# FISH PASSAGE CENTER

**1827 NE 44th Ave., Suite 240, Portland, OR 97213**
Phone: (503) 230-4099 Fax: (503) 230-7559
http://www.fpc.org/
e-mail us at fpcstaff@fpc.org


**MEMORANDUM**

TO: Tom Stuart

FROM: Michele DeHart

DATE: October 29, 2009

RE: Fall Chinook Jack Count 2009

In response to your data request regarding the high number of jacks counted in the adult return of Snake River fall Chinook at Lower Granite Dam this year, the FPC staff reviewed several sources of information and have summarized our conclusions in the following discussion. The FPC has reviewed both historic and present dam counts, PIT tag detections of adult fall Chinook, pertinent literature, hatchery data and physical and biological factors relating to jack returns. We have the following in response to your request:

- The high proportion of jacks in the count at Lower Granite Dam is likely a result of the hatchery program.
- The 2009 jack count at Lower Granite Dam is the largest in the historical record to date. Based on historic timing it is estimated that approximately 97% of the adult fall Chinook migration has passed Lower Granite Dam thus far in 2009. Based on dam counts the jack rate for 2009 is the highest observed in the historic record. Approximately 73% of all the total fall Chinook counted at Lower Granite Dam in 2009 (through 10/27/2009) were designated as jack fall Chinook based on length.
- Upper Columbia fall Chinook do not show the same high rates of jack returns as the Snake River fall Chinook.
- The jack dam counts, and the proportion of the total counts that are comprised of jacks, have increased considerably since the introduction of hatchery fall Chinook above Lower Granite Dam. In 1996 the first acclimation releases of Lyons Ferry Fall Chinook were made above Lower Granite Dam with release numbers increasing substantially in subsequent years.

- The disproportionate jack return in 2009 in part reflects the higher juvenile hatchery releases in 2008 compared to juvenile releases in 2007. The 2009 fall Chinook return is comprised primarily of jack returns from 2008 hatchery releases and adult returns from 2007 hatchery releases. The disproportionate jack component of the adult return in 2009 in part reflects the record high hatchery releases that occurred in 2008 while the lower proportion of adults in the 2009 return reflects the lower hatchery releases in 2007. The low hatchery releases in 2007, was in part due to a low proportion of females and low egg take in the 2006 brood year.
- The 2009 jack returns of PIT tags, suggest that the releases of yearling hatchery fall Chinook in the Snake River Zone and subyearlings released at Hells Canyon Dam are contributing disproportionately to the overall PIT-tagged jack and mini-jack population at LGR in 2009. Yearling releases in 2008 and 2009 made up approximately 31% of the PIT-tagged jack and mini-jack population at LGR in 2009. However, yearling releases to the Snake River Zone in 2008 and 2009 were only 17.4% and 14.4%, respectively, of the overall production releases of fall Chinook in the Snake River Zone.
- PIT-tag analyses revealed that yearling hatchery fall Chinook releases to the Snake River are the only releases that lead to mini-jack (0-Ocean) returns.
- Estimates of "PIT-tag Jack Return Percent" for migration year 2008 (return year 2009) indicate that jack rates in the Snake River increased in the 2009 return with the exception of natural fall Chinook.
- PIT-tag analyses showed that Upper Columbia hatchery fall Chinook (at Priest Rapids Dam) returned at a lower jack proportion (of total adults) than Snake River fall Chinook (at LGR). Furthermore, the jack proportion for returning Snake River fall Chinook at LGR was highest for yearling hatchery releases.
- Upper Columbia hatchery fall Chinook subyearlings are released at similar sizes as Snake River subyearlings but on average are released approximately 3-4 weeks later in the year. There are no yearling hatchery fall Chinook releases in the Upper Columbia.
- Research shows that hatchery rearing environment affects jacking rates in Chinook salmon. It is likely that increased jack rates in hatchery fall Chinook in the Snake River are a hatchery effect. Review of literature indicates that jacking is in some respects heritable and that one possible long term effect of increased jack rates could be an alteration of the age-structure of the natural spawning population, toward more jack returns, as the present hatchery supplementation program continues.

**Jack Fall Chinook and Dam Counts:**

Jack determination at the counting windows at dams is based on fish length. Beginning in the early 1990s through the present, jacks were identified as fish between 12 inches and 22 inches in length. Prior to that time, the size criteria for jack determination were 24 inches. The criteria were changed in the early 1990s through discussions in the Fish Operations and Maintenance Committee (FPOM) an interagency committee of fishery management agencies and hydropower operations agencies (personal communication with several FPOM committee members). Some proportion of fish return as mini-jacks, fish that are less than 12 inches at the counting windows. These are fish that return in the same year as their outmigration (0-ocean). The degree to which these mini-jacks are included in jack counts is unknown and variable among projects.

Jack returns in historic dam counts from 1975 to the late 1980's, reflect the larger size criteria used in those years to determine jacks. The jack proportions in those early years will be inflated when compared to more recent years of jack counts. The change in length criteria likely explains the higher proportion of jacks early in the historic record for the dam counts when only wild fish were present.

Dam counts of adult (≥2-Ocean) and jack (1-Ocean) fall Chinook were reviewed at Bonneville (BON), McNary (MCN) and Lower Granite (LGR) dams. The proportion of the total fall Chinook counts that were identified as jacks from 1960 to 2009 averaged 0.21 at BON (Figure 1), 0.30 at MCN (Figure 2), and 0.45 at LGR (1975-2009) (Figure 3). From the dam counts it was apparent that the high proportion of jack fall Chinook was unique to the Snake River (LGR).

