



## FISH PASSAGE CENTER

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### MEMORANDUM

TO: Fish Passage Advisory Committee

FROM: Michele DeHart

DATE: November 7, 2008

RE: Estimation of holdover proportion among PIT-tagged Snake River hatchery and wild fall Chinook, migration years 1997-2007

#### **Overview**

During the June 24, 2008 FPAC conference call, FPAC requested that the Fish Passage Center provide an update of information regarding trends in the prevalence of fall Chinook subyearling holdovers. An FPC memorandum dated May 10, 2005, addressed fall Chinook overwintering. That memorandum found that:

- Wild fall Chinook from the Clearwater River tend to have higher percentages of holdovers in their detection at the dams than do Snake River wild fall Chinook;
- Hatchery fall Chinook that are smaller fish tend to have higher percentages of holdovers in their detections at the dams;
- Later released (backfill) hatchery fall Chinook likewise have higher percentages of holdovers in their detections at the dams.

The earlier FPC memorandum suggested that the fall Chinook holdover phenomenon was likely due to hatchery and hydro-system management actions, such as fish size at time of release, and timing of hatchery release, as well as flow and spill passage provided.

The following is a summary of the findings from the analysis requested by FPAC on June 24, 2008. These findings largely support the findings of the earlier FPC memorandum. These summary points are followed by a more detailed discussion of methods and results.

- The prevalence of holdovers among wild Snake River and Clearwater River fall Chinook has decreased over recent years (Figure 1). From 1997-2003 the estimated holdover percent for wild Clearwater River fall Chinook ranged from 12.4% to 30.0%, whereas the percent holdovers from 2004-2007 only ranged from 12.8% to 15.4%. For wild Snake River fall Chinook the estimated holdover percent ranged from 4.5% to 15.7% in migration years 1997-2003, whereas recent migration years (2004-2007) ranged from 0.14% to 5.25%.
- Over the eight years where comparisons are possible (1998, 2001-2007), Clearwater River wild fall Chinook consistently had a higher estimated holdover percentage than Snake River wild fall Chinook. The estimated holdover percent for wild Clearwater River Chinook ranged from 4.66% to 30.0%, whereas that for wild Snake River Chinook ranged from 0.14% to 6.02%.
- Average spill proportion (in August) at Lower Granite Dam was found to have an effect on average holdover percent for Clearwater and Snake River wild fall Chinook. In general, as average daily spill proportion increased, percent holdovers for both Clearwater and Snake River wild fall Chinook decreased. This relationship was statistically significant for Clearwater wild fall Chinook ( $p < 0.1$ ) but not for Snake River wild fall Chinook.
- The prevalence of holdovers among hatchery Snake River and Clearwater River fall Chinook has also decreased in recent years (Figure 2). From 2000 to 2003, the estimated holdover percent for hatchery fall Chinook released from Big Canyon Creek acclimation pond in mid-May to early June ranged from 2.6% to 8.7%. From 2004 to 2007, these same releases resulted in an estimated holdover percentage that ranged from 0.0% to 0.42%. From 2000 to 2003, the mid-May to early June releases of hatchery fall Chinook from Captain Johns Landing and Pittsburg Landing acclimation facilities resulted in an estimated holdover percentage of 0.0% to 6.1%. These same releases from 2004 to 2007 had an estimated holdover percentage that ranged from 0.0% to 0.5%.
- It appears that later (mid-June to July) releases of hatchery Chinook from acclimation facilities on the Clearwater and Snake rivers had higher prevalence of holdovers than did earlier releases (May to early June) (Figure 2). Releases made from Big Canyon Creek and Captain John's Rapids in mid-June to early July generally resulted in estimated holdover percentages ranging from 5.4% to 14.8%, where as those made in mid-May to early June ranged from 0.00% to 8.71%. Beginning in 2004, these late season releases have been eliminated, which may be contributing to the observed decline in holdover prevalence in more recent years.
- In general hatchery fall Chinook released from acclimation facilities on the Clearwater River had higher estimated holdover percentage than did hatchery fall Chinook released from acclimation facilities on the Snake River. This was particularly true among the earlier releases made in mid-May to early June.
- Hatchery fall Chinook surrogates released into the Clearwater River had a much higher prevalence to holdover than did surrogates released into the Snake River. The estimated holdover percent for Snake River surrogates ranged from 0.0% to 0.7%, whereas that for Clearwater River surrogates ranged from 4.4% to 4.6% (Appendix B). The estimated holdover percent for Snake River surrogates were comparable to those seen for Snake

River wild fall Chinook while those for Clearwater surrogates were generally lower than those for wild Clearwater River fall Chinook.

- Among the years we analyzed, less than 25% of surviving hatchery, surrogate, and wild fall Chinook holdovers were first detected at LGR. Less than 25% of holdovers over-winter above LGR.
- In seven of the ten years analyzed, hatchery fall Chinook that out-migrated as holdovers returned as “jacks” at a higher rate than did hatchery fall Chinook that out-migrated as subyearlings. In these years, the percent of hatchery fall Chinook holdovers that returned as “jacks” ranged from 0.59% to 19.05%.

## **Prevalence of Holdovers:**

### **Methods:**

The analyses conducted for this data request relied on available PIT-tag data for hatchery and wild fall Chinook released above Lower Granite Dam (LGR) as subyearlings in migration years 1997 through 2007. It should be noted that, due to a switch to new PIT-tags and detectors in 2000, juveniles released in 1999 were excluded from this analysis because they could not have been detected in 2000. A holdover fall Chinook was considered to be any PIT-tagged juvenile that was detected at any of the FCRPS sites with PIT-tag detection capability as a yearling in the spring following their original out-migration year. Annual releases of Snake River and Clearwater River wild fall Chinook subyearlings were analyzed separately. Only migration years where greater than 350 PIT-tagged individuals were released were used for this analysis.

Releases of PIT-tagged hatchery fall Chinook subyearlings were analyzed based on proximity of release sites and release dates. Releases were categorized as being early, mid-season, or late depending on when they occurred. The FPC attempted to keep these windows as consistent as possible between the years analyzed. In general early releases were those releases made in mid-May to early June, mid-season releases were those releases from early June to mid-June, and late releases were those releases made from mid-June to early July.

