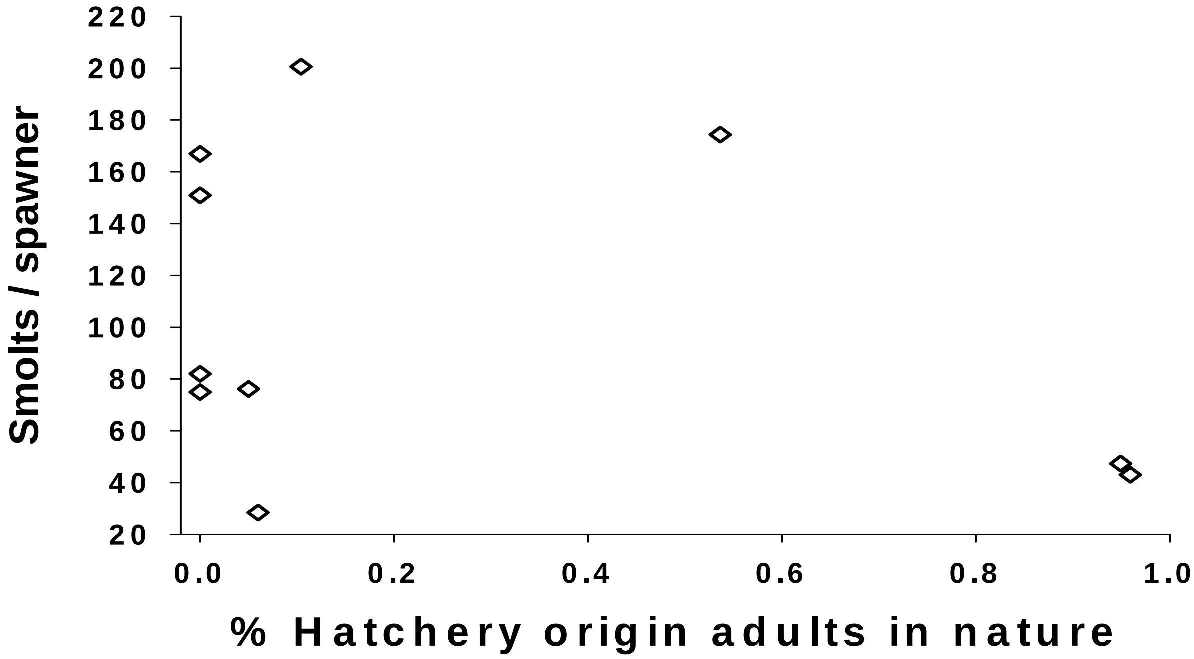

Figure 17. Relationship between percent hatchery-origin adults in nature and smolts-per-spawner for Upper Grande Ronde River spring Chinook salmon, 1996-2006 brood years (no data for 1999).