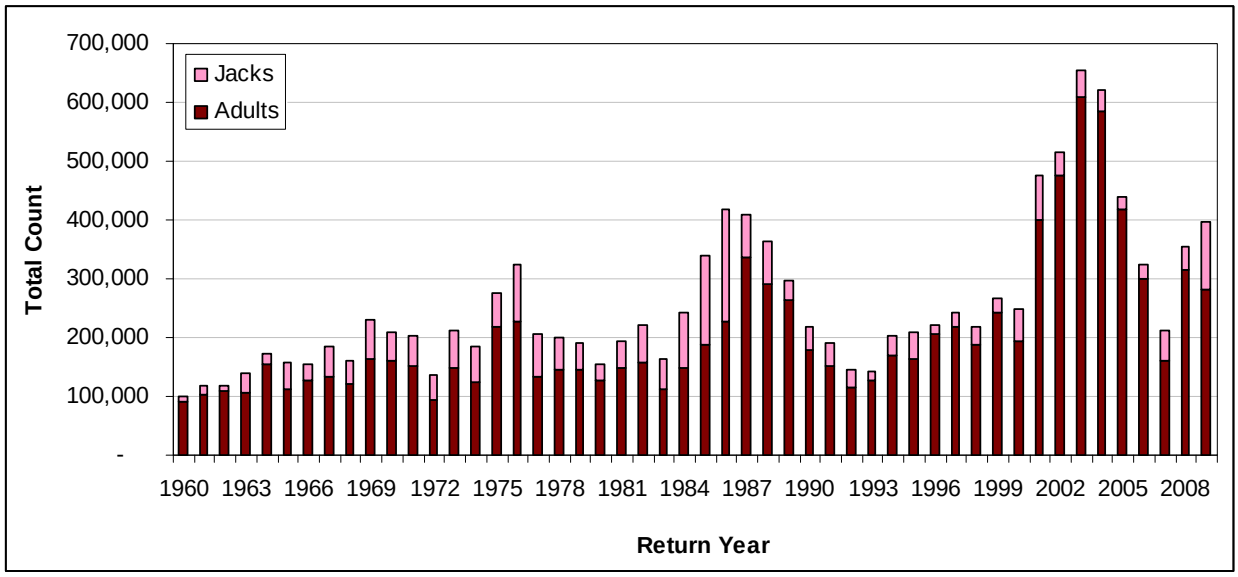


**Figure 1.** Fall Chinook counts at Bonneville Dam, 1960 to 2009.

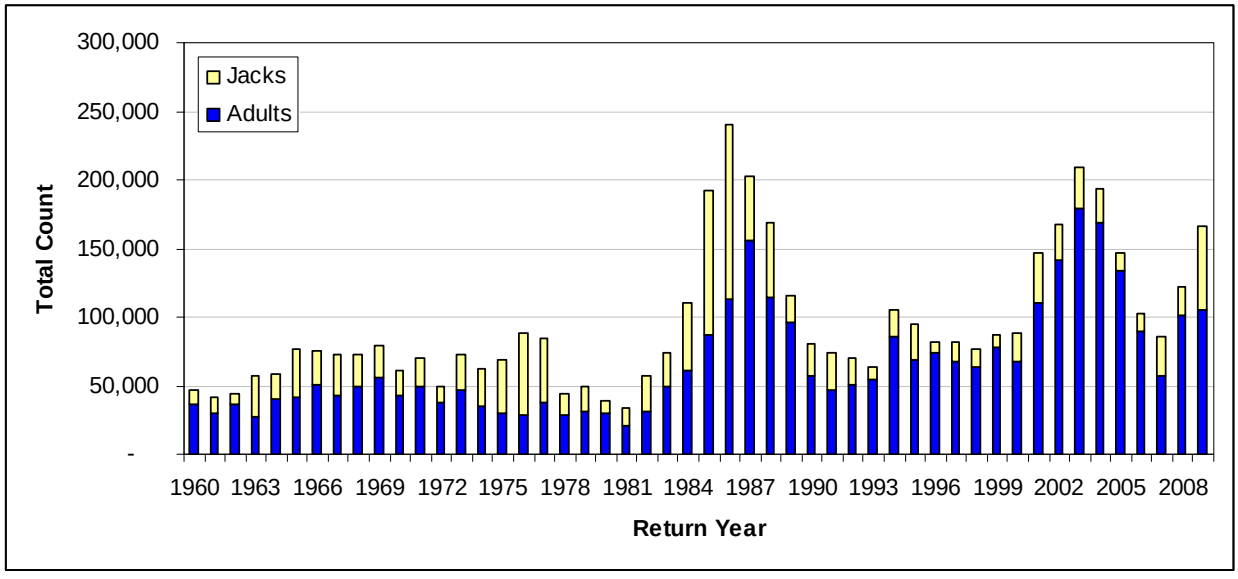

**Figure 2.** Fall Chinook counts at McNary Dam, 1960 to 2009.

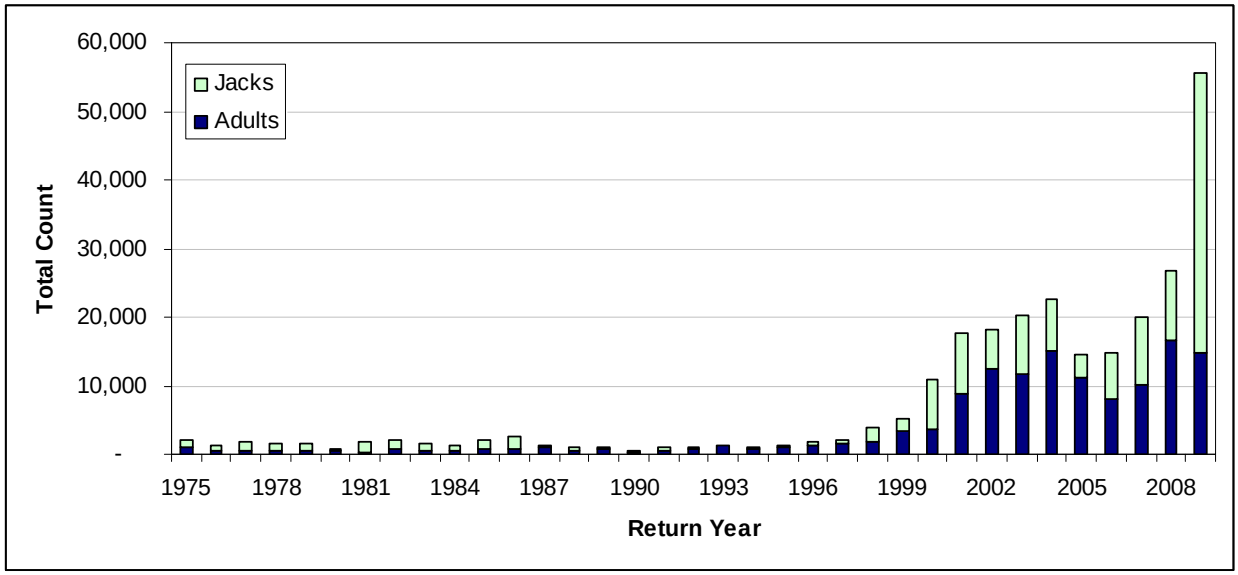


**Figure 3.** Fall Chinook counts at Lower Granite Dam, 1975 to 2009.

Based on data through 10/27/2009, the 2009 return to LGR was comprised mostly of jacks, based on the length criteria. This was the both the highest jack count observed in the historic record as well as the highest proportion of the total adult return.

**Hatchery Fall Chinook in the Snake River Zone:**

Hatchery production of fall Chinook to the Snake River Zone began in 1985 but was limited to releases from Lyons Ferry Hatchery (LYFE) below LGR. The hatchery fall Chinook program in the Snake River Zone began regular releases above LGR in 1996. From 1999 to present, the releases of hatchery fall Chinook above LGR have increased substantially, with a record release above LGR in 2008 (Figure 4). At first, hatchery fall Chinook released above LGR were released from acclimation ponds on the Clearwater River (Big Canyon Creek, BCCAP) and Snake River (Captain Johns Rapids, CJRAP and Pittsburg Landing, PLAP). A portion of these releases have been PIT-tagged since 1999. Fall Chinook released at these acclimation ponds are reared at Lyons Ferry Hatchery and there are typically two releases from each acclimation pond each year. The first of these releases occurs in April and is of yearling fall