For each release group, FPC staff estimated the proportion of the tagged release that was detected the following year as holdovers. However, because fall Chinook holdovers are detected the following spring as yearlings and because operations at the projects are variable, the FPC expanded the number of detections of holdovers based on estimates of the detection probability for yearling Chinook at each site. The detection probability of yearling Chinook for each site was based on PIT-tagged releases of spring Chinook yearlings from Rapid River Hatchery (Table 1). This methodology is not possible for years prior to 1997, due to insufficient PIT-tag detections at BON and JDA prior to that year. Finally, it should be pointed out that the estimates of holdover percent presented in this analysis are only those fish that survived the over-wintering period in order to out-migrate the following spring and be detected at the FCRPS projects. Therefore, these estimates do not include any over-wintering fall Chinook that died prior to out-migrating the following spring or those that out-migrated past FCRPS projects prior to the initialization of PIT-Tag detectors in early spring.

**Table 1.** Estimated detection probabilities of Rapid River hatchery yearling Chinook for each project and migration year analyzed. These estimates of detection probability were used to expand holdover detections at each site and year.

Migration Year		Estimated Yearling Chinook Detection Probability					
Subyearling Chinook	Yearling Chinook	LGR	LGS	LMN	MCN	JDA	BON
1997	1998	0.51	0.49	0.46	0.24	0.17	0.09
1998	1999	0.28	0.54	0.41	0.33	0.16	0.25
1999	2000	0.42	0.35	0.14	0.21	0.04	0.23
2000	2001	0.78	0.71	0.60	0.73	0.64	0.32
2001	2002	0.21	0.28	0.41	0.43	0.17	0.18
2002	2003	0.34	0.27	0.06	0.35	0.16	0.18
2003	2004	0.62	0.68	0.13	0.38	0.18	0.1
2004	2005	0.69	0.77	0.31	0.35	0.14	0.11
2005	2006	0.30	0.47	0.40	0.29	0.17	0.13
2006	2007	0.22	0.17	0.14	0.33	0.34	0.16
2007	2008	0.36	0.37	0.23	0.19	0.14	0.12

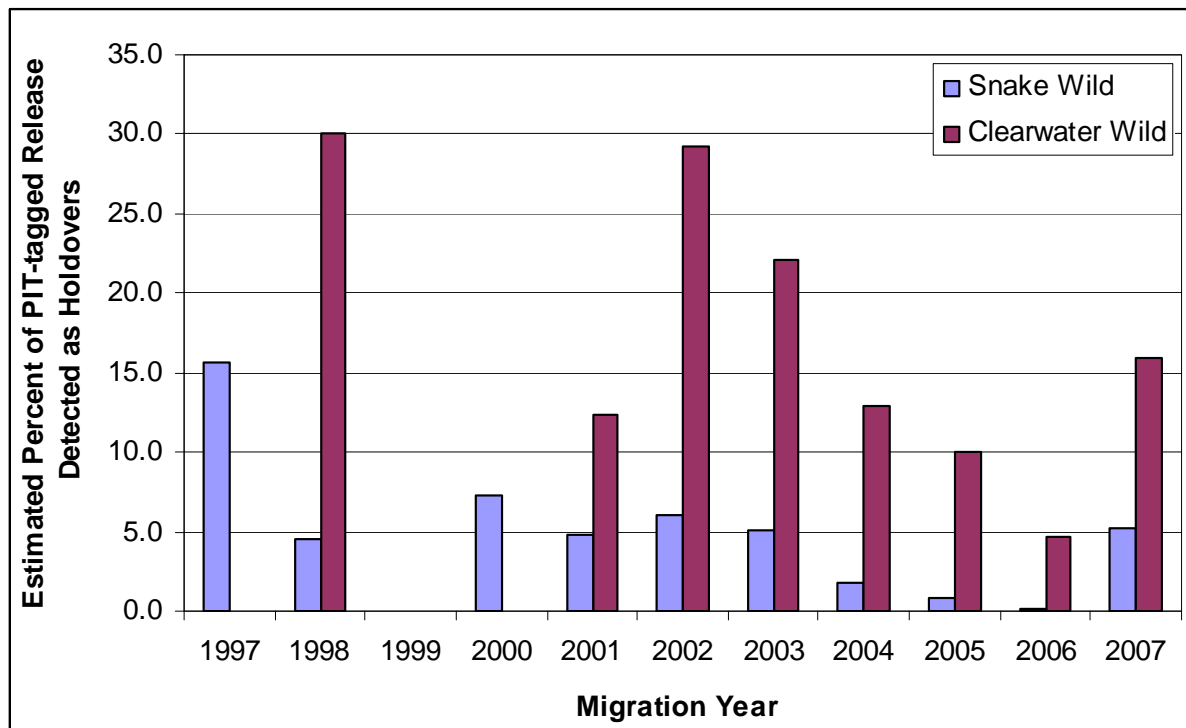
**Results:**

***PIT-tagged wild fall Chinook:***

Over the years presented in this analysis, the number of PIT-tagged wild fall Chinook subyearlings released in the Snake River (between Asotin and Hells Canyon Dam) has ranged from 641 in 1997 to 9,299 in 2005. Of the ten years in the FPC analysis (1997-1998, 2000-2007), five had an estimated holdover percent of 5.0% or less (Figure 1). Four of the years analyzed had an estimated holdover percent of 5.0% to 10.0% (Figure 1). In only one year (1997) was the estimated holdover percentage greater than 10% (estimated at 15.7%) for wild Snake River fall Chinook (Figure 1). In more recent years, the prevalence of wild subyearling Chinook holding over seems to have decreased. However, there was an increase in the estimated holdover percentage in MY 2007 compared to 2004-2006. The estimates of holdover percentage for each of the years analyzed can be found in Appendix A.

Of the 10 years we analyzed, migration years 1997 and 2000 did not have releases of greater than 350 PIT-tagged wild Clearwater River fall Chinook subyearlings. Therefore, these years were not included in this analysis. Of the eight years when PIT-tagging exceeded 350 wild Clearwater River subyearling Chinook, the PIT-tag release groups ranged from 395 in 1998 to 2,019 in 2005. Of these eight years, only 1 (2006) had an estimated holdover percent of less than 5% and zero had an estimated holdover percent between 5% and 10% (Figure 1). Four of the years analyzed had an estimated holdover percent between 10% and 20% (Figure 1). Finally, three of the years analyzed had an estimated holdover percent exceeding 20%, with a maximum estimate holdover percent of 30.0% in 1998 (Figure 1). As with Snake River wild subyearling Chinook, the prevalence of Clearwater River wild subyearling Chinook holding over has decreased in recent years. However, compared to 2004-2006, the estimated percent holdover for 2007 was high. Estimates of holdover percentage for each of the years analyzed can be found in Appendix A.

Given these estimates of holdover percentage, it is evident that there are major differences in holdover prevalence between Snake River and Clearwater River wild fall Chinook, with Clearwater River wild fall Chinook having a much higher prevalence of holding over.



