LSRCP Hatchery Mitigation

Snake River Fall Chinook

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This program is a cooperative effort of the Washington Department of Fish and Wildlife and the Nez Perce Tribe, funded by Bonneville Power Administration and administered by the United States Fish and Wildlife Service under the Lower Snake River Compensation Plan (LSRCP).

Mitigation Goals

Lower Snake River Compensation Plan (LSRCP) mitigation goals for Snake River fall Chinook salmon were established to offset losses due to the construction of the lower four Snake River Dam. The mitigation goals are 18,300 fish to the Snake River, plus 18,300 fish for sport harvest, and 54,900 fish for commercial harvest, totaling 91,500 adult and jacks. This equates to 4:1 downriver harvest to escapement ratio. Mini jacks are 0-salt aged and do not contribute towards these mitigation goals. Figure 1 shows historical run sizes of fall Chinook at Lower Monumental Dam (LMO) from 1969 - 2012. Counts at LMO are used in-season to determine the run size to the Snake River since the majority of fish crossing LMO remain in the system. Ice Harbor Dam is not used as an estimator as counts overestimate the Snake River return because Columbia River stocks dip in to the Snake River, cross the dam, and fall back over the dam, eventually returning to the Columbia River basin (Mendel and Milks 1997). Mendel and Milks also documented Snake River fall Chinook falling back over Ice Harbor Dam and re-ascending the ladder where they were counted again.

Window counts at dams during the early years counted total numbers of fish returning. It was not until 1981 that counts were split out by fork length in an effort to estimate the magnitude of jacks (1-salt) returning (Figure 1). The fork length criterion has remained static over the years and fish are tallied as adults if they measure greater than 56 cm total length (52 cm fork length) as the swim past the fish counting windows. Using length to determine jacks is problematic due to yearling jacks returning at larger sizes than subyearling jacks. It has been documented that yearling jacks can measure up to 75 cm fork length (Milks et al 2013). Overall, window counts

at the dams underestimate jacks and overestimate adults in the Snake River and should be used with caution. As discussed above concerning window counts, and in the "Adaptive Snake River Broodstock Management" summary, static fork length criteria to assign salt age is problematic, and often include mini jacks in the jack category (30-56 cm total length), jacks in the adult category, and adults in the jack category.

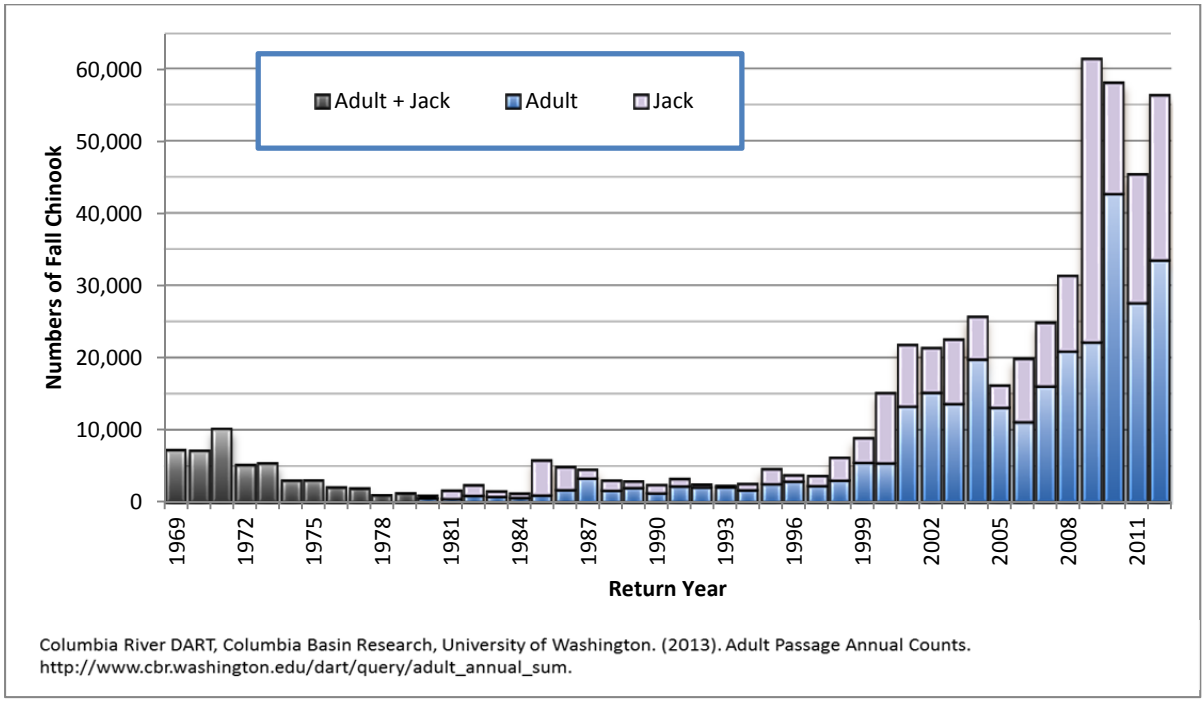

Figure 1. Historical counts of fall Chinook salmon, greater than 30 cm total length (includes mini jacks), at Lower Monumental Dam.

Returns were estimated for Snake River hatchery subyearling and yearling release groups and presented in Figure 2 and Table 1. Jacks were identified as two year old returns from subyearling releases and three year old returns for yearling releases. Mini jacks, regardless of length, were not included in Figures 2 or 3. Mini jacks have been documented as large as 56 cm fork length (Milks et al 2013), well within the size category counted at the dams. In addition, Figure 3 shows only the LSRCP portion of the returns for the same years, and does not include Idaho Power or Nez Perce Tribe releases. Estimated returns from 2005-2012 were calculated using the new run reconstruction method (Young et al 2013), and are considered final. Data from 2000-2004 will be revised if a method is crafted to more accurately estimate the run composition during those years because of differing trapping and sampling protocols.

The LSRCP mitigation goal of 18,300 fish returning to the Snake River was met in the last four years (Figure 3). Returns of fish used in the United States Army Corp of Engineers Consensus study (surrogates) were included in the mitigation numbers because they were reared at LFH and part of the LSRCP slated for Couse Creek direct release study that were shifted to the Consensus study.