Chinook. These yearling fall Chinook are typically larger at release, averaging approximately 10.3 fish per pound. The second of these releases occurs in late May to early June and is of subyearling fall Chinook. In earlier years, some of the subyearling releases occurred in late June and early July, as back-fill releases. However, these later back fill releases have not occurred since 2002. The subyearling fall Chinook released at these acclimation ponds are smaller than the yearlings, averaging approximately 74.4 fish per pound.

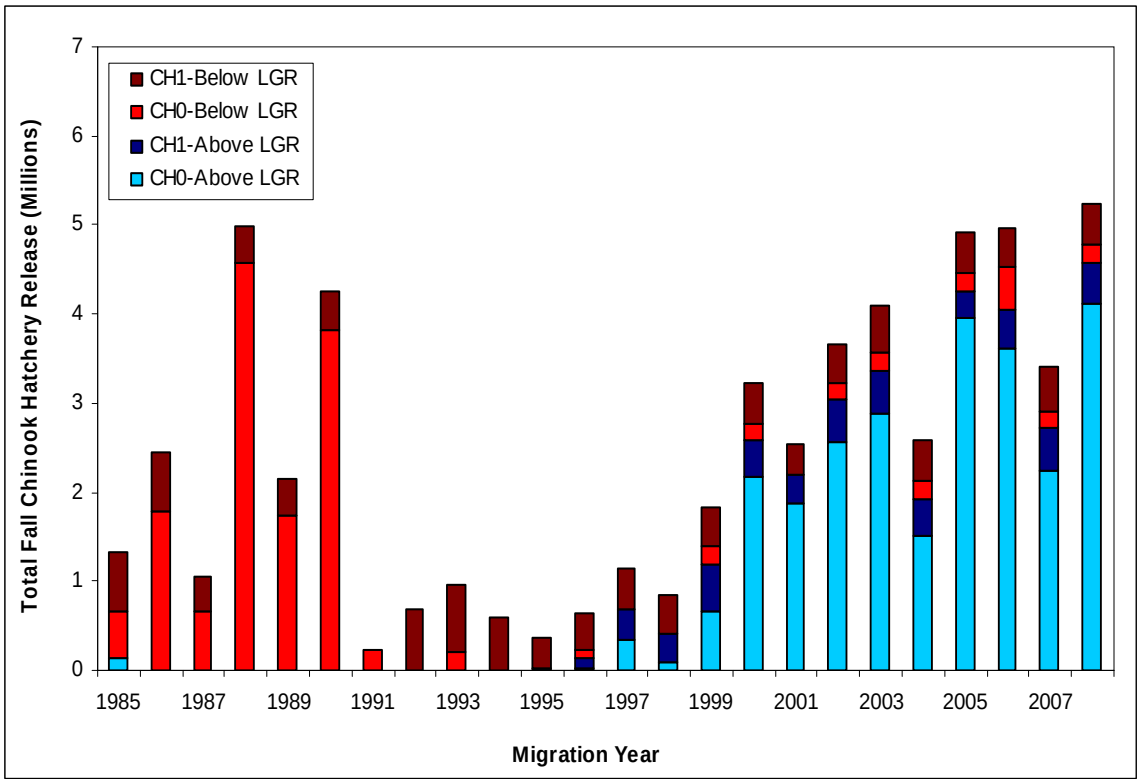


**Figure 4.** Total hatchery fall Chinook releases to the Snake River Zone by age at release (CH0 vs. CH1) and location of release (below LGR vs. above LGR)

Over the years, new release sites and hatcheries above LGR have come on line for fall Chinook. Since 2001, releases of fall Chinook subyearlings just below Hells Canyon Dam (HCD) have occurred. These subyearlings are reared at Oxbow Hatchery in Idaho and/or Umatilla Hatchery in Oregon and the releases typically take place in mid-May. These subyearlings are slightly larger than the subyearlings released at the acclimation facilities, averaging approximately 49.6 fish per pound. PIT-tagging of these HCD subyearlings began in 2002. The Nez Perce Tribal Hatchery (NPTH) began releasing subyearling fall Chinook to the Clearwater River and its tributaries in 2003. Many of these releases have been PIT-tagged. Average fish per pound for the NPTH subyearling releases over the years is 65.8.

