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MEMORANDUM

TO: Rod Sando
Curtis Michael, BPA.gov
FPAC

FROM: Michele DeHart

DATE: July 2, 2009

RE: High spring Chinook jack counts in 2009

The FPC received two requests regarding the jack counts recorded in 2009. We combined the responses to both of the requests into one response. In response to your request for an explanation for unusually high spring Chinook jack counts that occurred in 2009, the FPC staff reviewed historical count data, available literature regarding the jack life history, counting procedures and historic data that could provide some insight into the unusually high jack counts in 2009. Jack counts have been used as a predictor of subsequent year adult returns and have significant fishery management implications. **As a result of our review we could not conclude that a single factor was responsible for generating the high jack return observed in 2009. However, several of the factors described in the following discussion could be occurring at the same time resulting in the observed return. Three broad categories of potential actions could affect the production of jacks; hatchery practices, count procedures, and an actual high proportion of jacks returning from the 2008 outmigration**. In addition you requested that we specifically investigate the possibility that small adult salmon are being counted and recorded as jacks. Below are the conclusions of our review, followed by a detailed discussion of each point.

- Research shows that the production of jacks is related to rapid growth rate as juveniles. This can be modulated by hatchery practices. In addition research

shows that jacks that spawn successfully naturally are likely to produce a higher proportion of jacks. Hatchery jacks spawning with wild or naturally spawning populations could affect the proportion of jacks in the wild population.

- Jack rates for PIT Tagged Snake, Mid-Columbia, and Lower Columbia wild and hatchery/supplementation spring/summer Chinook are extremely variable. In addition to annual variation between years for both wild and hatchery/supplementation Chinook, jack rates for hatchery Chinook are also variable between groups.
- Of the hatchery/supplementation PIT Tagged Snake River spring/summer Chinook stocks we analyzed, the groups with the highest average jack rates were those released from the Lostine Acclimation Pond and the Imnaha Acclimation Pond.
- Jack rates of Snake River wild spring/summer PIT Tagged Chinook are also variable but do not show an increase in the magnitude observed in hatchery mark groups.
- John Day River, PIT Tagged wild spring/summer Chinook jack rates are variable but do not show an increase of the magnitude seen in hatchery marked groups.
- Jack rates of wild PIT Tagged spring/summer Chinook are generally lower than the jack rates for hatchery/supplementation spring/summer Chinook**.**
- When compared to the Snake River returns, Willamette River spring Chinook jack returns have not increased dramatically in recent years.
- Because spring/summer Chinook jack returns are highly variable and may reflect hatchery practices or environmental effects, they may not provide a reliable basis for predicting subsequent year's adult returns.
- Counting procedures at dams determine jacks by visual observation of size criteria. Counting small adults as jacks could inflate the jack count. Although it is possible that small adult fish could be counted as jacks, review of limited scale sampling and aging data at Bonneville Dam indicates that, at Bonneville Dam the jack count correlates with the limited scale aging data available for that project. However, this data should be considered with caution since modification of sampling which occurred at the project that may have biased sampling. Verification of count data by scale aging is not available at other projects.

Counting procedures at dams; small adults counted as jacks

Classification of jack versus adult spring/summer Chinook at hydroelectric project counting facilities is based on a visual estimation of size by the individual counting personnel. The counting criteria vary at projects as indicated in Table 1. Validation of visual size at age estimates, through scale sampling, is limited. Review of count data revealed the possibility that small adult fish could be counted as jacks. For example, the Chinook adult and jack counts at Ice Harbor and Lower Monumental Dam in 2009 demonstrate the potential difficulty in distinguishing between adults and jacks. As of June 29, 2009, a total of 106,176 combined jack and adult Chinook were counted at Ice Harbor Dam. Of this total, 70,561 Chinooks were

adults and 35,615 were jacks. At Lower Monumental Dam, the total combined adult and jack Chinook were similar at 109,776, however a higher number were recorded as adults (83,683) and a lower number were counted as jacks (26,093). Although the total combined adult and jack Chinook were similar at Ice harbor and Lower Monumental Dams, the number counted as adults and jacks differed between projects. It is possible that, when a fish came through the window that was close to the 22" adult/jack criteria, one project tended to count these fish as jacks while the other tended to call them adults. Making this differentiation would be especially difficult if numerous fish near the 22" criteria were to pass the count window simultaneously.