**Figure 1.** Estimated percent of the PIT-tagged releases being detected as holdovers for Snake River and Clearwater River wild fall Chinook for migration years 1997-1998, 2000-2007. Fewer than 350 PIT-tagged wild subyearling Chinook were released in the Clearwater Rivers in 1997 and 2000. Therefore, these years were not analyzed. Actual estimates of holdover percent can be found in Appendix A.

To investigate whether the decrease in holdover prevalence among more recent years may have been affected by the initiation of voluntary summer spill in the Snake River in 2005, FPC staff conducted linear regression analysis. For these regression analyses, FPC staff compared the expanded estimates of percent holdovers (Appendix A) to the average spill percent at Lower Granite Dam in August. Separate analyses were done for Clearwater and Snake River wild fall Chinook.

For both Clearwater and Snake River wild fall Chinook, there was a negative relationship between August spill percent and percent holdovers, where higher August spill percent tended to result in lower percent holdovers (Figure 2). This relationship was statistically significant at the  $\alpha = 0.1$  level for Clearwater wild fall Chinook ( $p = 0.075$ ). Although the same relationship was present for Snake River fall Chinook, it was not significant at the  $\alpha = 0.1$  level ( $p = 0.145$ ).

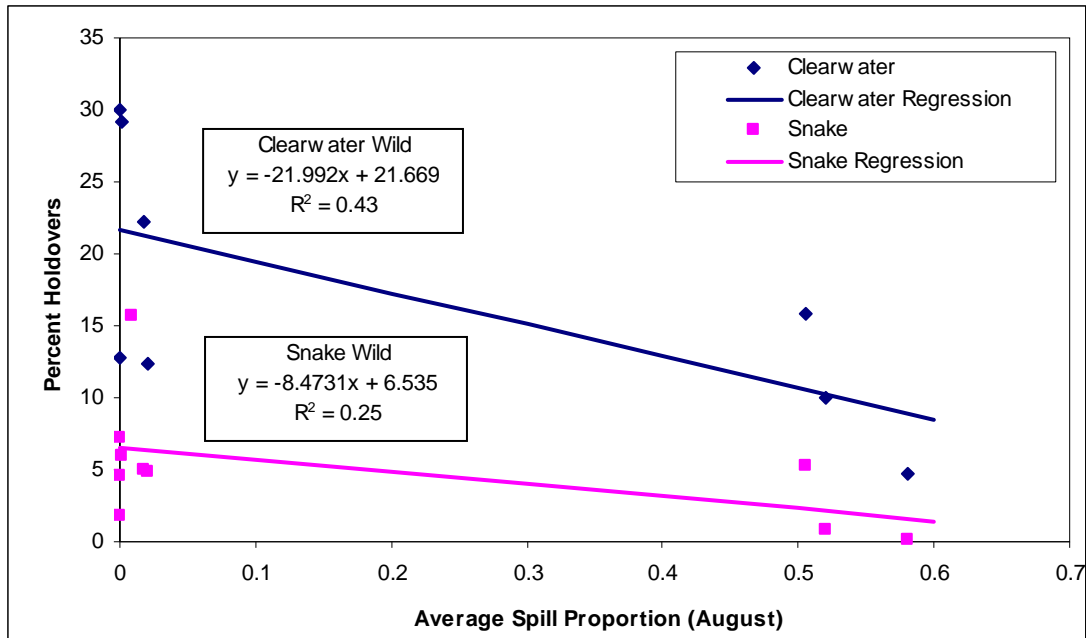


Figure 2. Linear regression analyses of average August spill proportion and percent holdovers for Clearwater and Snake River wild fall Chinook.