When egg takes are high, some subyearling fall Chinook are reared at Irrigon Hatchery and released into the Grande Ronde River. These Grande Ronde River releases are sometimes PIT-tagged. Finally, when egg takes are high enough, releases of subyearling fall Chinook surrogates to the Clearwater and Snake rivers occur. Fall Chinook surrogates are hatchery subyearling fall Chinook that are first reared at Lyons Ferry Hatchery and transferred to Dworshak NFH to be reared to a smaller size to more closely resemble wild fall Chinook subyearlings. Surrogates are then released at BCCAP on the Clearwater River in late June to mid-July and into the Snake River in early to mid-May. Surrogate releases are typically 100% PIT-tagged and have occurred in 2005, 2006, 2008, and 2009. Snake River wild fall Chinook typically out-migrate as subyearlings.

In 2007, the total hatchery output of fall Chinook juveniles to the Snake River Basin, above LGR, was 2,712,112. Of these, 2,251,450 were released as subyearlings and 460,662 were released as yearlings. However, in 2008, the total hatchery output of fall Chinook juveniles above LGR was the highest on record, at 4,569,527. Of juvenile fall Chinook released above LGR in 2008, 4,117,657 were released as subyearlings and 451,870 were released as yearlings. The low hatchery releases in 2007, was in part due to a low female to male ratio in the 2006 return to LGR, which resulted in low proportion females and low egg take for the 2006 brood year.

Given the lower hatchery release total in 2007, we would expect the returns of 2-ocean adults to be lower in 2009 relative to returns from 2008 jacks with other things such as ocean survival being equal. And since in 2008 there were record hatchery releases, we would expect to see a higher than average percent jacks in the dam counts in 2009 based on this disparity alone.

**Origin of 2009 Fall Chinook Jacks**

FPC analyzed adult PIT-tag detections of fall Chinook jacks (1-ocean) and mini-jacks (0-ocean) at LGR in 2009. This analysis was done for adult returns of PIT-tagged hatchery fall Chinook to LGR through October 27$^{th}$, 2009. These jack and mini-jack PIT-tag detections were divided by total PIT-tag release size to determine "adult" return rates for each PIT-tag release. The PIT-tagged jack and mini-jack return rates were multiplied by the total release number (marked and unmarked) for each PIT-tagged group to estimate a total return of jacks by PIT-tag release group. This approach accounts for the disproportionate number of PIT-tags in some release groups such as surrogate fall Chinook. We then divided the estimated jacks by release over the total estimated jacks to determine the proportion of returning jacks that were from each release. With these data, we were able to estimate what proportion each of the hatchery groups was contributing to the overall 2009 PIT-tagged jack and mini-jack population at LGR.

Based on these analyses, approximately 17% of the PIT-tagged jack and mini-jack population at LGR in 2009 were released as yearlings from acclimation ponds above LGR (Figure 5). These acclimation releases above LGR occurred on the Snake River (CJRAP and PLAP) and Clearwater River (BCCAP). A small portion of these were released in migration year 2009 and returned as mini-jacks (Figure 5). Surprisingly, approximately 15% of the PIT-tagged jack and mini-jack population at LGR in 2009 are from releases of yearling fall Chinook released from LYFE, below LGR (Figure 5).

Overall, subyearling hatchery releases to the Snake River Zone in 2008 accounted for 82.6% of the total hatchery output of fall Chinook to the Snake River Zone. However, subyearlings released in 2008 only accounted for about 69% of the PIT-tagged population of jacks and mini-jacks at LGR in 2009 (Figure 5). Of these, a large portion were from the groups that are reared at Oxbow and Umatilla hatcheries and released just below Hells Canyon Dam (Figure 5). A very small portion (~2%) of the estimated PIT-tagged jack and mini-jack population at LGR in 2009 were subyearling fall Chinook surrogates that were released in 2008 (Figure 5).

Given that the yearling fall Chinook releases in 2008 and 2009 accounted for only 17.4% and 14.4%, respectively, of the total hatchery production of fall Chinook to the Snake River

Zone in these years, it is interesting that approximately 31% of the estimated PIT-tagged jack and mini-jack population at LGR in 2009 were released as yearlings in 2008 or 2009 However, subyearling releases, which accounted for 82.6% of the total hatchery production for the Snake River Zone in 2008, accounted for only about 69% of the estimated PIT-tagged jack and mini-jack population at LGR in 2009. This indicates that the releases of yearling hatchery fall Chinook in the Snake River Zone are contributing disproportionately to the return of jacks at LGR. Also interesting to note is the relative contribution of subyearling Chinook below Hells Canyon to the estimated jack and mini-jack population at LGR in 2009. These releases accounted for approximately 18% of the total hatchery production to the Snake River Zone in migration year 2008. However, an estimated 29% of the jack and mini-jack population at LGR in 2009 were from these releases.