Table 1. Adult and Jack Salmon Length Classifications for Columbia and Snake River Dams' Fish Counts

Entity	Jack Chinook Length Used	Adult Chinook Length Used	Jack Coho Length Used	Adult Coho Length Used
USACE –	12" – 22"	>22"	12" – 18"	>18"
Grant PUD –	<22"	≥22"	<20"	≥20"
Chelan PUD –	12-24"	≥24"	<20"	≥20"
Douglas PUD	12" – 22"	>22"	not assessed	any coho
ODFW (Willamette Falls)	15"-22"	>22"	<18"	>18"

During the fish passage season (April through October) the COE uses visual counting from 0400-2000 PST, during periods with daylight savings time this time is actually 0500 to 2100. The COEs QA/QC program involves a one hour test each month for all fish counters. During this test, both the tested fish counter and the WDFW fish count supervisor each count each species passing for one hour. The tested fish counter must score within 95% of the counts recorded by the fish count supervisor for all species other than shad which is within 85%. According to WDFW fish count supervisors, falling below the 95% or 85% criteria is rare. Most deviations tend to occur when differentiating between jacks and adults that are near the size criteria.

In addition differing counting criteria exist among projects. (FPC memo Sept 2008) This resulted in count differences of fall Chinook jacks in 2008. Priest Rapids (PRD) and Wanapum Dam (WAN) have been including mini-jacks in their daily jack counts since 2006. PRD and WAN are the only projects that include mini-jacks in their jack counts. The high jack counts observed at PRD in 2008 were primarily due to increased numbers of mini-jacks included in the count in 2008. Therefore, extreme caution should be used when trying to use these jack counts to predict adult returns in future years.

The determination of whether a spring Chinook is an adult or "jack" is made by direct fish counting at the federal dams based on the length of the fish. All fish

counting windows have increments of length marked on the windows and these are used by the fish counters to assess whether a fish falls into the jack or adult category. However, it is possibile that some small 2-ocean and 3-ocean fish in the population might be counted as jacks. This could result in an overestimate of jacks passing the project.

In order to determine if the 2009 jack proportion in the population is an effect of incorrect visual observation we assessed the historic and present dam counts at Bonneville Dam. We used these data to compare with the scale pattern analysis that has been conducted annually since 1998 by the Columbia River Inter-tribal fish Commission. In addition, the Willamette Dam counts were reviewed to determine if the same pattern of increasing jack counts was apparent in this group of fish.

Bonneville Dam Counts

The Bonneville Dam counts for adult fish reach back to 1938. However, the adult population was only separated into jack and adult Chinook since 1960.

Table 2. Bonneville Dam counts for spring Chinook over the historic record and the proportion of spring Chinook jacks counted.

Year	Total SpCh	SpCh Jacks	Prop. Jacks	Year	Total SpCh	SpCh Jacks	Prop. Jacks
2009	181174	66630	0.37	**1984**	51142	4272	0.08
2008	143097	17554	0.12	**1983**	56838	1940	0.03
2007	84342	16860	0.20	**1982**	76044	6033	0.08
2006	99364	2908	0.03	**1981**	65009	2182	0.03
2005	78326	4288	0.05	**1980**	60987	7887	0.13
2004	179037	8885	0.05	**1979**	51462	2824	0.05
2003	206268	14258	0.07	**1978**	149863	2183	0.01
2002	275290	6477	0.02	**1977**	119508	3957	0.03
2001	405539	14172	0.03	**1976**	113448	20835	0.18
2000	199561	21259	0.11	**1975**	104104	6238	0.06
1999	47360	8691	0.18	**1974**	134535	10401	0.08
1998	39117	775	0.02	**1973**	142148	6716	0.05
1997	114963	963	0.01	**1972**	186140	7835	0.04
1996	56180	4687	0.08	**1971**	125517	15973	0.13
1995	12563	2371	0.19	**1970**	110976	7929	0.07
1994	20566	397	0.02	**1969**	173600	13700	0.08
1993	112172	1352	0.01	**1968**	99200	8900	0.09
1992	90582	2157	0.02	**1967**	84900	7300	0.09
1991	61235	3889	0.06	**1966**	112700	6400	0.06
1990	96104	2090	0.02	**1965**	84300	7900	0.09
1989	87259	5992	0.07	**1964**	91400	2900	0.03
1988	94746	4214	0.04	**1963**	75500	5600	0.07
1987	101807	3234	0.03	**1962**	91100	3600	0.04
1986	123334	4963	0.04	**1961**	98700	5900	0.06
1985	90964	7851	0.09	**1960**	69600	3500	0.05

From Table 2, it is clear that the proportion of jacks in the spring Chinook population is quite variable ranging from 0.1in 1978 to 0.37 in 2009, with an overall average of 0.07. The historic record also indicates that individual years can have high jack counts. However, these years usually occur in no specific pattern. The historic record does not contain a cluster of years observed with high jack counts, such as observed for 2007, 2008 and 2009, nor does the historic record show any year with a jack count as high as observed in 2009.

Comparison of Bonneville Dam Counts and Scale Pattern Analysis

Annually, since 1998, the Columbia River Inter-tribal Fish Commission (CRITFC) has conducted scale sampling at Bonneville Dam. The results of their research are published in annual reports on the CRITFC web page: http://www.critfc.org/tech/tech_rep.html. The following is a summary of the information obtained from the reports and by personal communication with Jeff Fryer, CRITC.