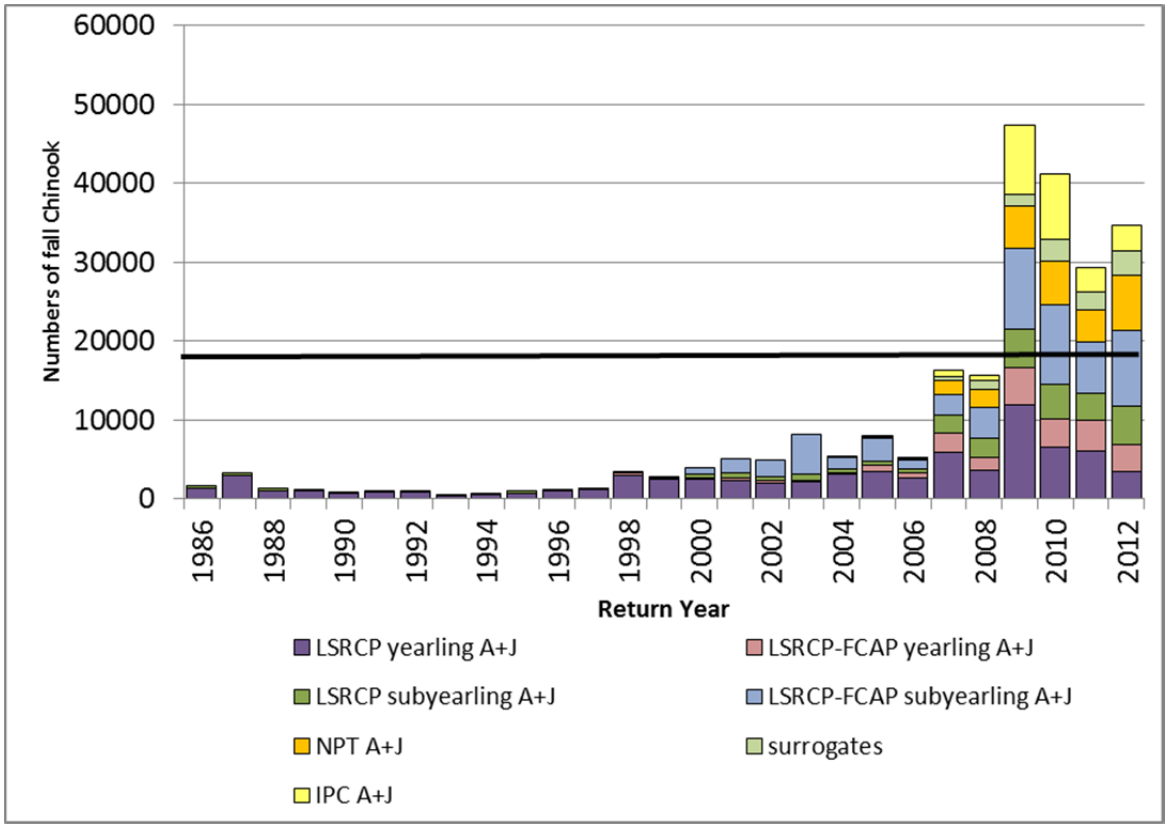

Figure 2. Estimated numbers of Snake River Hatchery fall Chinook returns (A+J, excludes mini jacks regardless of length) to the Snake River, 1986-2012. Black line represents the in-basin mitigation target of 18,300 fish. IPC – Idaho Power Corporation; LSRCP + FCAP – Lower Snake River Compensation Plan plus Fall Chinook Acclimation Project; NPTH – Nez Perce Tribal Hatchery.

Table 1. Estimated returns of Snake River Hatchery fall Chinook adults and jacks, estimated as return year minus brood year, to the Snake River with LSRCP returns in bold for the years that the in-basin goal was met. . IPC – Idaho Power Corporation; LSRCP + FCAP – Lower Snake River Compensation Plan plus Fall Chinook Acclimation Project; NPTH – Nez Perce Tribal Hatchery.

	Return Year							
Program A+J	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
IPC subyrl	35	118	895	766	8915	8309	2980	3175
LSRCP subyrl	457	478	2138	2564	**4905**	**4366**	**3310**	**4930**
LSRCP yrl	3418	2615	5927	3544	**11863**	**6548**	**6029**	**3492**
NPT subyrl	153	181	1837	2224	5283	5598	4188	7100
LSRCP FCAP subyrl	3070	1043	2643	3856	**10262**	**10112**	**6479**	**9519**
LSRCP FCAP yrl	803	704	2470	1607	**4726**	**3567**	**3985**	**3346**
Surrogates subyrl	0	106	431	1130	**1459**	**2614**	**2266**	**3024**
Total	7937	5245	16342	15692	47412	41114	29237	34585