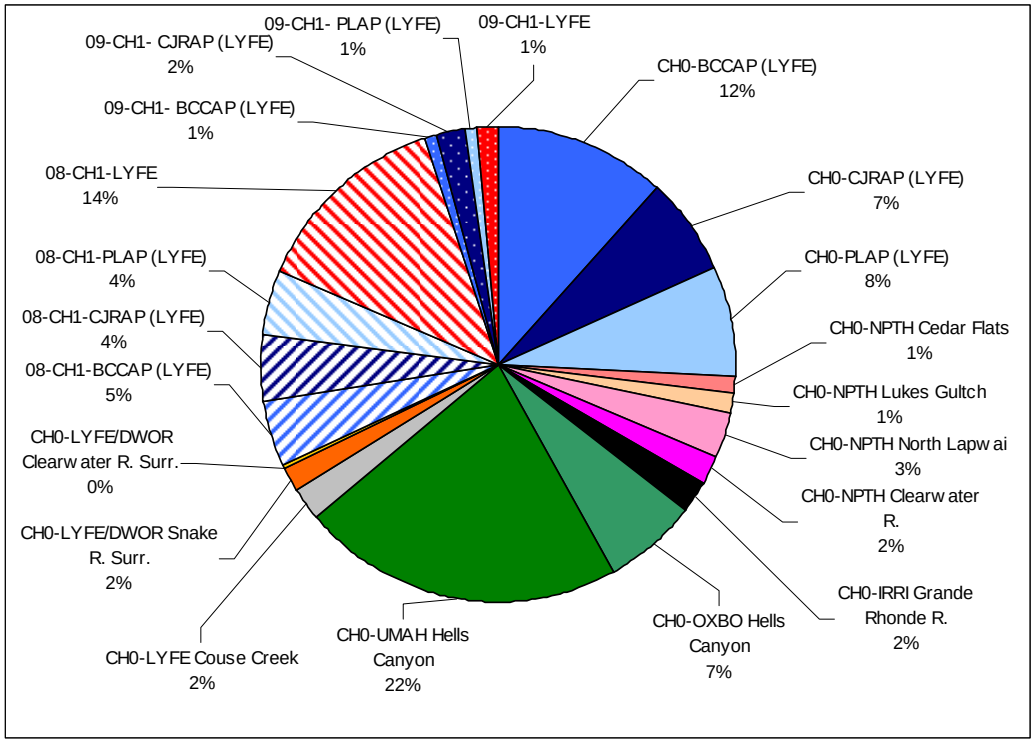


**Figure 5.** Estimated proportion of the PIT-tagged hatchery jack and mini-jack population at LGR in 2009. All groups labeled as CH0 were released in migration year 2008 and returned as jacks. The migration year is provided for CH1 groups, in order to distinguish between jack and mini-jack returns.

## Estimates of "PIT-tag Return Percent" for Mini-Jacks, Jacks, and Adults from Hatchery and Natural Snake River Fall Chinook:

To determine "PIT-tag Return Percent" for mini-jacks, jacks, and adults from hatchery and natural fall Chinook, FPC staff relied on releases of PIT-tagged hatchery and natural fall Chinook juveniles from migration year 1999 to 2008. Due to insufficient numbers of PIT-tags for natural fall Chinook in the Clearwater River, the FPC was only able to estimate "PIT-tag Return Percent" for natural Snake River fall Chinook. For the hatchery groups, the FPC concentrated on those hatchery releases that have five or more years of PIT-tagging data. The various release sites of hatchery fall Chinook from NPTH were lumped together into one group. Releases to the Grande Ronde River did not have a long enough time series to be included in this analysis. Furthermore, we did not include fall Chinook surrogate releases in this analysis

because of their tendency to holdover more frequently than other hatchery groups. Because it is impossible to know the entire holdover population, it is difficult to determine the return age of these fish based on PIT-tags. In this analysis, separate estimates of "PIT-tag Return Percent" were generated for mini-jacks (0-ocean), jacks (1-ocean), and adults (≥ 2-ocean) for each of the migration years and release groups that were possible. "PIT-tag Return Percent" was estimated as the number of PIT-tagged mini-jacks, jacks, or adults detected at LGR for each year of out-migration, divided by the number of PIT-tags released for that migration year. These estimates were multiplied by 100 in order to express them as percentages. Estimates of "PIT-tag Return Percent" for adults (≥ 2-ocean) were only possible through migration year 2006, as older adults from later migration years are yet to return to LGR. Estimates for migration year 2006 should be considered preliminary, as some 4-ocean and 5-ocean adults may still return in future years.

***Mini-Jack Return Percent***

The only groups of hatchery or natural fall Chinook juveniles that had estimates of "PIT-tag Mini-Jack Return Percent" that were greater than 0.00 were those hatchery fall Chinook groups that were released as yearlings (Table 1). Estimates of "PIT-tag Mini-Jack Return Percent" were variable over the years but migration year 2008 had the highest estimates for all the groups of yearling releases we analyzed (Table 1). For migration year 2008, these estimates ranged from 0.88% for the PLAP release to 3.00% for the CJRAP release (Table 1). Migration year 2006 also had fairly high estimates of "PIT-Tag Mini-Jack Return Percent", ranging from 0.38% for the BCCAP and PLAP releases and 1.35% for the CJRAP releases (Table 1). It is worth noting that, since these yearling fall Chinook juveniles are larger when they are released, it might be possible for some mini-jacks to be between 12-22 inches upon return and be counted as jacks at LGR.

***Jack Return Percent***

All of the hatchery and natural groups we analyzed had estimates of "PIT-tag Jack Return Percent" that were greater than 0.00 for at least some migration years, but these estimates were all less than 1.00% (Tables 1, 2, and 3). As with "PIT-tag Mini-Jack Return Percent", migration year 2008 had the highest estimates of "PIT-tag Jack Return Percent" for almost all the groups and migration years analyzed (Tables 1, 2, and 3).

Among the subyearling hatchery release groups, estimates of "PIT-tag Jack Return Percent" for migration year 2008 ranged from 0.37% for the NPTH release to 0.93% for the HCD releases (Table 2). It is worth noting that the BCCAP subyearling releases were historically the most prevalent producers of jacks among the subyearling releases we analyzed (Table 2). The only group of PIT-tagged fall Chinook whose migration year 2008 estimate of "PIT-tag Jack Return Percent" was not the highest was Snake River natural fall Chinook. Migration year 2008 resulted in an estimate of 0.13%, but both migration year 1999 and 2007 were higher, at 0.17% and 0.15%, respectively (Table 3).