Table 3. Bonneville Dam jack spring Chinook observed based on scale pattern analysis conducted by the Columbia River Inter-tribal Fish Commission since 1998.

YEAR	Scale Analysis Proportion Jacks	Dam Counts Proportion Jacks
1998	0.03	0.02
1999	0.22	0.18
2000	0.14	0.11
2001	0.03	0.03
2002	0.01	0.02
2003	0.07	0.07
2004	0.05	0.05
2005	0.05	0.05
2006	0.02	0.03
2007	0.24	0.20
2008	0.20	0.12
2009	0.48*	0.37

**based on preliminary data.

Oversampling of jacks may have occurred due to the new FPOM/COE configuration of the fish trap (Jeff Fryer, personal communication).

The scale pattern analysis strongly supports the estimation of the proportion jacks in the population based on size differentiation at the counting window at Bonneville Dam. The scale pattern analysis also reiterates the occurrence of high jack counts in the past three years. The proportion observed for the jacks in 2009 is considerably higher than observed for the dam counts. However, there was a significant change in the configuration of the fish trap at Bonneville Dam this year that could have caused an over-sampling of jack sized Chinook.

Willamette Dam Counts

The Willamette Dam spring Chinook counts are available back to 1946. The data were reviewed to determine if there were similar high jack counts observed for the spring Chinook entering the Willamette as observed for Columbia River stocks (Table 4). If similar proportions of jack spring Chinook were observed in the Willamette River it would suggest that both populations were affected by similar factors.

Table 4. Willamette Dam counts for spring Chinook over the historic record and the proportion of spring Chinook jacks counted.

Willamette Falls Count			
Proportion of Jacks			
Year	% Jacks	Year	% Jacks
2009	0.09	**1980**	0.02
2008	0.04	**1979**	0.04
2007	0.01	**1978**	0.04
2006	0.01	**1977**	0.04
2005	0.03	**1976**	0.05
2004	0.01	**1975**	0.06
2003	0.02	**1974**	0.01
2002	0.01	**1973**	0.03
2001	0.02	**1972**	0.03
2000	0.04	**1971**	0.01
1999	0.04	**1970**	0.02
1998	0.04	**1969**	0.08
1997	0.02	**1968**	0.08
1996	0.06	**1967**	0.04
1995	0.06	**1966**	0.09
1994	0.02	**1965**	0.08
1993	0.07	**1964**	0.13
1992	0.06	**1963**	0.04
1991	0.07	**1962**	0.15
1990	0.03	**1961**	0.09
1989	0.05	**1960**	0.10
1988	0.02	**1959**	0.07
1987	0.04	**1958**	0.05
1986	0.05	**1957**	0.06
1985	0.04	**1956**	0.01
1984	0.03	**1955**	0.07
1983	0.06	**1954**	0.06
1982	0.02	**1953**	0.05
1981	0.05		
Average	**0.05**		
Range	**0.01- 0.15**		

Review of the historic Willamette Falls annual counts indicates that the Willamette River jack rate of spring Chinook has not increased in the same way that it has increased in the Columbia River. The 2009 jack proportion for the Willamette is within the historic range observed in the count record, and is less than 10%, while the 2009 rate observed in the Columbia was the highest on record at 37%.

Factors affecting the production of jacks in salmon populations

Jacking, the propensity for salmon to mature at least one year prior to their year class is present in all salmon populations. Jacking is a life-history strategy that is thought to be an evolutionarily stable strategy in equilibrium with smoltification and late maturation within any population (Gross 1985). Increasing rates of jacking likely indicate either a shift in population equilibrium favoring early maturation, or an imbalance in the population due to changing selection pressures leading to instability and potentially greater extinction risk (Thorpe 2007).

Several likely causes of jacking have been identified by researchers investigating the early maturation life-history strategy common to many salmon species. The causes fall under the following broad categories; growth related environmental effects, heritability of genetic predisposition for higher jacking rates, and differential harvest of the largest individuals within populations. Early male maturation in Columbia Basin salmon likely results from a combination of all of these factors.

Generally, growth and development related effects are the most widely studied and reported cause of precocious maturation in salmonids jacking (Thorpe, 1991). Recent research by Aubin-Horth et. al. 2005 provided support for a physiological model of control of maturation by inhibition. The inhibition of early maturation could be overcome by environmental factors that favored rapid growth. Silverstein et. al. 1998 concluded that the effects of size and fatness from 1 year earlier, were shown to be significant predictors on incidence of sexual maturity. In contrast fasting during spring months delayed increases in total lipids and fat accumulation into the mesenteric store until June and suppressed maturation rates of male parr (Rowe et.al. 1991). Beckman et. al. 2007, studying the causes of minijacking, or maturation without migration, found male maturation was growth dependent, with groups fed to near satiation maturing at a rate double that found in fish fed at half ration. Those same investigators found that male maturation was also photoperiod dependent with a linear relation found between emergence date and rate of male maturation.