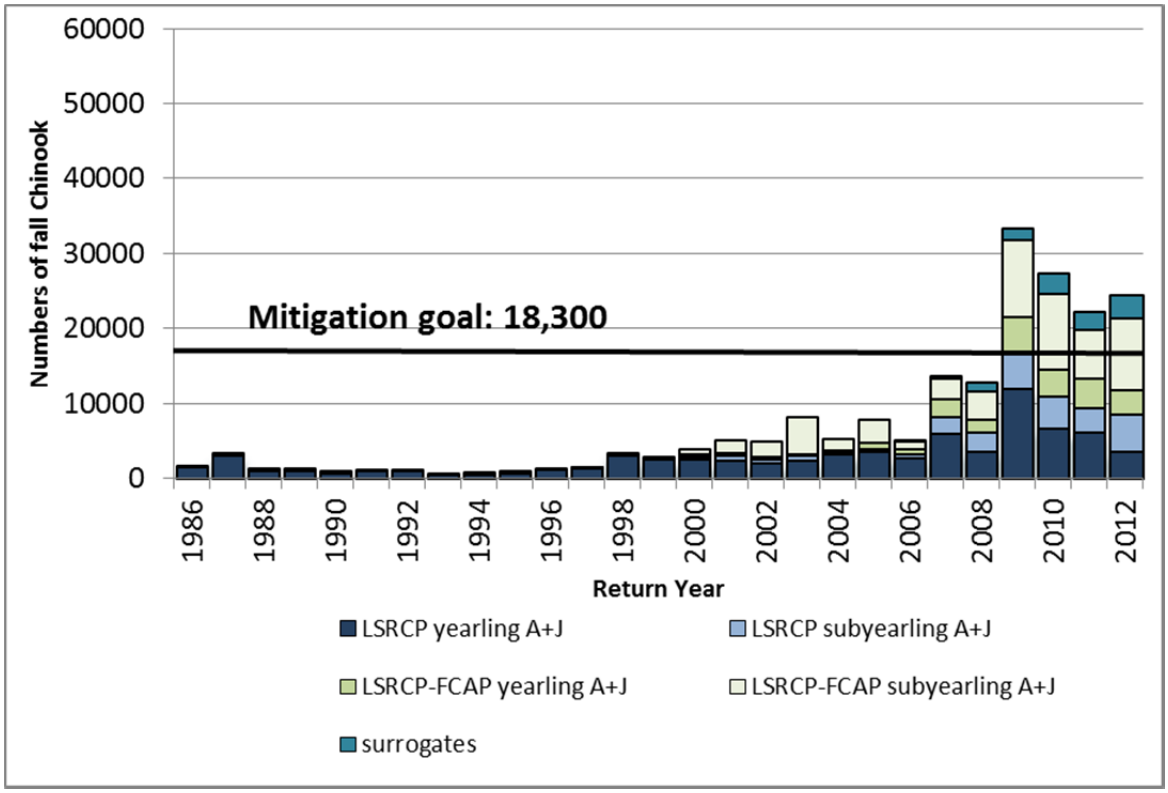

Figure 3. Estimated returns of LSRCP produced adults and jacks (excludes mini jacks regardless of length) to mitigation goals to the Snake River, 1986-2012. IPC – Idaho Power Corporation; LSRCP + FCAP – Lower Snake River Compensation Plan plus Fall Chinook Acclimation Project; NPTH – Nez Perce Tribal Hatchery.

It is also worthy to note that increased numbers of returns from 2008-2012 may be due to the U.S. and Canada agreement that harvest off the West Coast of Vancouver Island would cease for West Coast Trollers. The agreement was made when it was determined that Trollers were fishing earlier to reduce impacts on their own weak stocks. However, that action put more pressure on Columbia River and Puget Sound stocks. This agreement was made in 2008 and will be effective until 2017 (US v Oregon 2008).

Recoveries outside of the Snake River basin

Columbia River/Ocean Harvest

Harvest of Snake River hatchery fish outside of the Snake River basin is presented in Figure 4, and Table 2. The LSRCP mitigation goal of 73,200 harvested fish outside the Snake River basin has not been met to date. Data were expanded to include estimated harvest of untagged fish associated with CWT's. However, adjustments have not been made to account for visual sampling or the improper reporting of sample type as electronic when the catch was visually sampled. Canada and Alaska primarily sample only adipose clipped fish. Since some of the releases of Snake River hatchery fall Chinook are CWT tagged but unclipped, those fish are not sampled and thus not reported. At release sites where fish are CWT without a fin clip, there is usually a proportion of the release that is ADCWT with a different tag code. Adjustments could

be made for those fisheries using the ADCWT group to determine the interception rate which can be applied to the CWT no clip group. However, this has not been done yet; therefore the estimates of harvest should be considered a minimum. As such, adjustments have not been made for unclipped CWT releases that were caught in Canada or Alaska Fisheries.

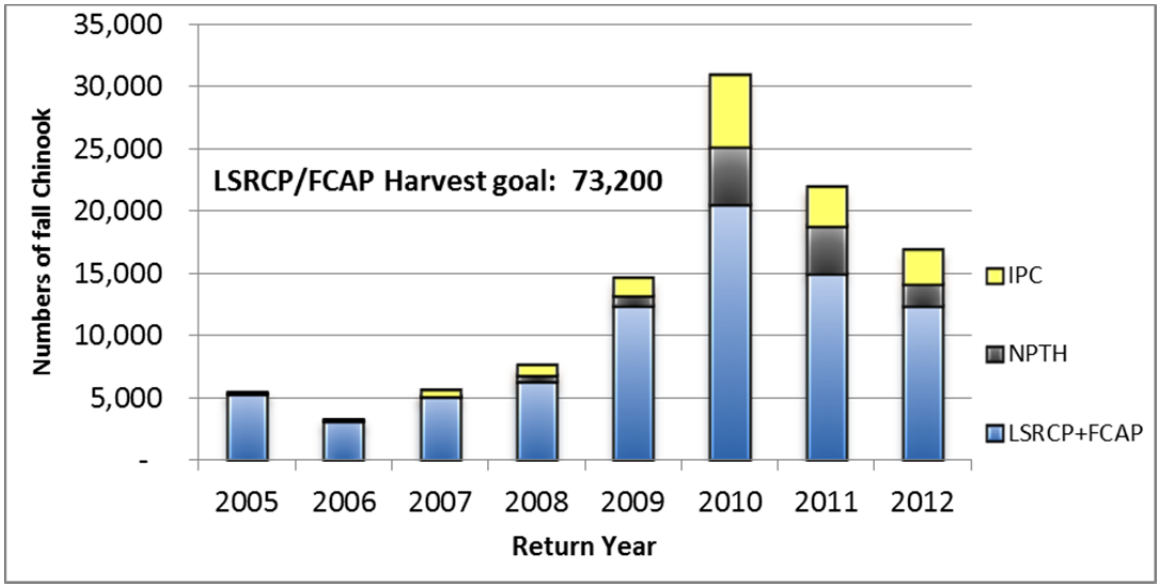

Figure 4. Estimated combined commercial and sport harvest of Snake River Hatchery fish outside of the Snake River basin, 2005-2012. IPC – Idaho Power Corporation; LSRCP + FCAP – Lower Snake River Compensation Plan plus Fall Chinook Acclimation Project; NPTH – Nez Perce Tribal Hatchery.