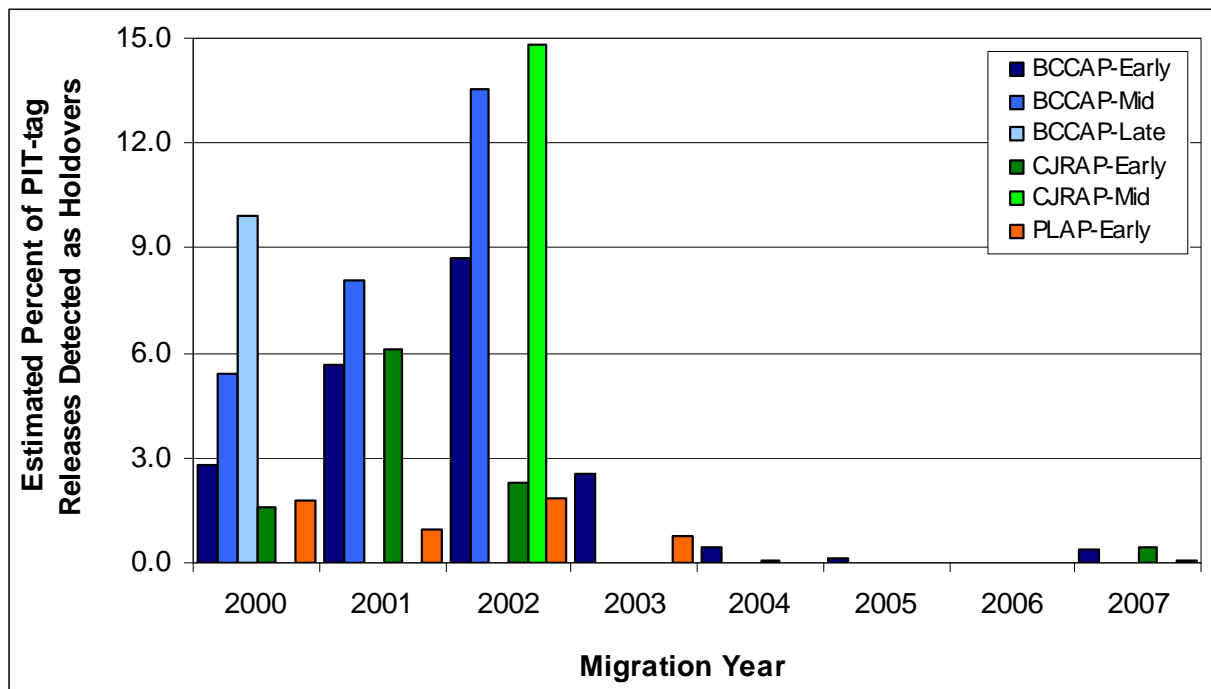
### *PIT-tagged hatchery fall Chinook*

PIT-tagging efforts of hatchery fall Chinook have increased substantially over the 10 years analyzed by the FPC. Of these releases, there have only been a few releases that have been consistent over the time frame presented in this analysis. These consistent releases include releases of PIT-tagged hatchery fall Chinook subyearlings to the Snake River from acclimation ponds at Captain Johns Rapids (River km 522.263) and Pittsburg Landing (River km 522.346) and to the Clearwater River from acclimation ponds at Big Canyon Creek (River km 522.057). Releases of PIT-tagged subyearling Chinook have taken place at these three sites since 2000. Furthermore, since 2002 there have been consistent releases of PIT-tagged hatchery fall Chinook subyearlings to the Snake River, just below Hells Canyon Dam. In more recent years, additional releases of PIT-tagged hatchery fall Chinook subyearlings have occurred from the Nez Perce Tribal Hatchery and other sites along the Clearwater River. There have been many research releases of PIT-tagged fall Chinook subyearlings to both the Snake and Clearwater River throughout the years. Finally, in 2005 and 2006, PIT-tagged surrogate fall Chinook subyearlings were released to both the Clearwater River (from Big Canyon Creek AP) and Snake River.

#### *Acclimation Facility Releases:*

Given their consistency over the past seven years, the releases of hatchery fall Chinook subyearlings from acclimation facilities on the Snake and Clearwater rivers provide a good time-series of data with which to look at holdover prevalence. Furthermore, in the early years, some of these sites made multiple releases as the season progressed. These multiple releases allow for an investigation as to whether there is a trend in holdover prevalence as releases occur later in the season.

As with wild subyearling Chinook, the prevalence of hatchery subyearling Chinook holding over has decreased in recent years. In fact, since migration year 2003, only one release of hatchery subyearling Chinook (BCCAP-2003) resulted in an estimated holdover percentage greater than 1% (Figure 2). Also, hatchery subyearling Chinook released from acclimation facilities on the Snake River (CJRAP or PLAP) tended to have a lower holdover percentage than did hatchery subyearling Chinook released from facilities on the Clearwater River (BCCAP) (Figure 2). This is a very similar to the pattern seen for wild subyearling Chinook from the Snake River versus those from the Clearwater River. When an acclimation facility made early, mid-, and/or late season releases, there was a tendency for the holdover percentage to increase as the releases progressed throughout the season (Figure 2). Appendix B provides a full listing of the estimates of holdover percentage for hatchery subyearling Chinook for each of the years analyzed.



**Figure 2.** Estimated percent of the PIT-tagged releases being detected as holdovers for hatchery subyearling Chinook released at acclimation facilities on the Snake River (CJRAP and PLAP) and Clearwater River (BCCAP) in migration years 2000-2007. The only late season releases from BCCAP occurred in 2000. There were no mid-season releases from BCCAP after 2002. MY 2002 was the only mid-season release from CJRAP. Actual estimates of holdover percent can be found in Appendix B.

*Other Noteworthy Releases of Hatchery Subyearling Chinook:*

As mentioned above, there have been consistent releases of PIT-tagged hatchery subyearling Chinook to the Snake River just below Hells Canyon Dam since 2002. These releases usually occur in late April to early May. No holdovers have ever been detected from these early releases since they began in 2002. However, approximately 21,500 PIT-tagged subyearling Chinook from Umatilla Hatchery were also released near this site on May 10, 2004. Of these, approximately 0.03% were detected as holdovers the following year (Appendix B).

In more recent years, additional releases of PIT-tagged hatchery fall Chinook to the Clearwater River have occurred from the Nez Perce Tribal Hatchery and other sites along the Clearwater River. Overall, these releases have resulted in fairly low estimates of holdover percentage (Appendix B). There was only one release (2003, Mid-season) that resulted in an estimated holdover percentage greater than 5% (Appendix B). The estimated holdover percentage for this year was 7.85%.

Finally, in 2005 and 2006, NOAA released hundreds of thousands of PIT-tagged hatchery fall Chinook surrogates into the Snake and Clearwater rivers. These surrogates are intentionally reared to a smaller size in order to more closely resemble wild fall Chinook juveniles. Compared to those released to the Clearwater River, the fall Chinook surrogates released to the Snake River had a much lower prevalence to holdover. The estimated holdover percent for Snake River surrogates ranged from 0.0 to 0.7%, whereas that for Clearwater River surrogates ranged from 4.40 to 4.57% (Appendix B). The estimated percent holdover for Snake River surrogates were comparable to those seen for Snake River wild fall Chinook while those for Clearwater surrogates were generally lower than those for wild Clearwater River fall Chinook.

## **Location of Holdovers**

### **Methods:**

Among the individuals that were determined to be known holdovers (i.e., PIT-tagged individuals with a detection at a juvenile detection facility in the spring following their original year of out-migration), FPC identified the site of first holdover detection. The purpose behind this analysis was to provide a rough idea of where known holdovers who survived to the following spring might be overwintering. It should be noted that this analysis only provides a rough estimate, as it is possible for a holdover to out-migrate through a project or several projects without being detected. However, we have accounted for some of this by expanding detections of surviving holdovers based on project specific detection probabilities of yearlings for each year. Assuming that fall Chinook holdovers have similar detection probabilities as yearling spring/summer Chinook out-migrants, this expansion provides an estimate of how many holdovers may have passed each project undetected.

Because it is difficult to determine if a surviving holdover that was first detected at a lower project overwintered directly above that project or several projects above, these data should be interpreted with caution. However, this uncertainty is not true for holdovers that were first detected at LGR, as these individuals must have overwintered in the Snake or Clearwater River above LGR. Given this, we will discuss these results in more detail. However, we provide estimates of the proportion of surviving holdovers that were first detected at each of the FCRPS projects in Tables 2 and 3 below. Caution should be used when interpreting some of these proportions, as some years had very low estimated numbers of holdovers to begin with and, therefore, sample sizes in these years are low.

### **Results:**

#### ***Hatchery and Surrogate Fall Chinook***



As mentioned above, the estimates of expanded numbers of holdovers and the proportion of holdover that were first detected at each of the FCRPS detection sites for hatchery and surrogate fall Chinook are presented in Table 2.

In only two of the ten years analyzed were more than 15% of all surviving holdovers first detected at LGR. These two years were 2005 and 2006, when 100% and 60.55% of Snake River hatchery Chinook holdovers were first detected at LGR, respectively. However, both of these years had extremely low numbers of estimated holdovers (3 in 2005 and 8 in 2006). These low estimates of holdovers are likely why the estimates of percent first detected at LGR are so high. In years where the estimated number of holdovers is greater than 50, the percent of surviving holdovers that were first detected at LGR ranged from 2.63% (1998) to 14.21% (2000) for Clearwater River hatchery Chinook and 3.42% (1998) to 14.76% (2000) for Snake River hatchery Chinook (Table 2). These results indicate that a very small proportion (<15%) of surviving hatchery fall Chinook holdovers overwinter above LGR. Therefore, it is likely that a significant proportion of hatchery fall Chinook partially migrate through the hydrosystem before overwintering somewhere in the hydrosystem.