While environment likely plays a key role in early maturation, there is also 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). Heath et. al. 2002, found that males with high propensity for jacking in genes produce offspring with high propensity for jacking. Hard et. al. 1985 found distinctly different jacking rates in two populations of Chinook salmon reared in identical

settings. Heath et al 1994 found significantly different allele frequency distributions for jacks and immature Chinook salmon indicating a family effect on the incidence of precocious maturation in population in a British Columbia. Heath et. al. 2002 concluded that jacking in Chinook salmon likely follows a threshold model, where the threshold is either fixed or partially environmentally determined, but that in either case phenotypic variance would vary with environment.

The effects of growth rate in the ocean have also been considered as a possible cause of increased jacking rates (Koseki and Fleming 2006, Vøllestad et. al. 2004). While ocean productivity likely affects numbers of returning salmon to some extent, analyses of ocean affects on early sexual maturation by Koseki and Fleming 2006 concluded that "…freshwater processes, such as juvenile growth, timing of migration and breeding competition , operating at evolutionary and intragenerational time-scales, are probably the predominant forces affecting phenotype frequency." Their results confirmed earlier work by Vøllestad *et al*. (2004) that found that triggers for early maturation occurred primarily during early life in freshwater. Vøllestad *et al*. 2004 went on to suggest that growth potential at sea likely neutrally affected or even inhibited early maturation.

Size selective fisheries may also effect 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. He went on to say that inhibition of maturation may be a genetic stabilizing mechanism, favoring average rather than high or low heterozygosity and inhibiting Atlantic and other salmon populations from evolving toward residency.

Jack Returns of PIT tagged spring/summer Chinook

For migration years 2000 through 2007, FPC staff reviewed PIT-tag detections of hatchery/supplementation and wild Snake, Mid-Columbia, and Lower Columbia River spring/summer Chinook adults detected at the Bonneville Dam fishway to estimate jack return rates. This was done for individual hatcheries throughout these basins as well as for certain groups of wild PIT-tagged fish. FPC staff focused on those hatchery/supplementation and wild groups that have released large numbers of PIT-tags over this entire range of time, in order to investigate whether jack rates have changed in a particular manner over these years. The Bonneville Dam fishway did not have full adult PIT-tag detection capabilities until return year 2002, so it was not possible to go beyond migration year 2000 for this analysis.

Appendix A contains tables with the estimates of jack rates for the various hatchery/supplementation groups we used for this analysis, along with some

information about the hatchery/supplementation groups themselves. This appendix also contains a table with the estimated jack rates for the three groups of wild spring/summer Chinook from this analysis.

In considering these data it is important to note that the jacks returning in 2009 have outmigrated in 2008. It is not possible to estimate the jack rate for that 2008 outmigrating group, until 2-ocean adults begin to return in 2010. In almost every case, the highest estimates of jack rates were among the most recent migration year which tends to agree with jack counts at projects in recent return years. However, this should also be interpreted with some caution. This analysis is based on PIT-tag detections of adult spring/summer Chinook to Bonneville Dam as of June 11, 2009. However, returns for migration year 2007 are incomplete, as no 3-ocean adults have returned yet. For the most part, 3-ocean adults make up a relatively small proportion of the overall adult return. However, some hatchery/supplementation groups have seen a large proportion of 3-ocean adults in some years. Therefore, these estimates are preliminary and should not be considered final until all 3 and 4-ocean adults have returned.

Snake River spring/summer Chinook:

Jack rates for PIT-tagged hatchery/supplementation Snake River spring Chinook varied significantly over the years we analyzed. In addition, there was a high degree of variation between the hatcheries from our analysis (Figure 1, Table A-1). Of the spring Chinook hatchery/supplementation groups we analyzed, those released on-site at Dworshak NFH generally had the lowest jack rates, with an average jack rate of 9.0% over the years we analyzed. Yearly jack rates for Dworshak NFH ranged from a low of 0.4% for migration year 2000 to a high of 20.4% for migration year 2007. The Lostine Acclimation Pond consistently had the highest jack rates, with an overall average of 25.3%. Yearly jack rates for this release group ranged from 10.5% in migration year 2000 to 50% in migration year 2001. This release group is part of a spring Chinook supplementation program where some returning adults are collected for spawning at Lookingglass Hatchery and some are allowed to spawn in the wild to generate "natural" stock spring Chinook. Of the spring Chinook hatchery/supplementation groups we analyzed, the jack rates for the Catherine Creek Acclimation Pond, Dworshak NFH, and Rapid River hatcheries all seemed to have increased steadily since migration year 2004 (Figure 1, Table A-1).