Table 2. Estimated harvest of Snake River Hatchery fall Chinook in commercial and sport fisheries. IPC – Idaho Power Corporation; LSRCP + FCAP – Lower Snake River Compensation Plan plus Fall Chinook Acclimation Project; NPTH – Nez Perce Tribal Hatchery.

	Year harvested							
Program	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
IPC	50	89	515	899	1,460	5,699	3,120	2,740
LSRCP+FCAP	5,322	3,101	5,048	6,264	12,379	20,583	14,998	12,377
NPTH	43	56	73	517	809	4,638	3,839	1,803
Grand Total	5,416	3,246	5,637	7,680	14,649	30,920	21,957	16,920

Straying of Snake River Hatchery fish

Snake River hatchery fall Chinook have a high fidelity to the Snake River. Figure 5 shows that less than 200 recoveries (0.1%) have occurred at other hatcheries over the last 8 years. Likewise, Figure 6 shows that less than 470 recoveries (0.2%) have occurred on spawning grounds outside of the Snake River basin.

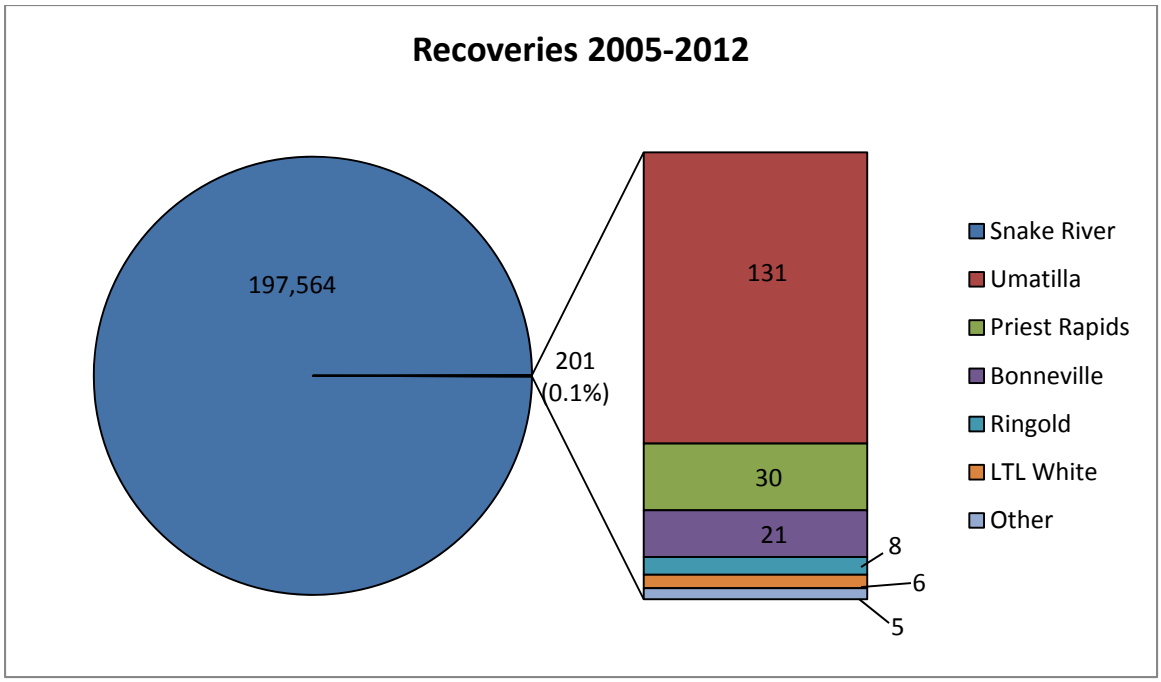

Figure 5. Fidelity of Snake River hatchery fall Chinook (all programs) compared to recoveries at hatcheries outside of the Snake River basin, 2005-2012.

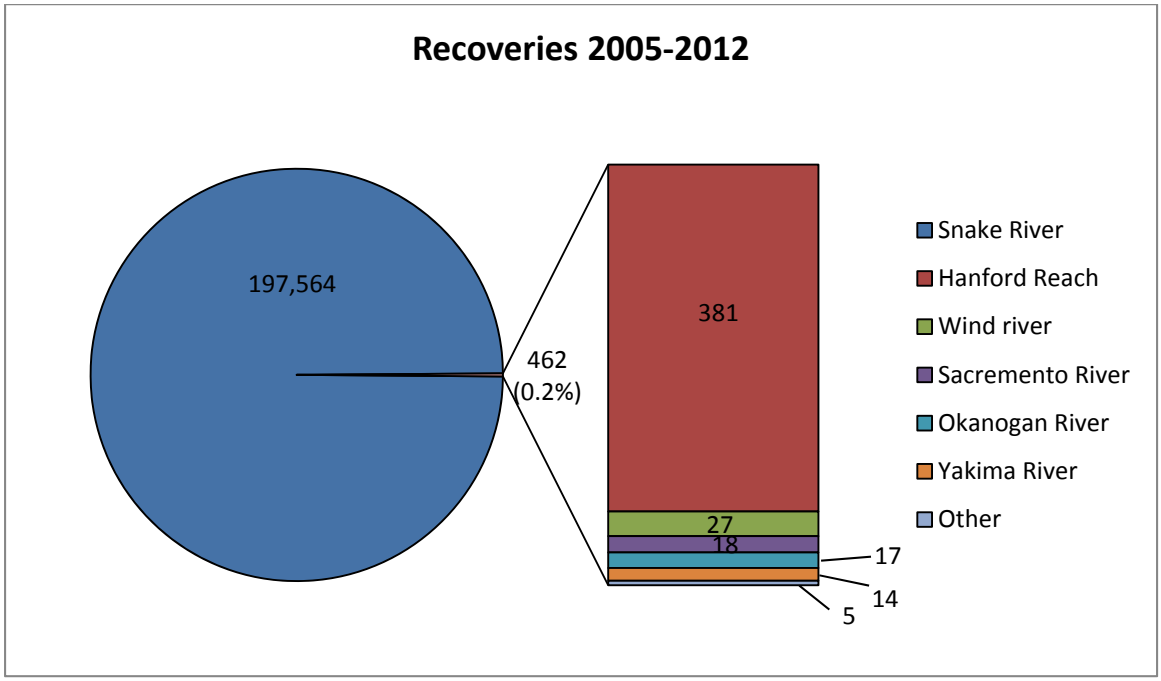

Figure 6. Fidelity of Snake River hatchery fish (all programs) compared to recoveries on spawning grounds located outside of the Snake River, 2005-2012.