Among the yearling hatchery release groups, estimates of "PIT-tag Jack Return Percent" for migration year 2008 ranged from 0.90% for the CJRAP release to 0.97% for the BCCAP release (Table 1). In general, estimates of "PIT-tag Jack Return Percent" for the yearling fall Chinook hatchery groups released at BCCAP, CJRAP, and PLAP were higher than subyearling hatchery fall Chinook released at the same locations (Tables 1 and 2). This was particularly true among more recent migration years.

***Adult Return Percent***

Estimates of "PIT-tag Adult Return Percent" were only possible through migration year 2006. For the subyearling hatchery release groups, estimates of "PIT-tag Adult Return Percent" ranged from 0.00% to 0.41% among all of the migration years we analyzed (Table 2). Estimates for Snake River natural fall Chinook ranged from 0.09% in 2004 to 1.25% in 1999 (Table 3). In general, estimates of "PIT-tag Adult Return Percent" for Snake River natural fall Chinook were higher than for any of the hatchery release groups. Finally, estimates of "PIT-tag Adult Return Percent" for the yearling hatchery release groups ranged from 0.00% to 0.16% among all the migration years we analyzed (Table 1). In general, estimates of "PIT-tag Adult Return Percent" for the yearling hatchery release groups were lower than those same release groups (BCCAP, CJRAP, and PLAP) of subyearling hatchery fall Chinook (Tables 1 and 2).

**Table 1** Yearling hatchery fall Chinook estimates of "PIT-tag Return Percent" for mini-jacks, jacks, and adults. Migration years missing from the table are those where no releases of PIT-tags occurred. Estimates of PIT-tag Adult Return Percent were not possible for migration years after 2006, as these adults are yet to return.

| Release Site / Release Type | Migration Year | Mini-Jack Return Percent | Jack Return Percent | Adult Return Percent |
|---|---|---|---|---|
| BCCAP / Acclimation | 1999 | 0.02 | 0.05 | 0.01 |
| | 2000 | 0.00 | 0.05 | 0.07 |
| | 2001 | 0.00 | 0.00 | 0.01 |
| | 2002 | 0.01 | 0.00 | 0.01 |
| | 2003 | 0.05 | 0.07 | 0.05 |
| | 2004 | 0.04 | 0.00 | 0.00 |
| | 2005 | 0.02 | 0.08 | 0.10 |
| | 2006 | 0.38 | 0.32 | 0.08 |
| | 2007 | 0.08 | 0.10 | |
| | 2008 | 1.05 | 0.97 | |
| CJRAP / Acclimation | 1999 | 0.00 | 0.00 | 0.00 |
| | 2000 | 0.00 | 0.32 | 0.04 |
| | 2001 | 0.00 | 0.04 | 0.00 |
| | 2002 | 0.08 | 0.04 | 0.04 |
| | 2003 | 0.12 | 0.12 | 0.08 |
| | 2004 | 0.12 | 0.06 | 0.02 |
| | 2006 | 1.35 | 0.51 | 0.16 |
| | 2007 | 0.05 | 0.00 | |
| | 2008 | 3.00 | 0.90 | |
| PLAP / Acclimation | 1999 | 0.02 | 0.00 | 0.01 |
| | 2000 | 0.00 | 0.01 | 0.07 |
| | 2001 | 0.00 | 0.01 | 0.01 |
| | 2002 | 0.07 | 0.08 | 0.07 |
| | 2003 | 0.01 | 0.03 | 0.01 |
| | 2004 | 0.00 | 0.00 | 0.00 |
| | 2005 | 0.00 | 0.08 | 0.16 |
| | 2006 | 0.38 | 0.12 | 0.14 |
| | 2007 | 0.10 | 0.12 | |
| | 2008 | 0.88 | 0.94 | |

**Table 2.** Subyearling hatchery fall Chinook estimates of "PIT-tag Return Percent" for mini-jacks, jacks, and adults. Migration years missing from the table are those where no releases of PIT-tags occurred. Estimates of PIT-tag Adult Return Percent were not possible for migration years after 2006, as these adults are yet to return.

| Release Site / Release Type | Migration Year | Mini-Jack Return Percent | Jack Return Percent | Adult Return Percent |
|---|---|---|---|---|
| BCCAP / Acclimation | 1999 | 0.00 | 0.61 | 0.41 |
| | 2000 | 0.00 | 0.13 | 0.27 |
| | 2001 | 0.00 | 0.16 | 0.27 |
| | 2002 | 0.00 | 0.12 | 0.38 |
| | 2003 | 0.00 | 0.04 | 0.04 |
| | 2004 | 0.00 | 0.00 | 0.08 |
| | 2005 | 0.00 | 0.16 | 0.08 |
| | 2006 | 0.00 | 0.31 | 0.41 |
| | 2007 | 0.00 | 0.00 | |
| | 2008 | 0.00 | 0.70 | |
| CJRAP / Acclimation | 1999 | 0.00 | 0.29 | 0.39 |
| | 2000 | 0.00 | 0.10 | 0.40 |
| | 2001 | 0.00 | 0.10 | 0.35 |
| | 2002 | 0.00 | 0.16 | 0.22 |
| | 2003 | 0.00 | 0.00 | 0.08 |
| | 2004 | 0.00 | 0.00 | 0.04 |
| | 2005 | 0.00 | 0.00 | 0.03 |
| | 2006 | 0.00 | 0.11 | 0.29 |
| | 2007 | 0.00 | 0.00 | |
| | 2008 | 0.00 | 0.42 | |
| PLAP / Acclimation | 2000 | 0.00 | 0.20 | 0.20 |
| | 2001 | 0.00 | 0.03 | 0.01 |
| | 2002 | 0.00 | 0.03 | 0.04 |
| | 2003 | 0.00 | 0.03 | 0.02 |
| | 2004 | 0.00 | 0.00 | 0.00 |
| | 2005 | 0.00 | 0.00 | 0.04 |
| | 2006 | 0.00 | 0.16 | 0.11 |
| | 2007 | 0.00 | 0.00 | |
| | 2008 | 0.00 | 0.59 | |
| Hells Canyon Dam / Direct | 2002 | 0.00 | 0.20 | 0.10 |
| | 2003 | 0.00 | 0.04 | 0.02 |
| | 2004 | 0.00 | 0.04 | 0.02 |
| | 2005 | 0.00 | 0.01 | 0.01 |
| | 2006 | 0.00 | 0.12 | 0.18 |
| | 2007 | 0.00 | 0.07 | |
| | 2008 | 0.00 | 0.93 | |
| NPTH / Direct & Acclim. | 2003 | 0.00 | 0.02 | 0.02 |
| | 2004 | 0.00 | 0.00 | 0.00 |
| | 2006 | 0.00 | 0.27 | 0.20 |
| | 2007 | 0.00 | 0.11 | |
| | 2008 | 0.00 | 0.37 | |