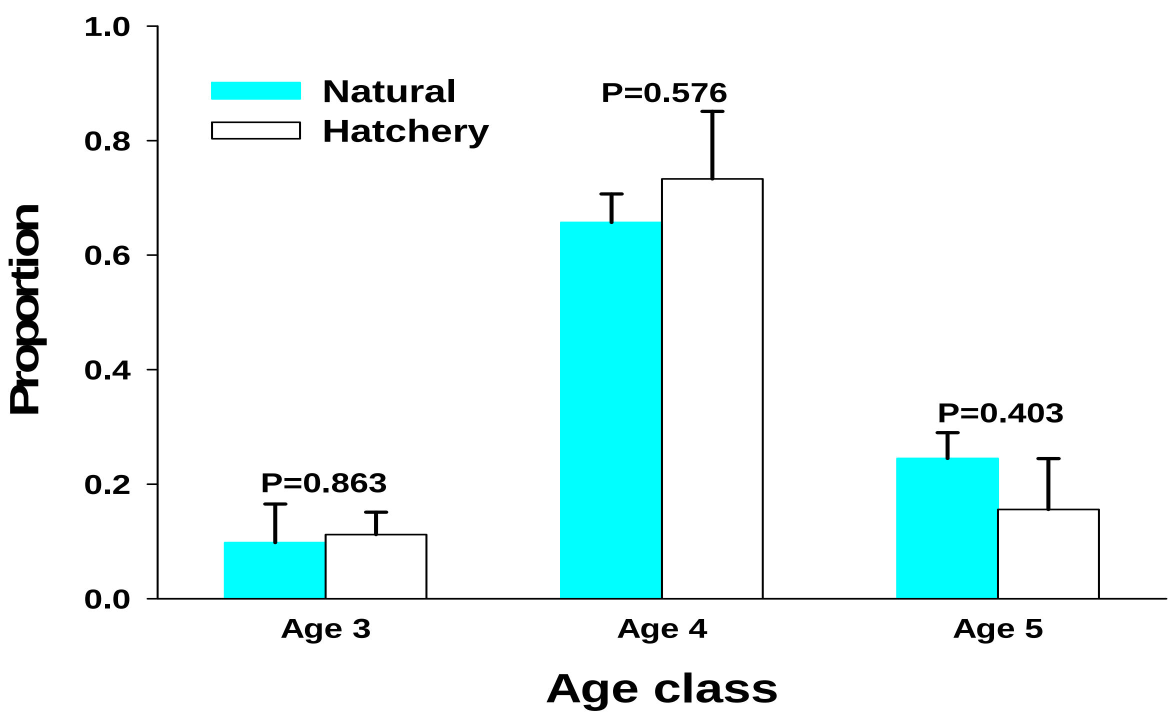

Figure 18. Mean age-at-return distribution for conventional hatchery- and natural-origin Upper Grande Ronde River spring Chinook salmon, 2001-2004 brood years.

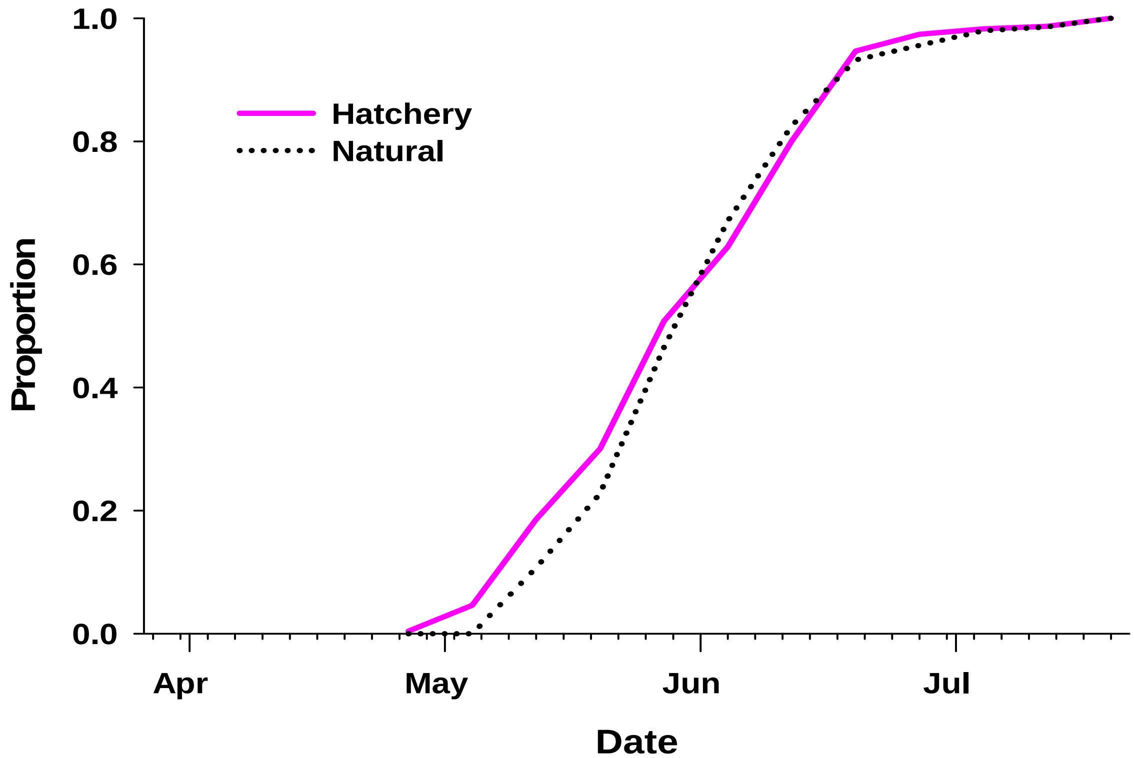

Figure 19. Adult migration timing (date of annual at weir) of conventional hatchery- and natural-origin fish at Upper Grande Ronde River weir, mean 2005-2009.