SAR and SAS

To calculate smolt-to-adult returns to the project area (SARs) and total smolt-to-adult survival (SAS), the regional mark information system (RMIS) database was queried on 7/23/2013 for recoveries from brood years 1994-2007. SARs and SASs include jacks unless otherwise noted, but none of the SARs or SASs include mini-jacks (0-salt returns).

SARs to the Snake River were estimated by combining RMIS reported Snake River harvest below Lower Granite Dam, the composition of fish trapped at Lyons Ferry, the estimated escapement to the Tucannon River, and run reconstruction estimates to Lower Granite Dam (Table 3). These estimates include all CWT groups regardless of type of fin clip since sampling on the Snake River is 100% electronic.

SASs estimates combined Snake River SARs and Columbia River and Ocean harvest estimates and included all CWT tagged fish regardless of marks (Table 3). These should be considered minimum estimates because expansions have not been made at this time for unclipped fish likely caught in the Alaska and Canada fisheries. WDFW and the co-managers will adjust these estimates and provide results in annual reports at a later date.

Table 3. Average percent (%) Smolt – to – Adult Return (SAR) to Snake River and Smolt – to – Adult Survival (SAS) including Columbia River and Ocean harvest estimates from brood years 1994-2007. IPC – Idaho Power Corporation; LSRCP – Lower Snake River Compensation Plan; FCAP - Fall Chinook Acclimation Project; NPTH – Nez Perce Tribal Hatchery.

Program	Yearling		Subyearling	
	SAR (%)	SAS (%)	SAR (%)	SAS (%)
IPC	-	-	0.67	1.02
LSRCP	0.94	1.65	0.40	0.60
FCAP	0.33	0.64	0.41	0.59
NPTH	-	-	0.42	0.54

Table 4 shows that the majority (86.9%) of the RMIS data were for adipose clipped releases, but the proportion of CWT fish from brood years 1994-2007 released into the Snake River Basin that had an adipose clip was only 65.5%. These results indicated that the mark selective sampling protocols used in Canada and Alaska underrepresented the harvest of unmarked hatchery fish in their reports. Therefore, in the following sections (exploitation rates, yearling and subyearling

comparisons) only ADCWT recoveries were used to assure that recoveries reported in Canada and Alaska were included for all groups.

Table 4. Estimated numbers of CWT recoveries outside of the Snake River basin as reported to RMIS and summarized by program and mark type for completed Snake River hatchery returns from brood years 1994-2007. IPC – Idaho Power Corporation; LSRCP – Lower Snake River Compensation Plan; FCAP - Fall Chinook Acclimation Project; NPTH – Nez Perce Tribal Hatchery

Program	AD clip	No clip	Total
IPC	**4,863**		**4,863**
LSRCP	**46,150**	**5,226**	**51,375**
FCAP	**20,099**	**4,591**	**24,691**
NPTH	**2,173**	**1,210**	**3,382**

Exploitation rates

Exploitation rates were calculated for ADCWT groups only (Table 5). For an unknown reason at this time, LSRCP and FCAP programs were exploited at a much higher rate than IPC and NPTH programs. These differences should be explored in later analysis.

Table 3. Estimated number of Snake River hatchery fall Chinook surviving to adult (Returns + Harvest) and percent (%) exploitation rates in the Columbia River and ocean (Col R/Ocean), Snake River and total exploitation rate by recovery site and program from brood years 1994 - 2007for ADCWT groups only. . IPC – Idaho Power Corporation; LSRCP – Lower Snake River Compensation Plan; FCAP - Fall Chinook Acclimation Project; NPTH – Nez Perce Tribal Hatchery.

Program	Returns + Harvest	Col R/Ocean (%)	Snake R. (%)	Total (%)
IPC	24,791	20	0.1	20
LSRCP	104,684	44	0.3	44
FCAP	45,284	44	0.3	45
NPTH	8,334	26	<0.1	26

Yearling survivals vs Subyearling survivals

Release years 2006-2008

SARs

Hatchery fall Chinook have been released from multiple locations with varying mark and tag combinations over the years. It was not until brood year 2005 that both yearling and subyearling releases were ADCWT tagged so comparisons could be made between them. As such, SAR comparisons by sites releasing both yearling and subyearlings were done only for release years 2006-2008. Subyearlings from brood year 2005-2007 and yearlings from brood years 2004-2006 were compared. Chinook released as yearlings outperformed subyearlings at all sites except Big Canyon AF when adults and jacks were combined (Figure 7, Table 6). When jacks are removed from the SAR estimates, subyearlings slightly out performed yearlings at all sites, but most notably at the Big Canyon AF (Figure 8).

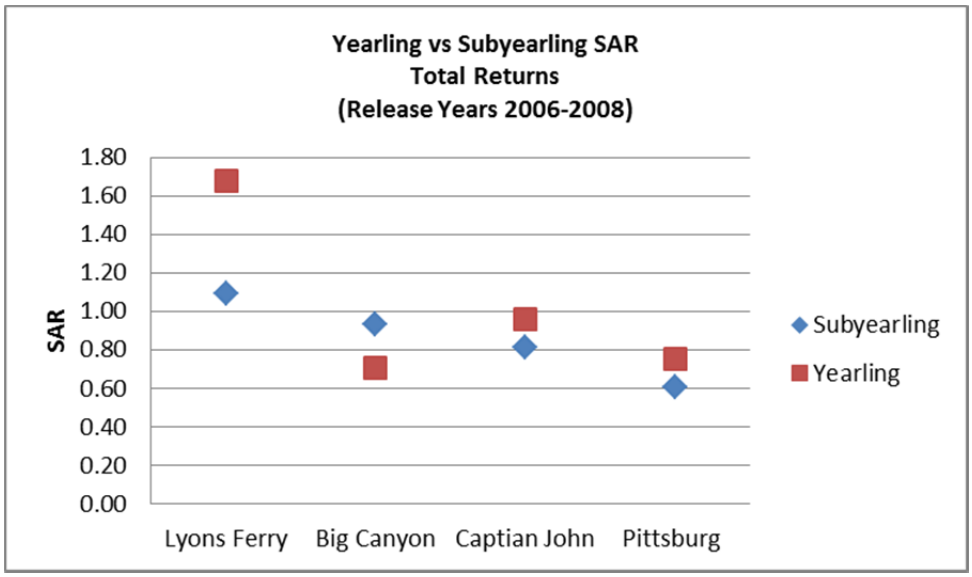

Figure 7. Average Smolt-to-Adult Returns (SARs) of ADCWT yearling and subyearlings for adults and jacks for release years 2006-2008.