**Table 3.** Snake River natural fall Chinook estimates of "PIT-tag Return Percent" for mini-jacks, jacks, and adults. Estimates of PIT-tag Adult Return Percent were not possible for migration years after 2006, as these adults are yet to return.

| Release Site / Release Type | Migration Year | Mini-Jack Return Percent | Jack Return Percent | Adult Return Percent |
|---|---|---|---|---|
| Snake R. / Natural | 1999 | 0.00 | 0.17 | 1.25 |
| | 2000 | 0.00 | 0.00 | 0.17 |
| | 2001 | 0.00 | 0.07 | 0.43 |
| | 2002 | 0.00 | 0.00 | 0.43 |
| | 2003 | 0.00 | 0.08 | 0.23 |
| | 2004 | 0.00 | 0.04 | 0.09 |
| | 2005 | 0.00 | 0.05 | 0.20 |
| | 2006 | 0.00 | 0.00 | 0.42 |
| | 2007 | 0.00 | 0.15 | |
| | 2008 | 0.00 | 0.13 | |

**Comparison of PIT-tagged Upper Columbia fall Chinook Jack Returns and Snake River Jack Returns, Expressed as a Proportion of Total Adult Returns:**

We analyzed PIT-tag adult detections at Priest Rapids Dam of hatchery fall Chinook released at Priest Rapids hatchery and detections at McNary Dam (MCN) of wild fall Chinook marked and released in the Hanford Reach. We compared detections of adults from these release groups to those of fish returning to the Snake River. We estimated the proportions of adult PIT-tag detections that were jacks for the Upper Columbia tag groups and compared the result to those reported for Snake River fall Chinook that returned to LGR. We grouped data by juvenile migration year and expressed the jack proportion as the total jack detections (0-Ocean and 1-Ocean) divided by total adult detections (including jacks).

Based on the PIT-tag analysis the jack proportion for Upper Columbia subyearling fall Chinook (Hanford Reach Wild) at MCN averaged about 0.08 (Table 4) A similar calculation for Snake River hatchery and natural subyearling fall Chinook resulted in an average jack proportion of 0.44 and 0.14, respectively (Table 4). A limited number of adult return data was available for Priest Rapids Hatchery fall Chinook. Those returns showed that of all adult detections (25 total adult detections between migration year 2000 and 2008) 2 were jacks for a proportion of 0.08 -- which was similar to the wild Hanford jack proportion. Based on these results, it appears that Snake River subyearling hatchery and natural fall Chinook both had higher jack proportions than did Upper Columbia subyearling hatchery and wild fall Chinook. Snake River hatchery subyearling Chinook had a higher average jack proportion than did Snake River natural subyearling Chinook. Finally, hatchery Snake River yearling fall Chinook had an average jack proportion of 0.92, which was higher than that for hatchery Snake River subyearling fall Chinook (Table 4).

**Table 4**. Snake River fall Chinook jack return proportions compared to that for Upper Columbia River fall Chinook.

| Migration Year | Snake River Fall Chinook | | | Upper Columbia Fall Chinook |
|---|---|---|---|---|
| | Hatchery Subyearlings | Hatchery Yearlings | Naturals | Wild |
| **1999** | 0.57 | 0.83 | 0.12 | 0.14 |
| **2000** | 0.33 | 0.54 | NA[2] | 0.08 |
| **2001** | 0.37 | 0.50 | NA | 0.03 |
| **2002** | 0.35 | 0.68 | 0.00 | 0.00 |
| **2003** | 0.52 | 0.72 | 0.27 | 0.00 |
| **2004** | 0.44 | 0.92 | NA | 0.00 |
| **2005** | 0.50 | 0.41 | 0.21 | 0.13 |
| **2006** | 0.46 | 0.89 | NA | NA |
| **All years** | 0.44 | 0.79 | 0.14 | 0.08 |

[1] No surrogate releases were made until 2005.
[2] No data are presented where fewer than 10 adult PIT-tags were detected

## Literature Discussion:

Jack returns of PIT-tagged Snake River Fall Chinook appear to be affected by the hatchery environment. Size at release as well as age at release may affect early maturation consistent with recent research. Vøllestad *et al*. (2004) found that triggers for early maturation occurred primarily during early life in freshwater and went on to suggest that growth potential at sea likely neutrally affected or even inhibited early maturation. Larsen et al. (2006) demonstrated that growth and therefore feeding regime the year prior to maturation was important in determining jack rates in a population of spring Chinook salmon in the Yakima River Basin hatchery fish. Larsen et al. (2006) identified two critical periods of growth (summer and autumn prior to release) that could lead to higher jack rates. Research by (Beckman et al., 2007) on Sacramento River winter Chinook concluded that growth rate as well as emergence timing (i.e. ponding) affected subsequent jacking rates.