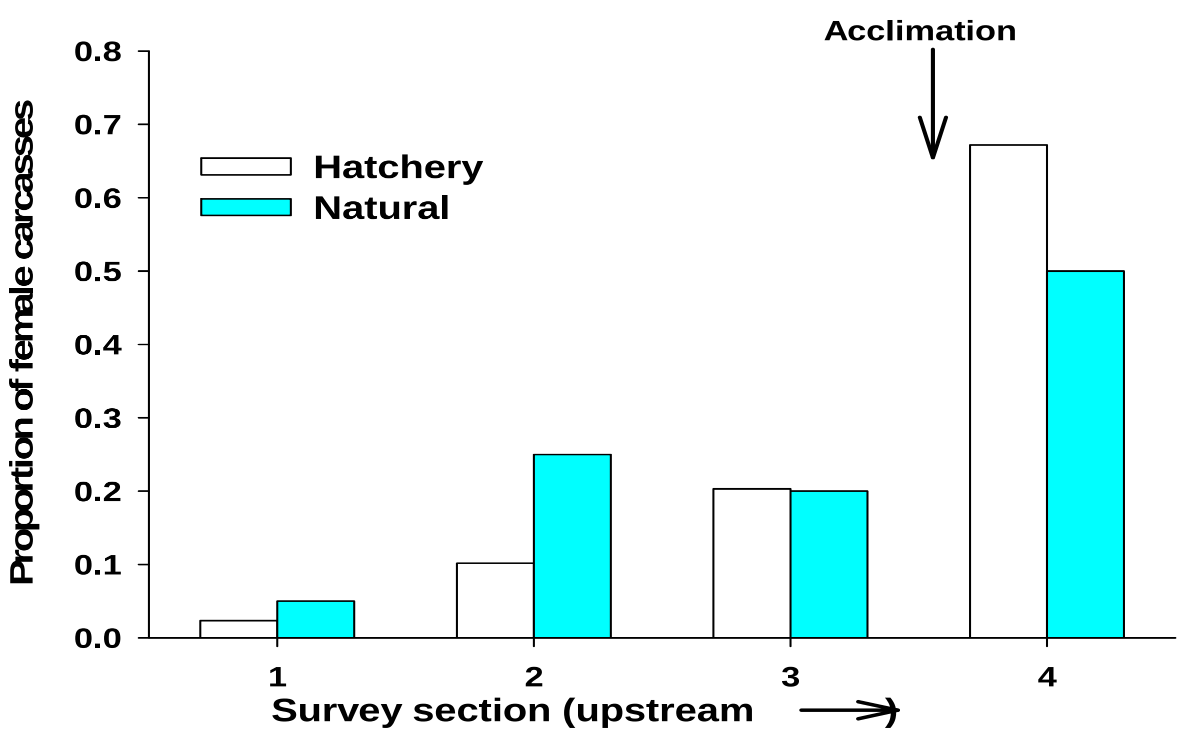

Figure 20. Spawning distribution of all hatchery- and natural-origin females in the Upper Grande Ronde River, natural is 2002-2008 and hatchery is 2004-2008 spawn years.

SUMMARY AND CONCLUSIONS

Broodstock Development and Management

The transition from non-local origin broodstock to local endemic broodstock has been relatively successful. However, a number of significant challenges have limited the success. The very small number of natural-origin adults that return to the Upper Grande Ronde River has limited broodstock availability and smolt production in all years. The low abundance of natural-origin adults produces high proportions of hatchery fish in the broodstock and in the natural spawners, resulting in very low PNIs. Significant numbers of adults have remained below the adult weir in some years. These fish were subject to extremely high temperatures (over 22° C) and suffered extensive prespawning mortality. The weir was relocated in 2005 to address these issues. However, delay and mortality remained a problem at the new weir site. A new weir management strategy was adopted in 2010 to minimize weir effects on adult migration. The weir is removed and adult handling/collection is discontinued when river temperature exceeds 20° C. Although this strategy may prove effective for eliminating delay and exposure to warm river temperatures, it will result in selective broodstock collection of fish from the early component of the run.