Table 4. Average Smolt-to-Adult Returns (SARs) of yearling and subyearling fall Chinook to the Snake River by release site for ADCWT tagged releases for release years 2006-2008.

	Percent SAR of Adults + Jacks			Percent SAR of Adults Only		
Release site	Subyearling	Yearling	yrl SAR/ sub SAR	Subyearling	Yearling	yrl SAR/ sub SAR
Lyons Ferry	1.09	1.68	1.53	0.59	0.56	0.95
Big Canyon	0.93	0.70	0.76	0.55	0.28	0.51
Captain John	0.81	0.96	1.18	0.50	0.42	0.83
Pittsburg	0.61	0.75	1.24	0.29	0.27	0.94

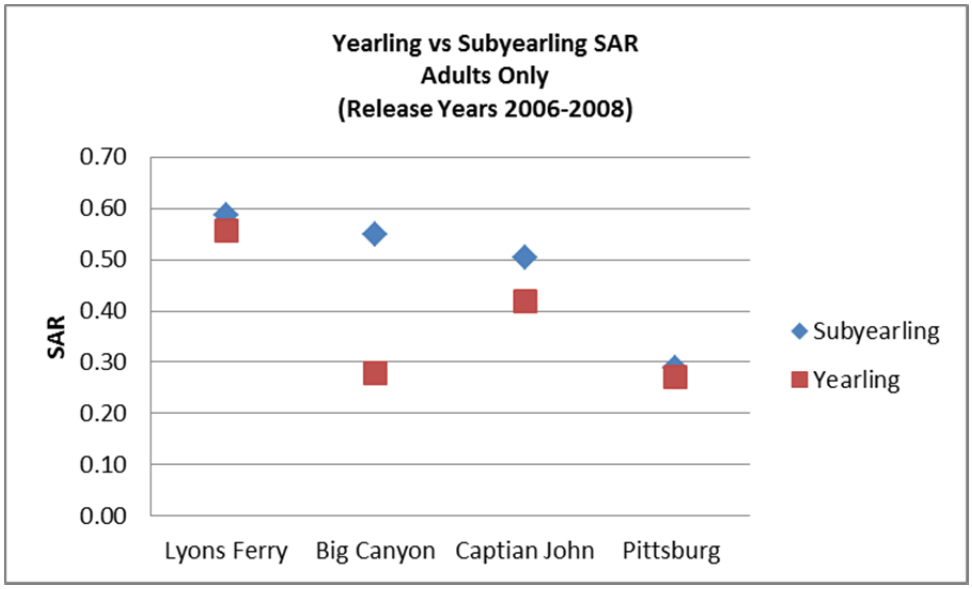

Figure 8. Average Smolt-to-Adult Returns (SARs) of yearling and subyearlings for adults from release years 2006-2008. Jacks are excluded.

Comparisons were made between average SARs estimated using total returns (adults and jacks) and average SARs estimated using only adult returns. The average SAR of yearlings was divided by the average SAR of subyearlings to calculate a demographic boost that occurs when comparing two rearing types for total returns and adult only returns. A value greater than one indicated a survival advantage for yearling compared to subyearling releases. Results demonstrated that survival from yearling releases outperformed subyearling releases when adults and jacks were combined, but subyearling releases outperformed yearling releases for adults only (Figure 9). This indicated that survival advantage from yearling releases mainly resulted from increased jack returns.

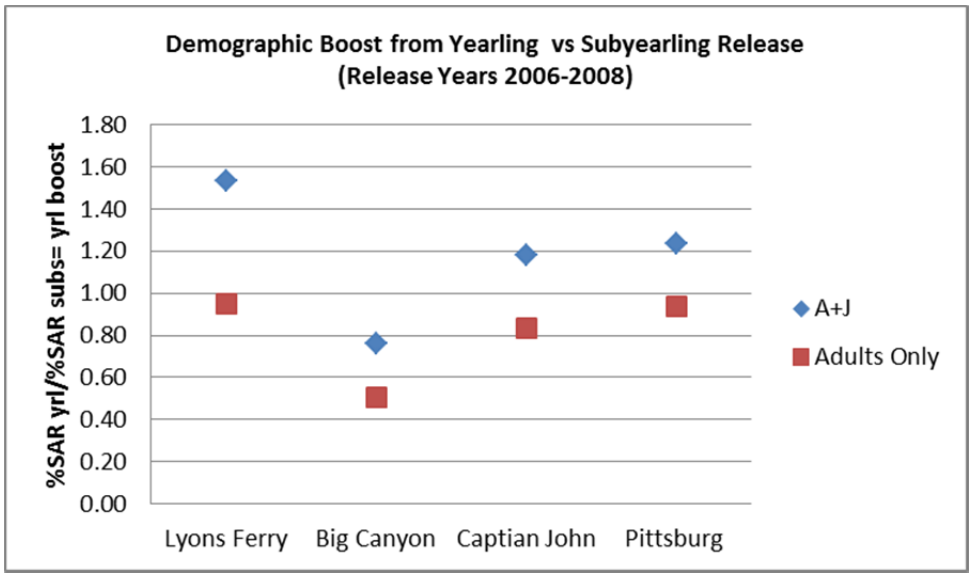

Figure 9. Demographic boost comparisons of yearling Smolt-to-Adult Returns (SARs) to subyearling SARs for adult plus jack returns and adult only returns, release years 2006-2008.