Jack rates for PIT-tagged hatchery/supplementation Snake River summer Chinook also showed temporal variation over the years we analyzed. As with the spring Chinook, there was also variation between the hatcheries we analyzed (Figure 1, Table A-2). Of those hatcheries releasing Snake River summer Chinook juveniles, juveniles released from McCall Hatchery had the lowest overall jack rate, with an average of 16.5% over the years we analyzed. Yearly jack rates for this release group were variable, ranging from 8.2% for migration year 2005 to 29.2% for migration year 2003. With an average of 26.94%, juvenile summer Chinook released from the Imnaha Acclimation Pond had the highest overall jack rate among

the groups of hatchery/supplementation Snake River summer Chinook that we analyzed. As with other groups, these jack rates were variable from one year to the next and ranged from 16.9% for migration year 2004 to 44.9% for migration year 2003. Juvenile hatchery summer Chinook released from Johnson Creek Acclimation Pond had an average jack rate of 20.7% over the years we analyzed. This release group is part of a summer Chinook supplementation program where some returning adults are collected for spawning at McCall Hatchery, while some are allowed to spawn in the wild to generate "natural" stock summer Chinook. There does not seem to be a trend in increasing or decreasing jack rates among the hatchery summer Chinook groups that we analyzed.

Jack rates for PIT-tagged wild Snake River spring/summer Chinook were also variable between the migration years we analyzed (Figure 1, Table A-4). Overall, the average jack rate for wild Snake River spring/summer Chinook was 4.9%. Yearly jack rates ranged from a low of 1.3% for migration year 2004 to a high of 7.9% in 2002. In every case, the average jack rate for Snake River wild spring/summer Chinook was lower than that for any of the Snake River hatchery/supplementation spring or summer Chinook stocks we analyzed.

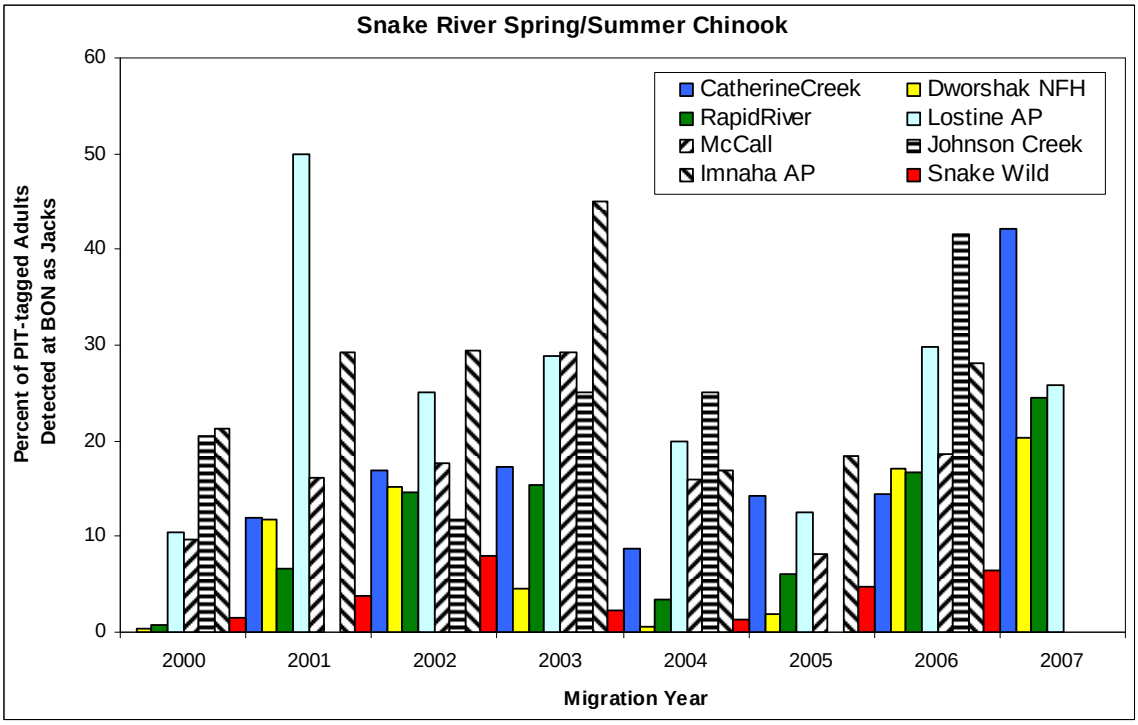

Figure 1. Estimated jack rates of returning Snake River spring/summer Chinook released from various locations throughout the Snake River basin and detected at the Bonneville Dam adult fishway. Striped bars indicate those hatcheries that release Snake River summer Chinook. Estimates of jack rates for migration years 2006 and 2007 are based on incomplete returns as of June 11, 2009 and may change as additional adults are detected. Furthermore, jack return rates for Snake River summer Chinook (MY 2007) were not possible due to their later timing as adults. Snake River wild Chinook are a combination of both spring and summer stocks released throughout the basin.