In-Hatchery Performance

Prespawning mortality of adults collected and held for broodstock is typically low. However, mortality has exceeded 30%, in two of nine years of program operations. This limited egg and smolt production for some brood years. Egg-to-smolt survival for the conventional program has been high and has not limited the program.

Production, Survival, and Adult Return Performance

We have only reached the smolt production goal in one year due to availability of adult returns and poor performance of the captive broodstock program in some years. Smolt survival to Lower Granite Dam is among the lowest observed for Oregon’s hatchery spring Chinook salmon smolts. Adult returns to the compensation area have improved in recent years but remain below the goal of 1,617. The low returns are a result of low smolt release numbers and SARs that are below the goals for most years. The SARs have improved through time and have been near or at our goal for about 50% of the recent brood years.

Upper Grande Ronde River Chinook salmon are exploited at low rates with a majority of the adults produced escaping to the Grande Ronde River basin. There are few Upper Grande Ronde River hatchery fish straying into the Minam and Wenaha rivers, however a substantial number stray into Lookingglass Hatchery. Although tribal fisheries have occurred in some years, we have been unable to open tributary sport fisheries that target Upper Grande Ronde River hatchery fish for many reasons. The low abundance of natural origin adults, which is well below the critical abundance threshold, prevents any impact on the natural-origin returns. In addition, in some years hatchery fish are not visibly marked, prohibiting the ability to execute a mark-selective fishery.

Supplementation: Life history and Spawning Characteristics

We have not observed significant differences in life history characteristics (including age-at-return or adult migration timing) between hatchery and natural-origin adults. This is in contrast to Imnaha River hatchery Chinook that show differences in both age-at-return and migration timing. We have few completed brood years to assess life history differences so our conclusions should be considered preliminary.

Supplementation: Abundance and Productivity

We are early in program implementation so our observations and supplementation conclusions should be considered preliminary. It appears that we have increased the total number of adults spawning in nature with the addition of large numbers of F_1 captive and conventional hatchery adults to the spawning grounds. We have not seen a consistent increase in smolt abundance in response to increased adult spawners. We observed a strong signal of density dependence with a significant reduction in smolts-per-spawner at higher spawner densities associated with high proportions of hatchery fish. We have not observed an increase in natural-origin adult spawner abundance since supplementation was initiated. Natural spawner productivity has remained below 0.5 for the four recent completed brood years, 2001-2004.

FUTURE PROGRAM CHALLENGES AND NEEDS

The consistently poor productivity of natural spawners and the low abundance of natural-origin and hatchery-origin adult returns continue to limit the success of the program. Low and variable numbers of returns make it difficult to meet annual smolt production goals and to improve PNI. In addition, limited harvest can be provided with the current level of returns. Improved smolt survival to Lower Granite Dam and improved SARs are needed to increase hatchery adult returns.

Improving natural spawner production and natural-origin abundance is a difficult challenge because it requires significant improvement in survival across the entire life cycle. Improvements in tributary and mainstem migratory habitat will take many years. The Upper Grande Ronde River spring Chinook salmon population is at the highest risk of extinction of any population in the Grande Ronde/Imnaha Chinook Major Population Group.

Our lack of understanding of the mechanisms driving the poor natural spawner productivity and low adult abundance, limits our ability to focus management actions and make adaptive changes to the program. Research has been initiated to begin developing a better understanding of the primary habitat factors that are influencing productivity. This new research, along with ongoing supplementation studies will provide new knowledge needed to inform future management decisions.

The hatchery supplementation program appears to be an essential conservation action required to maintain this genetic resource. Given the low current natural spawner productivity, this population is at very high risk of extinction and would not persist long if the spawner abundance is not continually supplemented with hatchery fish. The hatchery program should only be considered an interim measure to conserve the population in the near term. The hatchery program can do nothing to enhance natural productivity and cannot serve as a cornerstone for recovery of this population. Recovery to healthy sustainable levels can only be achieved by addressing the primary limiting factors via restoration of high quality habitat conditions and natural processes throughout the entire life cycle. Mainstem migration and hydrosystem survival and tributary habitat conditions must be improved or this population will linger on the edge of extinction indefinitely, even with continued aggressive hatchery intervention.