Harvest plus returns: SAS

Average smolt to adult survivals (SAS) including all harvest and recoveries of adults and jacks, were estimated and compared for yearling and subyearling releases from four LSRCP release sites on the Snake and Clearwater rivers (Figure 10). Mini jacks were not included in these estimates. Fish released as yearlings survived at a higher rate than subyearlings at all sites except Big Canyon AF. The greatest increase in yearling SAS was observed for releases from Lyons Ferry Hatchery. Results were mixed for release sites above LGR, with subyearling SAS greater than yearlings from the Clearwater River site at Big Canyon. The yearling survival advantage corresponded to a demographic boost for releases from Lyons Ferry Hatchery, Captain John AF and Pittsburg Landing AF (Table 7). Again, the number of jacks in the yearling groups provides the difference in overall survivals.

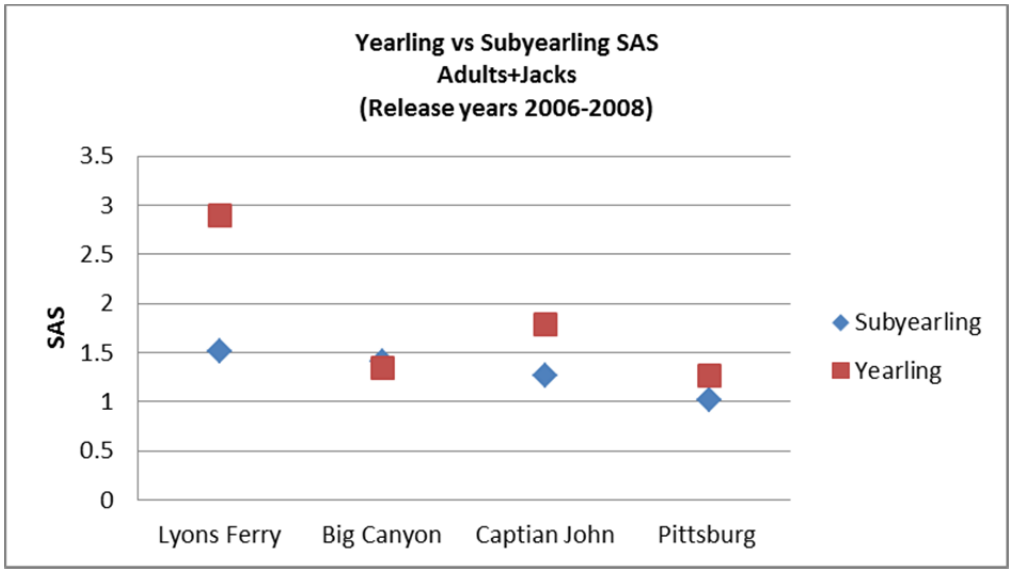

Figure 10. Average smolt to adult survivals (SAS) of subyearling and yearlings released at Lyons Ferry Hatchery, Big Canyon Acclimation Facility, Captain John Acclimation Facility, and Pittsburg Landing Acclimation Facility, release years 2006-2008.

Table 5. Average percent Smolt to adult survivals (SAS) of returning adult and jack hatchery fall Chinook released as subyearlings and yearlings, release years 2006-2008.

Release site	% SAS subyearling	% SAS Yearling	Demographic boost %SAS yrl /%SAS subs	Subyearling Brood year	Yearling brood year
Lyons Ferry	1.52	2.89	1.91	BY05-07	BY04-06
Big Canyon	1.41	1.34	0.95	BY05-07	BY04-06
Captain John	1.26	1.79	1.42	BY05-07	BY04-06
Pittsburg	1.01	1.26	1.25	BY05-07	BY04-06

Variations in survivals

Survival estimates in both yearling and subyearling releases have been highly variable over the years. Figure 11 shows SAS calculated for ADCWT yearlings and Figure 12 shows SAS calculated for ADCWT subyearlings released in the Snake River basin. Due to the multitude of release sites, differing marking scenarios, and ages at release of juveniles released into the Snake River Basin, determining performance between the release groups is challenging. However, examining all yearling and subyearling releases revealed a consistent pattern in survival by year. Release year 2008 demonstrated the highest overall survival, with survival as high as 5.4% from LFH yearling releases and 3.0% from Hells Canyon Dam (IPC) subyearling releases. Yearling and subyearling releases in 2006 showed the next highest survival with 2007 releases the lowest. Given that survival differences were consistent across years, but not juvenile release stage (yearling vs subyearling), river migration conditions and ocean environmental condition likely had the greatest influence on survival of Snake River fall Chinook salmon. Survivals from the LFH releases are consistently the highest for the three years provided, but the other release locations were inconsistent between years. Further analysis of this data needs to occur, and additional years of data are needed.