Mid- and Lower Columbia River spring Chinook:

Jack rates for PIT-tagged hatchery Mid-Columbia River spring Chinook varied significantly over the years we analyzed. As with the Snake River stocks, there was also a high degree of variation between the hatcheries in our analysis (Figure 2, Table A-3). Of the three Mid-Columbia hatcheries we analyzed, Leavenworth NFH had the lowest jack rates, with an average jack rate of 7.1% over the years we analyzed. Yearly jack rates for Leavenworth NFH ranged from a low of 0.0% for migration year 2001 to a high of 22.2% for migration year 2005. Cle Elum hatchery on the Yakima River had a slightly higher average jack rate of 9.9% but was more variable (3.7% for MY 2001 to 33.7% for MY 2007). Winthrop NFH had the highest jack rates, with an overall average of 19.1%. Yearly jack rates for this release group ranged from 0.0% in migration years 2001 and 2005 to 25% in migration years 2006 and 2007.

Only one group of Lower Columbia hatchery spring Chinook was used in this analysis. This group (Carson NFH) had a relatively low average jack rate of 3.7% and was less variable than the other sites (0.0% for MY 2003 to 13.0% for MY 2007) (Figure 1, Table A-3). However, the yearly jack rate of Carson NFH spring Chinook seems to be increasing since migration year 2003 (Figure 2).

As with wild Snake River spring/summer Chinook, jack rates for wild Mid- and Lower Columbia River spring Chinook were variable between migration years (Figure 2, Table A-4). Overall, the average jack rate for wild Yakima River spring Chinook was 10.0%. Yearly jack rates for this stock ranged from a low of 0.0% for migration year 2007 to a high of 23.5% for migration year 2006. The average jack rate for Yakima River wild spring Chinook is comparable to what was seen for the Mid-Columbia hatchery spring Chinook from our analyses and extremely close to what was estimated for Cle Elum Hatchery. The average jack rate for wild John Day River spring Chinook was 6.15%, with a low of 2.1% in migration year 2007 and a high of 14.9% for migration year 2007.

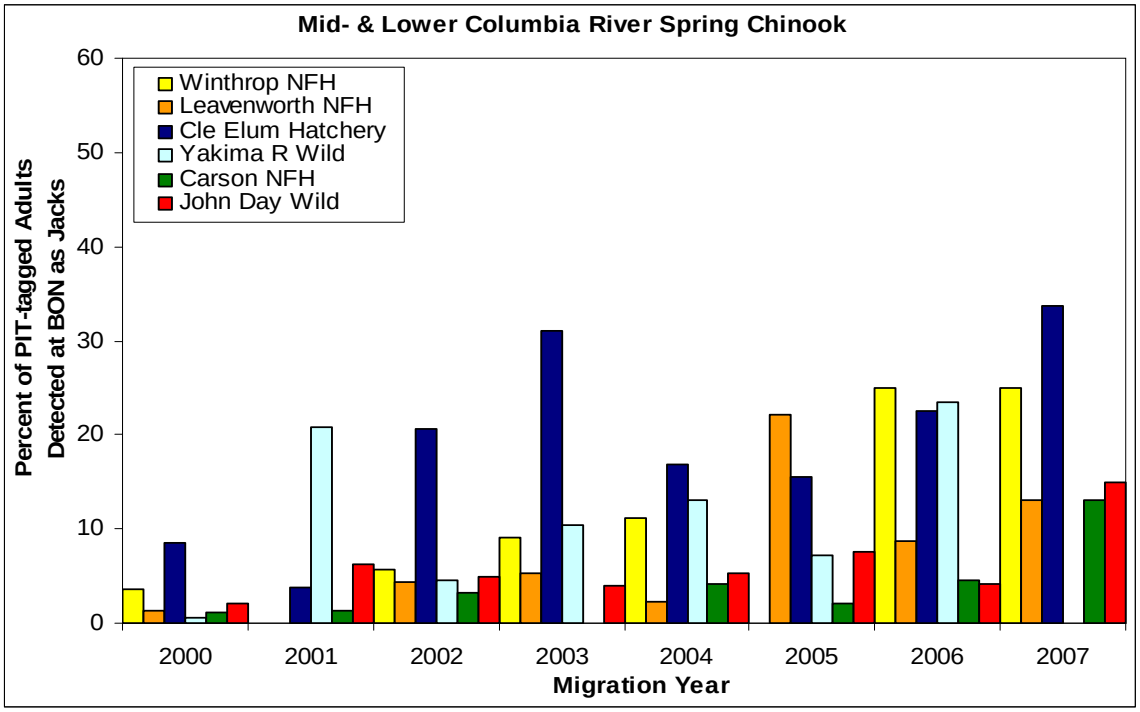

Figure 2. Estimated jack rates of returning Mid- and Lower Columbia spring Chinook released from various locations throughout these basins and detected at the Bonneville Dam adult fishway. Estimates of jack rates for migration years 2006 and 2007 are based on incomplete returns as of June 11, 2009 and may change as additional adults are detected.