The estimates of the proportion of surrogate fall Chinook holdovers that overwinter above LGR were slightly higher than that for hatchery fall Chinook (Table 2). The percent of surviving holdovers that were first detected at LGR ranged from 6.88% (2006) to 23.66% (2005) for Clearwater River surrogate fall Chinook. The range for Snake River surrogate fall Chinook was slightly larger but the maximum was very similar. The percent of surviving holdovers that were first detected at LGR ranged from 0.00% (2006) to 22.65% (2005) for Snake River surrogate fall Chinook. Although the maximum estimates were higher for surrogate fall Chinook, these results still indicate that a substantial portion of the surrogate fall Chinook holdovers partially migrate through the hydrosystem before overwintering somewhere in the hydrosystem. Finally, there does not seem to be a pattern in the percent of holdovers overwintering above LGR between Snake and Clearwater River hatchery and surrogate fall Chinook, as these percentages are quite similar between the two release regions within years.

**Table 2. Hatchery and Surrogate (gray rows) fall Chinook - Estimated proportion of surviving holdovers with first time detections (as holdovers) at each of FPRPS juvenile detection facilities. First time detects at LGR have been shaded for ease or presentation. Expansion of detected holdovers at LGR based on detection probability of hatchery yearling Chinook the following spring.**

Migration Year	Release River	Estimated Number of Surviving Holdovers (Expanded)	Percent of Holdovers with First Time Detect at:					
			LGR	LGS	LMN	MCN	JDA	BON
1997	CLWR	1,496	6.42	8.81	14.19	51.48	12.62	6.48
1997	SNAKE	3,713	7.33	8.93	16.27	43.38	10.17	13.93
1998	CLWR	2,038	2.63	11.44	25.94	24.69	28.41	6.89
1998	SNAKE	2,089	3.42	10.90	27.67	24.83	26.84	6.34
2000	CLWR	808	14.21	30.55	16.05	23.94	8.69	6.57
2000	SNAKE	253	14.76	24.04	19.68	27.61	7.76	6.16
2001	CLWR	1,959	6.23	29.33	19.22	21.55	13.58	10.00
2001	SNAKE	2,512	11.05	31.38	18.26	16.68	13.77	8.86
2002	CLWR	558	5.76	13.48	39.60	15.49	14.5	11.17
2002	SNAKE	7,521	6.65	17.07	31.07	16.63	19.46	9.12
2003	CLWR	331	7.74	15.57	45.67	9.48	18.62	2.93
2003	SNAKE	347	10.37	11.35	48.93	11.29	12.09	5.97
2004	CLWR	28	5.08	0.00	22.74	20.20	51.98	0.00
2004	SNAKE	1	0.00	100.00	0.00	0.00	0.00	0.00
2005	CLWR	3	100.00	0.00	0.00	0.00	0.00	0.00
2005	SNAKE	5	0.00	45.68	54.32	0.00	0.00	0.00
2005	CLWR-Surr	2,093	23.66	22.41	21.25	10.60	17.66	4.41
2005	SNAKE-Surr	73	22.65	20.29	20.68	4.76	0.00	31.63
2006	CLWR	8	60.55	0.00	0.00	39.45	0.00	0.00
2006	SNAKE	86	10.75	6.89	8.62	21.01	30.41	22.31
2006	CLWR-Surr	4,824	6.88	15.57	25.59	16.75	22.78	12.43
2006	SNAKE-Surr	164	0.00	7.19	40.46	14.61	29.98	7.76
2007	CLWR	209	2.68	11.61	8.17	15.06	31.47	31.01
2007	SNAKE	16	0.00	33.94	0.00	66.06	0.00	0.00

### **Wild Fall Chinook**

As with the hatchery and surrogate fall Chinook, the estimates of expanded numbers of holdovers and the proportion of holdover that were first detected at each of the FCRPS detection sites for wild fall Chinook are presented in the table below (Table 3).

In only two of the ten years analyzed were more than 20% of all surviving holdovers first detected at LGR. These two years were 1997 and 1998, when 23.38% and 23.00% of Snake River wild Chinook holdovers were first detected at LGR, respectively. Among the 10 years analyzed for Snake River wild fall Chinook, one (2006) had very low estimates of surviving holdovers (n = 3). Among the 9 years where holdover estimated were greater than 50, the percent of surviving holdovers that were first detected at LGR ranged from 0.00% (2001) to 23.38% (1997) for Snake River wild fall Chinook (Table 3). For Clearwater River wild Chinook, there were only eight years of available data for this analysis. All 8 years had estimates of holdovers of greater than 50. For Clearwater River wild fall Chinook, the percent of surviving holdovers that were first detected at LGR ranged from 3.27% (2003) to 18.87% (2002).

As with hatchery and surrogate fall Chinook holdovers, these results indicate that a small proportion of surviving wild fall Chinook holdovers overwinter above LGR. Therefore, it is likely that a significant proportion of wild fall Chinook partially migrate through the hydrosystem before overwintering somewhere in the hydrosystem. Finally, there was some evidence that a larger proportion of Clearwater River wild fall Chinook holdovers overwinter above LGR than do Snake River wild fall Chinook holdovers.

**Table 3. Wild fall Chinook - Estimated proportion of surviving holdovers with first time detections (as holdovers) at each of FPRPS juvenile detection facilities. First time detects at LGR have been shaded for ease or presentation. Expansion of detected holdovers at LGR based on detection probability of hatchery yearling Chinook the following spring.**