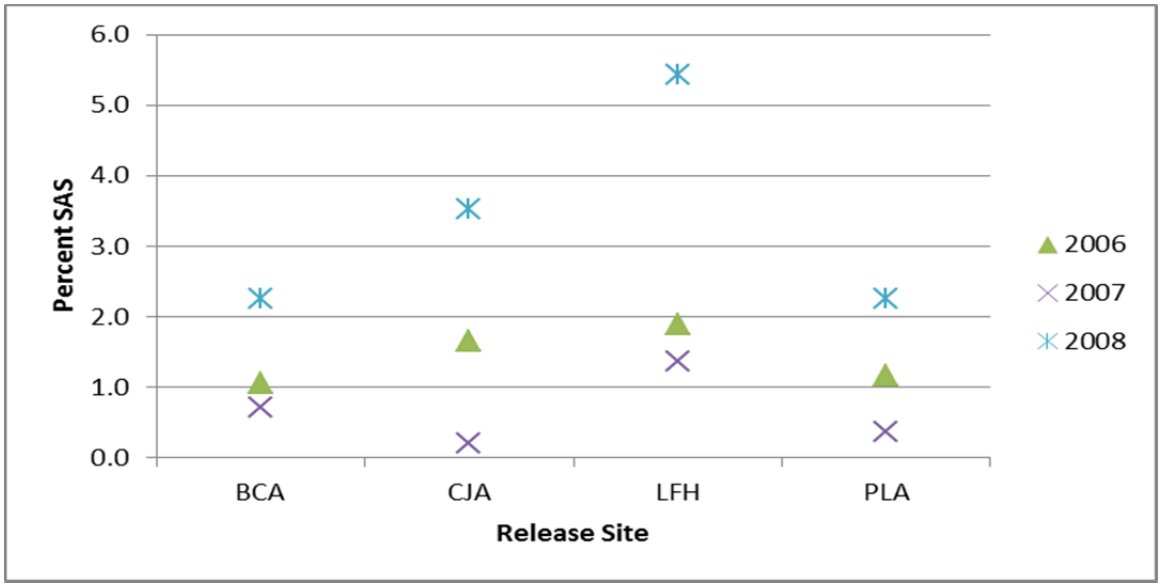

Figure 11. Average percent Smolt to adult survival (SAS) of ADCWT yearlings returning from juveniles released in 2006-2008 by release site and release year. Big Canyon acclimation facility (BCA), Captain John acclimation facility (CJA), Lyons Ferry Hatchery (LFH), and Pittsburg Landing acclimation facility (PLA).

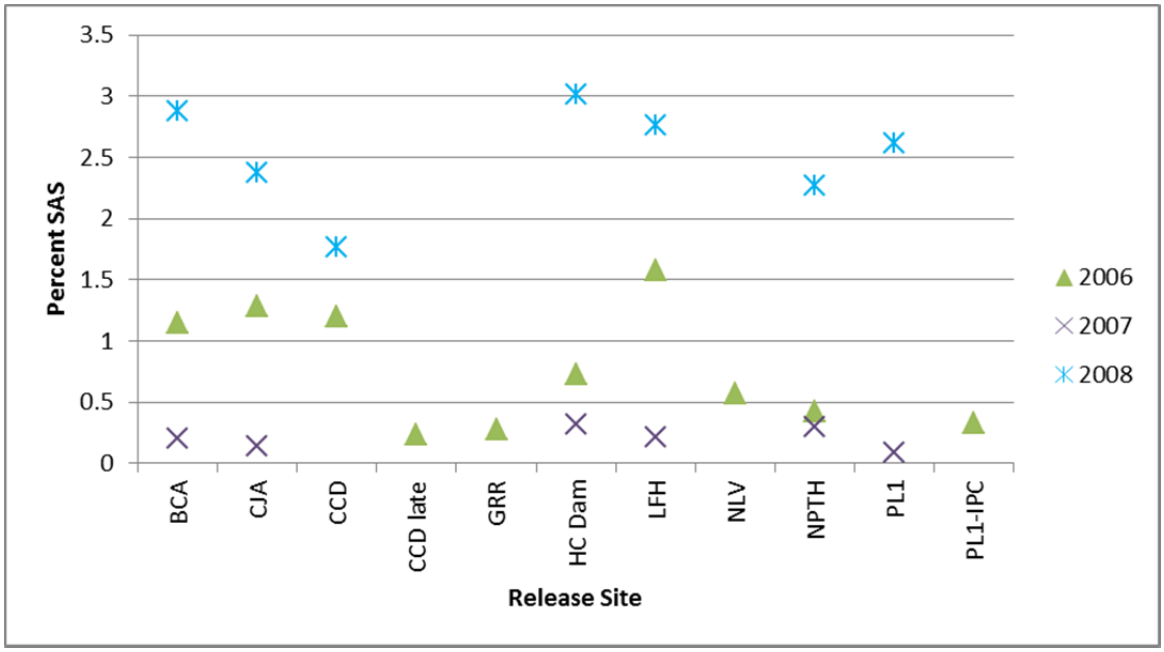

Figure 12. Average percent Smolt to adult survival (SAS) of ADCWT subyearlings returning from juveniles released in 2006-2008 by release site and release year. Big Canyon acclimation facility (BCA), Captain John acclimation facility (CJA), Snake River direct releases near Couse Creek (CCD), Grande Ronde River (GRR), Hells Canyon Dam (HC dam), LFH, North Lapwai Valley acclimation facility (NLVA), Nez Perce Tribal Hatchery (NPTH), and Pittsburg Landing acclimation facility (PLA).

SUMMARY AND CONCLUSIONS

The project area adult return mitigation goal was met for 2009-2012 returns to the Snake River, although harvest goals (downriver or within the Snake River basin) have yet to be achieved. Survivals of hatchery fall Chinook have exceeded the 0.2% adults and jacks back to the project area goal originally set forth in the LSRCP agreement. Exploitation rates of LSRCP and FCAP fish with AD clips have averaged 44% in the Columbia River and ocean, but only 0.3% in the Snake River basin. Lack of established sport or commercial fisheries in the Snake River basin is the primary reason exploitation is currently so low.

Due to the lack of electronic sampling in all fisheries, it is critically important to continue ADCWT tagging some proportion of all releases to be able to fully estimate exploitation rates from ocean and mainstem Columbia River fisheries. Straying of Snake River Hatchery fall Chinook to hatchery racks or spawning grounds outside of the basin occurs at a very low rate indicating this stock has a high fidelity to the Snake River basin.

Due to changes in yearling and subyearling production and marking/tagging strategies used since the mid-1990s as the fall Chinook grew in size, only three release years can be used to compare survivals of subyearlings to yearlings. However, current marking and tagging protocols outlined in US v Oregon insure consistency between marks/tags and release sites until 2017. Preliminary results indicate that yearling releases generally outperform subyearling releases when jacks are

included in the analysis, except at Big Canyon AF. Jacks are an important factor in the analysis and cannot be disregarded because they contribute to the downstream fisheries. There is a desire among the co-managers in the basin to move the program away from yearling production towards increasing subyearling production. This change would have some positive benefits by decrease the numbers of 0-salt, mini jacks, and jacks returning to the basin, but may have a negative impact to downstream fisheries as many jacks are harvested. More analysis needs to be done to determine how many subyearlings would need to be raised to offset the survival advantage yearlings have, where the fish would be reared, and how those different release groups contribute to economically important Columbia River corridor and ocean fisheries.

Citations

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