Juvenile Passage Conditions in 2008

Historical data and analysis indicates that increased jack counts and subsequent smolt to adult return rate is related to juvenile passage conditions, spill flow and resulting juvenile survival (Schaller et al, 2007). The high numbers of jacks seen in spring/summer adults in the Snake River are likely due in part, to relatively high in-river survivals through this portion of the hydro-system coupled with good early ocean survival. High flows and relatively high spill proportions in the Lower Granite Dam to McNary Dam reach were likely important in explaining the relatively high survivals in that reach.[1] Yearling Chinook survival estimates for the 2008 cohorts ranged between 0.57 (a relatively imprecise estimate for the earliest cohort) and 0.81 with all but the earliest group otherwise at or above 0.73 (see Figure 3). The average for the reach for all years and cohorts was 0.73, indicating that reach survivals in 2008 were above average, reflecting the relatively short water transit times and high spill proportions yearling Chinook experienced during outmigration. The river conditions were relatively good in 2008, with water transit times relatively low at 9.0 days on average for the survival cohorts and spill proportions averaging 42% of total discharge through the reach, as high as any year analyzed. High flows and relatively high spill proportions in the reach were likely important in explaining the relatively high reach survivals.

[1] Estimates of juvenile survival through the McNary to Bonneville river reach in 2008 were not possible due to removal of travelling screens at Bonneville 2 powerhouse, resulting turbine passage and high tailrace mortality related to TSW testing at John Day Dam.

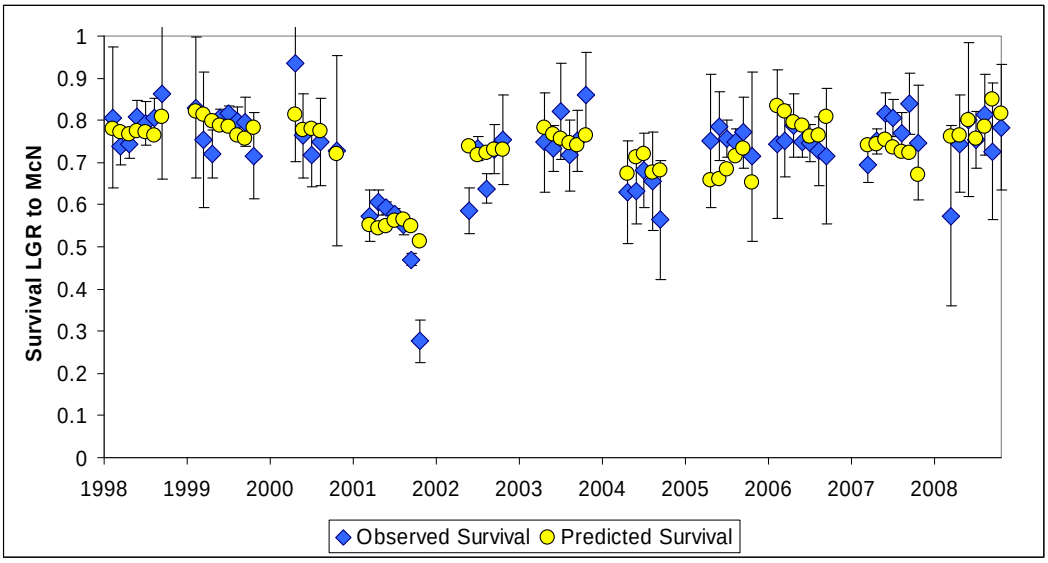

Figure 3. Observed yearling spring/summer Chinook survival estimates and standard errors, in the reach LGR to McN 1998 to 2008 compared to predicted survivals for same reach using weighted average coefficients from multi-model regression analysis (Correlation coefficient 0.82 based on bootstrap).

Appendix A

Jack Return Rates for Snake, Mid-Columbia, and Lower Columbia Hatchery and wild Chinook Stocks

Table A-1Estimated jack rates of returning Snake River PIT-tagged hatchery/supplementation spring Chinook adults and jacks detected at the Bonneville Dam adult fishway.