Migration Year	Release River	Estimated Number of Surviving Holdovers (Expanded)	Percent of Holdovers with first time detect at:					
			LGR	LGS	LMN	MCN	JDA	BON
1997	CLWR	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1997	SNAKE	101	23.38	6.15	8.61	45.29	5.86	10.71
1998	CLWR	119	12.04	18.74	6.22	38.83	20.79	3.38
1998	SNAKE	93	23.00	17.89	18.49	23.07	13.23	4.31
2000	CLWR	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2000	SNAKE	88	8.78	23.05	30.19	26.47	7.97	3.54
2001	CLWR	61	8.00	39.23	4.01	19.22	11.71	17.83
2001	SNAKE	67	0.00	0.00	18.23	27.99	21.32	32.46
2002	CLWR	139	18.87	16.20	22.65	24.81	13.40	4.07
2002	SNAKE	145	6.06	18.21	32.74	17.93	17.22	7.84
2003	CLWR	147	3.27	11.02	51.42	12.46	15.25	6.59
2003	SNAKE	240	0.67	4.91	63.01	7.63	11.68	12.11
2004	CLWR	259	10.57	17.07	33.63	18.81	19.93	0.00
2004	SNAKE	99	2.92	6.60	32.75	26.19	22.46	9.08
2005	CLWR	190	17.42	30.11	18.57	9.15	12.58	12.17
2005	SNAKE	75	4.43	17.01	26.97	4.65	16.00	30.94
2006	CLWR	74	12.45	23.96	19.97	16.22	27.41	0.00
2006	SNAKE	3	0.00	0.00	0.00	100.00	0.00	0.00
2007	CLWR	267	6.30	8.08	9.60	25.57	10.96	39.49
2007	SNAKE	215	6.52	3.76	15.88	19.52	20.40	33.92

## Returns of “Jacks”

### Methods:

The FPC also conducted an analysis to determine whether holdover fall Chinook return more frequently as jacks than do juvenile fall Chinook that out-migrate as subyearlings. This analysis relied on the same PIT-tag data as the analyses above. A substantial proportion of every release is never detected at any of the juvenile detection sites after release. Given that there are no detections, it is impossible to determine if adults that return from these undetected juveniles were holdovers or out-migrated as subyearlings. Therefore, adult returns of juveniles with no juvenile detections were not included in this analysis. As above, a holdover fall Chinook was considered to be any PIT-tagged juvenile that was detected at any of the FCRPS sites with PIT-tag detection capability as a yearling in the spring following their original out-migration year. A non-holdover was considered to be any PIT-tagged juvenile that was detected at any of the

FCRPS sites with PIT-tag detection capability as a subyearling and no detections the following spring as a yearling. For non-holdovers, we considered all adults that were detected at the BON, MCN, and/or LGR adult detection sites in the fall, in either their year of their out-migration (i.e., 0-ocean) or one year after their out-migration (i.e., 1-ocean) as “jacks”. For holdovers, only adults that were detected at the BON, MCN, and/or LGR adult detection sites in the fall of the year that they out-migrated as a yearling (i.e., 0-ocean) we considered “jacks”. Holdover fall Chinook that return after 1 year in the ocean are likely to be large enough to not be included in the jack counts at the dams.

For each life-history (holdover or non-holdover), FPC staff estimated the proportion of the detected juveniles that returned as “jacks”. This was done for hatchery, wild, and surrogate fall Chinook separately. All release sites (Clearwater River and Snake River) were combined for this analysis.

### **Results:**

For each of the groups we analyzed (hatchery, wild, and surrogate fall Chinook), estimates of the percent of holdovers and non-holdovers that returned as “jacks” are summarized in Table 4.

In seven of the years analyzed (1997-1998, 2001-2003, 2006-2007), a higher proportion of hatchery holdover fall Chinook returned as “jacks” than did hatchery Chinook that out-migrated as subyearlings (Table 4). Over these years, the percent of hatchery holdovers that returned as “jacks” ranged from 0.59% to 19.05%, whereas the percent of non-holdovers that returned as “jacks” ranged from 0.06% to 0.31%. In the remaining three years (2000, 2004, and 2005) there were no returns of “jacks” from hatchery fall Chinook juveniles that out-migrated as holdovers. In these years, the percent of non-holdovers returning as “jacks” ranged from 0.02% to 0.35%.

In two of the years analyzed (1997 and 2000), there were no returns of “jacks” from juveniles that out-migrated as holdovers or as subyearlings (Table 4). In two of the years analyzed (2001 and 2007), a higher proportion of the wild holdover fall Chinook returned as “jacks” than did wild Chinook that out-migrated as subyearlings. Over these years, the percent of wild Chinook holdovers that returned as “jacks” ranged from 2.25% to 2.78%, whereas only 0.36% to 0.48% of non-holdovers returned as “jacks”. In the remaining six years (1998, 2002-2006) there were no returns of “jacks” from wild fall Chinook juveniles that out-migrated as holdovers. However, in these years, the percent of non-holdovers returning as “jacks” ranged from 0.08% to 0.25%.

Finally, of the years analyzed, only two had releases of surrogate fall Chinook (2005 and 2006). In both of these years, a higher proportion of the surrogate fall Chinook that out-migrated as holdovers returned as “jacks” than did those that out-migrated as subyearlings. The estimated percent of surrogate hatchery fall Chinook holdovers that returned as “jacks” ranged from 0.85 to 1.31%, whereas only 0.12% to 0.21% of non-holdovers returned as “jacks”.

**Table 4. Estimated percent of hatchery, wild, and surrogate holdover and non-holdover juvenile fall Chinook that returned as “jacks”.**

<b>Migration Year</b>	<b>Rearing Type</b>	<b>Number of Holdovers</b>	<b>Percent of Holdovers Returning as “Jacks”</b>	<b>Number of Non-holdovers</b>	<b>Percent of Non-holdovers Returning as “Jacks”</b>
1997	Hatchery	1,518	0.59	28,634	0.07
1997	Wild	32	0.00	190	0.00
1998	Hatchery	1,320	1.89	39,103	0.08
1998	Wild	71	0.00	1121	0.18
2000	Hatchery	702	0.00	5,390	0.35
2000	Wild	58	0.00	448	0.00
2001	Hatchery	1,261	2.22	38,557	0.22
2001	Wild	36	2.78	281	0.36
2002	Hatchery	1,549	1.48	28,245	0.29
2002	Wild	61	0.00	2,032	0.13
2003	Hatchery	186	1.61	62,221	0.06
2003	Wild	84	0.00	2,001	0.25
2004	Hatchery	8	0.00	10,117	0.04
2004	Wild	134	0.00	2,556	0.08
2005	Hatchery	3	0.00	13,054	0.02
2005	Surrogate	709	0.85	27,780	0.12
2005	Wild	84	0.00	1,956	0.10
2006	Hatchery	23	17.39	91,640	0.31
2006	Surrogate	1,146	1.31	64,215	0.21
2006	Wild	19	0.00	830	0.12
2007	Hatchery	42	19.05	9,549	0.06
2007	Wild	89	2.25	833	0.48

# APPENDIX A

Estimated holdover percentages for wild subyearling Chinook tagged and released in the Snake and Clearwater rivers (MY 1997-2007). Only those releases of greater than 350 tagged juveniles were analyzed.