Jack returns of Snake River fall Chinook from Lyons Ferry Hatchery follow patterns described in the literature. Jack rates of fish released as yearlings showed the highest proportions of adults returning as jacks, suggesting that prolonged rearing within the hatchery contributed to high jacking rates. Based on our analysis of PIT-tag returns, only the yearling releases produced any mini-jacks (0-Ocean). Again, this suggests that prolonged rearing in the hatchery caused some increase in precocious maturation. Finally, surrogate fish grown to smaller size at release tended to show relatively lower jack rates. This too was consistent with recent research suggesting that retarding growth during critical periods (albeit as yet unknown periods for fall Chinook at least) could decrease jack rates in hatchery Chinook salmon.

There is strong evidence that the propensity for jacking is heritable (Iwamoto et al. 1984, Hard et al. 1985, Heath et al. 1994a, Heath et al. 1994b, and Heath et al. 2002). Beckman et al. (2008) found that jacking rates in spring Chinook were heritable maternally but that sire did not appear to affect jacking rates. However, other researchers have shown sire to be more important in determining heritability of jack rates.

Size selective fisheries may also affect jacking. Fish populations likely respond to heavy exploitation with a reduction in both the age and the size at which the average individual completes sexual maturity (Ricker 1981). Thorpe (2007) cautioned that exploitation should not focus on the slower-developing, larger members of salmon populations, to avoid disturbance of the stabilizing influence of genetic diversity. However, selective fisheries have not appeared to increase jack rates in Upper Columbia fall Chinook returns, suggesting that this is not the cause of high jack rates in Snake River fall Chinook.

At this point it is unclear what impacts jack returns will have on the naturally spawning fall Chinook in the Snake River. Increasing jack rates may not just be considered an indicator of subsequent 2-Ocean or older adult returns in the future but may also signal genetic modifications to the naturally spawning populations as supplementation continues; the long-term effects of which may be detrimental while in the short run increased adult returns result.

**Literature Cited:**


Beckman B. R., B. Gadberry, P. Parkins, K. A. Cooper, and K. D. Arkush. 2007. State-dependent life history plasticity in Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*): interactions among photoperiod and growth modulate smolting and early male maturation. *Canadian Journal of Fisheries and Aquatic Science*. **64**(2): 256–271.

Beckman, B. R., B. A. Gadberry, P. Parkins, D. A. Larsen. 2008. The effect of Yakima River spring Chinook salmon sire life history type on emergence timing and size of progeny. *Transactions of the American Fisheries Society*, 137:1285-1291.

Hard, JJ, A.C. Wertheimer, W. R. Heard, R. M. Martin. 1985. Early male maturity in two stocks of chinook salmon (*Oncorhynchus tshawytscha*) transplanted to an experimental hatchery in southeastern Alaska. *Aquaculture* **48**: 351–359.

Heath, D.0., R.H. Devlin, W. Heath, and G.K. Iwama. 1994a. Genetic, environmental, and interaction effects on the incidence of jacking in Chinook salmon (*Oncorhynchus tshawytscha*). *Heredity*, 72, 146-154.

Heath, DD, Iwama, GK, Devlin, RH 1994b. DNA fingerprinting used to test for family effects on precocious sexual maturation in two populations of *Oncorhynchus tshawytscha* (chinook salmon). *Heredity* **73**: 616–624.

Heath, D.D., L. Rankin, C. A. Bryden, J. W. Heath and J. M. Shrimpton. 2002. Heritability and Y-chromosome influence in the jack male life history of Chinook salmon (*Oncorhynchus tshawytscha*). *Heredity* **89**, 311–317.

Iwamoto. R. N., B.A. Alexander, and W.K. Hershberger. 1984. Genotypic and environmental effects on the incidence of sexual precocity in coho salmon (Oncorhynchus kisutch). *Aquaculture*, 43, 105-121.

Larsen, D.A., Beckman, B.R., Strom, C.R., Parkins, P.J., Cooper, K.A., Fast, D.E., and Dickhoff, W.W. 2006. Growth modulation alters the incidence of early male maturation and physiological development of hatchery reared spring Chinook salmon: a comparison with wild fish. *Transactions of the American Fisheries Society.* 135, 1017-1032.

Ricker, *W.E.* 1981. Changes in the average size and average age of Pacific salmon. *Canadian Journal of Fisheris and Aquatic Science.* 38, pp. 1636–1656.

Thorpe, J E. 2007. Maturation responses of salmonids to changing developmental opportunities. *Mar Ecol Prog Ser* 335: 285–288.

Vøllestad, L.A., Peterson, J. & Quinn, T.P. 2004. Effects of freshwater and marine growth rates on early maturity in male coho and chinook salmon. *Transactions of the American Fisheries Society*, **133**, 495–503.

**FISH PASSAGE CENTER**
**1827 NE 44th Avenue, Suite 240, Portland, OR 97213**
Phone: (503) 230-4099 Fax: (503) 230-7559
http://www.fpc.org
e-mail us at fpcstaff@fpc.org

## DATA REQUEST FORM

**Request Taken By:** Michele DeHart **Date:** 28-Sept-09

**Data Requested By:**
**Name:** Tom Stuart **Phone:** 208 343-3017
**Address:** _____ **Fax:** _____
**Email:** tomstuart@cableone.

**Data Requested:**
Factors that may explain high fall chinook jack counts at LGR in 2009

**Data Format:** **Hardcopy** ☐ **Text** ☐ **Excel** ☐

**Delivery:** **Mail** ☐ **Email** ☑ **Fax** ☐ **Phone** ☐

**Comments:**
Request and Mem. attached

**Data Compiled By:** Jerry Mccann, Jack Tumikowski **Date:** 29-Oct-09

**Request #** 80