Snake River wild fall Chinook			Clearwater wild fall Chinook		
Migration Year	Tags Released	Percent Holdover	Migration Year	Tags Released	Percent Holdover
1997	641	15.69	1997	---	---
1998	2060	4.52	1998	395	30.01
2000	1213	7.26	2000	---	---
2001	1392	4.80	2001	492	12.37
2002	2405	6.02	2002	478	29.17
2003	4742	5.06	2003	663	22.16
2004	5534	1.78	2004	2019	12.84
2005	9299	0.80	2005	1883	10.06
2006	2154	0.14	2006	1588	4.66
2007	4096	5.25	2007	1682	15.88

## APPENDIX B

Estimated holdover percentages for hatchery subyearling Chinook tagged and released in the Snake and Clearwater rivers (MY 1997-2007). Releases of hatchery Chinook are broken by migration year, release location, release type (e.g., research, acclimation, surrogate), and time of release (e.g., early, mid-season, and late). Release Times: E = Early Season, M = Mid-Season, and L = Late Season. Shaded cells represent those release sites on the Clearwater River while un-shaded cells are release sites on the Snake River.

### Migration Year 1997, detected as holdovers in 1998

Release Site(s)	River Kilometer(s)	CoordID(s)	Release Time (Date Range)	Number Released	Percent Holdovers
CLWR	522.057	BDA, RNI	E (5/15-6/8)	5,190	3.73
CLWR	522.057	BDA, RNI, WPC	M (6/9-6/18)	20,209	3.84
CLWR	522.057	BDA, RNI	L (6/19-7/8)	14,588	3.61
SNAKER	522.265	WPC	E (5/15-6/8)	1,253	1.32
SNAKER	522.265	RNI, WPC	M (6/9-6/18)	2,505	7.70
SNAKER	522.265	RNI, WPC	L (6/19-7/8)	3,749	15.65
SNAKER	522.346	RNI	E (5/15-6/8)	15,220	3.32
SNAKER	522.346	RNI, WPC	M (6/9-6/18)	23,301	8.72
SNAKER	522.346	RNI	L (6/19-7/8)	3,765	10.08

### Migration Year 1998, detected as holdovers in 1999

Release Site(s)	River Kilometer(s)	CoordID(s)	Release Time (Date Range)	Number Released	Percent Holdovers
CLWR	522.057	BDA	E (5/15-6/2)	5,090	0.89
CLWR	522.057	BDA, WDM	M (6/3-6/16)	10,459	3.27
CLWR	522.057	BDA, WDM	L (6/17-7/7)	15,969	10.34
SNAKER	522.265, 522.270	WDM	E (5/15-6/2)	1,262	1.05
SNAKER	522.265, 522.270	WDM	M (6/3-6/16)	16,648	2.63
SNAKER	522.265, 522.270	WDM	L (6/17-7/7)	3,774	5.35
SNAKER	522.346	WDM, WPC	E (5/15-6/2)	7,014	0.38
SNAKER	522.346	WDM	M (6/3-6/16)	2,525	5.59
SNAKER	522.346	WDM, WPC	L (6/17-7/7)	22,285	5.69

**Migration Year 2000, detected as holdovers in 2001**

<b>Release Site(s)</b>	<b>River Kilometer(s)</b>	<b>CoordID(s)</b>	<b>Release Time (Date Range)</b>	<b>Number Released</b>	<b>Percent Holdovers</b>
BCCAP	522.224.057	BDA	E (5/25-6/8)	1,014	2.83
BCCAP	522.224.057	BDA	M (6/9-6/23)	5,169	5.41
BCCAP	522.224.057	BDA	L (6/24-7/13)	5,026	9.94
CJRAP	522.263	BDA	E (5/25-6/8)	1,001	1.56
SNAKER	522.266	WDM	E (5/25-6/8)	2,490	3.06
SNAKER	522.266	WDM	M (6/9-6/23)	2,479	1.90
SNAKER	522.266	WDM	L (6/24-7/13)	2,487	1.77
PLAP	522.346	BDA	E (5/25-6/8)	1,001	1.76
SNAKER	522.346	WDM	E (5/25-6/8)	2,488	0.78
SNAKER	522.346	WDM	M (6/9-6/23)	2,487	0.65
SNAKER	522.346	WDM	L (6/24-7/13)	2,474	0.70

**Migration Year 2001, detected as holdovers in 2002**

<b>Release Site(s)<sup>1</sup></b>	<b>River Kilometer(s)</b>	<b>CoordID(s)</b>	<b>Release Time (Date Range)</b>	<b>Number Released</b>	<b>Percent Holdovers</b>
BCCAP (BCCAP)	522.224.057	BDA	E (5/18-6/2)	2027	5.67
BCCAP (LYFE)	522.224.057	BDA	E (5/18-6/2)	3956	5.36
BCCAP (BCCAP)	522.224.057	BDA	M (6/3-6/16)	2495	8.08
BCCAP (LYFE)	522.224.057	BDA	M (6/3-6/16)	7702	6.31
BCCAP (LYFE)	522.224.057	BDA	L (6/17-7/4)	11966	7.90
SNAKER	522.254	DMM	E (5/18-6/2)	74242	3.02
CJRAP	522.263	BDA	E (5/18-6/2)	1998	6.13
SNAKER	522.265	WDM	E (5/18-6/2)	1871	2.80
SNAKER	522.265	WDM	M (6/3-6/16)	2494	0.65
SNAKER	522.265	WDM	L (6/17-7/4)	2494	0.62
PLAP (PLAP)	522.346	BDA	E (5/18-6/2)	1974	0.96
SNAKER, PLAP (LYFE)	522.346	WDM	E (5/18-6/2)	2490	1.01
PLAP (LYFE)	522.346	WDM	M (6/3-6/16)	2494	0.22
PLAP (LYFE)	522.346	WDM	L (6/17-7/4)	2489	0.24

<sup>1</sup> Tag site in parentheses to distinguish between multiple releases from same site for different purposes



**Migration Year 2002, detected as holdovers in 2003**

Release Site(s) <sup>1</sup>	River Kilometer(s)	CoordID(s)	Release Time (Date Range)	Number Released	Percent Holdovers
BCCAP	522.224.057	SJR	E (5/24-6/8)	2,499	8.71
BCCAP	522.224.057	SJR	M (6/9-6/18)	2,517	13.53
SNAKE3	522.254	DMM	E (5/24-6/8)	54,105	5.91
SNAKE3	522.254	DMM	M (6/9-6/18)	43,809	7.14
CJRAP	522.263	SJR	E (5/24-6/8)	2,507	2.26
CJRAP	522.263	SJR	M (6/9-6/18)	2,517	14.79
SNAKER	522 - 522.265	WDM, HLB	E (5/24-6/8)	2,844	8.08
SNAKER	522 - 522.265	WDM, HLB	M (6/9-6/18)	2,610	6.98
SNAKER	522 - 522.265	WDM, HLB	L (6/19-7/2)	2,514	7.28
PLAP	522.346	SJR	E (5/24-6/8)	2,539	1.86
PLAP (LYFE)	522.346	WDM	E (5/24-6/8)	3,142	1.67
PLAP (LYFE)	522.346	WDM	M (6/9-6/18)	2,370	1.96
PLAP (LYFE)	522.346	WDM	L (6/19-7/2)	1,842	1.51
HCD	522.397	DTV	E (5/21)	999	0.00

<sup>1</sup> Tag site in parentheses to distinguish between multiple releases from same site for different purposes

**Migration Year 2003, detected as holdovers in 2004**

Release Site(s) <sup>1</sup>	River Kilometer(s)	CoordID(s)	Release Time (Date Range)	Number Released	Percent Holdovers
NLVP, NPTH	522.224.019 - .038	BDA	E (5/22-6/8)	5,819	1.37
NPTH	522.224.019 - .038	BDA	M (6/9-6/20)	2,386	7.96
BCCAP	522.224.057	SJR	E (5/22-6/8)	2,495	2.56
SNAKE3	522-522.254	DMM, WDM	E (5/22-6/8)	53,581	0.37
SNAKE3, SNAKER	522-522.254	DMM, WDM, HLB	M (6/9-6/20)	3,335	2.05
CJRAP	522.263	SJR	E (5/22-6/8)	2,498	0.00
PLAP (PLAP)	522.346	SJR	E (5/22-6/8)	2,492	0.78
PLAP (LYFE)	522.346	WDM	E (5/22-6/8)	14,991	0.26
SNAKE4	522.395	DTV	E (5/22-6/8)	9,970	0.00

<sup>1</sup> Tag site in parentheses to distinguish between multiple releases from same site for different purposes

**Migration Year 2004, detected as holdovers in 2005**

Release Site(s)	River Kilometer(s)	CoordID(s)	Release Time (Date Range)	Number Released	Percent Holdovers
NPTH	522.224.038	BDA	E (5/28-6/4)	2,615	0.69
BCCAP	522.224.057	SJR	E (5/28-6/4)	2,490	0.42
CJRAP	522.263	SJR	E (5/28-6/4)	2,493	0.05
PLAP	522.346	SJR	E (5/28-6/4)	2,496	0.00
HCD	522.397	DTV	E (5/28-6/4)	9,915	0.00

**Migration Year 2005, detected as holdovers in 2006**

Release Site(s) <sup>1</sup>	River Kilometer(s)	CoordID(s)	Release Time (Date Range)	Number Released	Percent Holdovers
BCCAP (BCCAP)	522.224.057	SJR	E (5/15-6/2)	2,498	0.13
BCCAP (DWOR) <sup>2</sup>	522.224.057	DMM	L (6/21-7/8)	45,790	4.57
SNAKE3 (DWOR) <sup>2</sup>	522.253	DMM	E (5/15-6/2)	124,447	0.06
SNAKER	522.254	MLS	E (5/15-6/2)	3,465	0.13
CJRAP	522.263	SJR	E (5/15-6/2)	3,494	0.00
PLAP	522.346	SJR	E (5/15-6/2)	2,492	0.00
SNAKE4	522.395	DTV	E (4/28)	9,972	0.00

<sup>1</sup> Tag site in parentheses to distinguish between multiple releases from same site for different purposes

<sup>2</sup> Tag site of DWOR identifies releases of surrogate hatchery fall Chinook

**Migration Year 2006, detected as holdovers in 2007**

Release Site(s) <sup>1</sup>	River Kilometer(s)	CoordID(s)	Release Time (Date Range)	Number Released	Percent Holdovers
NPTH	522.224.038	BDA	M (6/3-6/18)	3,002	0.15
BCCAP (LYFE)	522.224.057	SJR	E (5/2-6/2)	2,500	0.00
BCCAP (LYFE)	522.224.057	DMM	E (5/2-6/2)	55,840	0.05
BCCAP (DWOR) <sup>2</sup>	522.224.057	DMM	L (6/19-7/10)	109,491	4.40
CEFLAF, LUGUAF	522.224.120	BDA	M (6/3-6/18)	9,772	0.03
SNAKE3 (DWOR) <sup>2</sup>	522.234-522.254	DMM	E (5/2-6/2)	224,896	0.07
SNAKE3 (DWOR) <sup>2</sup>	522.234-522.254	DMM	M (6/3-6/18)	4,167	0.00
SNAKE3 (LYFE)	522.253-522.254	DMM, MLS	E (5/2-6/2)	15,479	0.07
SNAKE3 (LYFE)	522.253-522.254	DMM, MLS	L (6/19-7/10)	10,872	0.06
CJRAP	522.263	SJR	E (5/2-6/2)	3,487	0.00
COUGRC	522.271	DMM	L (6/19-7/10)	25,357	0.12
PLAP (UMAH)	522.346	SJR	E (5/2-6/2)	2,500	0.00
PLAP (UMAH)	522.346	DMM	E (5/2-6/2)	24,396	0.01
SNAKE4 (OXBO)	522.395	DTV	E (5/2-6/2)	12,083	0.00
HCD (UMAH)	522.397	DMM	E (5/2-6/2)	21,534	0.03

<sup>1</sup> Tag site in parentheses to distinguish between multiple releases from same site for different purposes

<sup>2</sup> Tag site of DWOR identifies releases of surrogate hatchery fall Chinook

**Migration Year 2007, detected as holdovers in 2008**

Release Site(s)	River Kilometer(s)	CoordID(s)	Release Time (Date Range)	Number Released	Percent Holdovers
NLVP	522.224.019	BDA	E (5/8-5/25)	3,090	0.00
NPTH	522.224.038	BDA	M (5/26-6/15)	3,095	2.31
BCCAP	522.224.057	BDA	E (5/8-5/25)	2,891	0.37
CEFLAF, LUGUAF	522.224.120	BDA	M (5/26-6/15)	6,192	2.05
CJRAP	522.263	BDA	E (5/8-5/25)	2,892	0.46
PLAP	522.346	BDA	E (5/8-5/25)	2,889	0.09
SNAKE4	522.395	DTV	E (5/8-5/25)	9,969	0.00