Hatchery	Migration Year	Release Dates	Number Released	Fish Per Pound	Percent Jacks
Dworshak NFH	2000	3/22-4/6	1,017,873	24.0	0.4
	2001	3/28	333,120	19.7	11.8
	2002	3/27-3/28	1,000,561	20.0	15.1
	2003	3/19-3/20	1,033,982	21.4	4.6
	2004	3/31-4/1	1,078,923	20.2	0.5
	2005	4/4-4/6	1,072,359	19.2	2.0
	2006[A]	3/27-3/29	1,007,738	20.0	17.1
	2007[A]	3/28-3/28	963,211	17.7	20.4
Catherine Creek AP	2000	4/1-4/18	37,980	22.5	0.0
	2001	4/1-4/16	136,833	19.7	12.0
	2002	4/1-4/15	180,343	18.6	16.9
	2003	3/17-3/23	105,292	12.8	17.2
	2004	3/15-3/22	92,105	23.1	8.7
	2005	3/14-4/4	189,580	25.1	14.3
	2006[A]	3/27	45,604	21.5	14.5
	2007[A]	3/26-4/11	71,268	26.6	42.2
Rapid River	2000	3/15-4/25	2,462,354	19.2	0.7
	2001	3/15-4/24	736,601	18.8	6.6
	2002	3/12-4/22	2,669,476	19.8	14.7
	2003	3/17-4/28	2,330,557	18.8	15.4
	2004	3/15-4/23	2,762,058	24.5	3.4
	2005	3/15-4/22	2,761,430	19.1	6.1
	2006[A]	3/13-4/21	2,530,528	19.3	16.6
	2007[A]	3/15-4/27	2,498,246	20.0	24.4
Lostine AP	2000	4/18	34,986	21.0	10.5
	2001	3/19	133,883	19.6	50.0
	2002	4/1-4/14	109,015	16.6	25.0
	2003	3/17-4/14	242,749	16.3	28.9
	2004	3/15-4/14	245,968	22.5	20.0
	2005	3/11-4/1	164,819	23.0	12.5
	2006[A]	3/10-4/17	242,818	25.0	29.8
	2007[A]	3/16-4/17	230,010	21.1	25.8

[A] Incomplete returns through June 11, 2009 at BOA

Table A-2Estimated jack rates of returning Snake River PIT-tagged hatchery/supplementation summer Chinook detected at the Bonneville Dam adult fishway.

Hatchery	Migration Year	Release Dates	Number Released	Fish Per Pound	Percent Jacks
McCall	2000	4/3-4/6	1,039,930	23.3	9.8
	2001	3/26-3/29	1,165,231	19.4	16.2
	2002	3/25-3/28	1,064,250	23.0	17.7
	2003	3/31-4/3	1,053,660	21.1	29.2
	2004	3/22-3/25	1,088,810	20.9	16.0
	2005	3/18-3/21	1,047,530	20.9	8.2
	2006[A]	3/20-3/24	1,096,130	18.1	18.6
	2007‡	3/19-3/22	1,087,170	19.1	
Imnaha AP	2000	3/22-4/18	179,797	19.1	21.3
	2001	3/21-4/16	123,014	16.0	29.3
	2002	3/21-4/17	303,737	14.1	29.5
	2003	4/1-4/15	268,426	16.3	44.9
	2004	4/1-4/15	398,469	26.1	16.9
	2005	3/29-4/8	435,186	24.5	18.4
	2006[A]	3/21	320,752	27.12	28.1
	2007‡	3/21-4/1	432,530	21.58	
Johnson Creek AP	2000	3/27-3/30	78950	28.6	20.5
	2001				
	2002	3/18-3/19	57392	23.0	11.8
	2003	3/20-3/21	73000	27.5	25.0
	2004	3/15-3/17	112870	27.1	25.0
	2005	3/14-3/16	105230	25.7	0.0
	2006[A]	3/13-3/16	90625	25.0	41.7
	2007‡	3/12-3/14	120415	26.9	

[A] Incomplete returns through June 11, 2009 at BOA

‡ Jack return rates for Snake River hatchery summer Chinook (MY 2007) were not possible due to their later timing as adults to Bonneville Dam.

Table A-3Estimated jack rates of returning Mid-Columbia and Lower Columbia River PIT-tagged hatchery spring Chinook detected at the Bonneville Dam adult fishway.

Hatchery	Migration Year	Release Dates	Number Released	Fish Per Pound	Percent Jacks
Winthrop NFH	2000	4/10	377,696	14.0	3.6
	2001	4/17	175,869	13.7	0.0
	2002	4/15	201,604	17.6	5.8
	2003	4/15	265,039	18.9	9.1
	2004	4/12	537,530	17.3	11.1
	2005	4/15	384,603	15.7	0.0
	2006[A]	4/20	484,090	15.7	25.0
	2007[A]	4/11	589,693	18.6	25.0
Leavenworth NFH	2000	4/18	1,680,904	18.2	1.2
	2001	4/17	1,630,089	16.8	0.0
	2002	4/22	1,554,362	22.4	4.3
	2003	4/21	1,288,893	16.2	5.2
	2004	4/19	1,422,100	25.7	2.2
	2005	4/15	1,476,046	18.4	22.2
	2006[A]	4/17	1,005,505	19.0	8.8
	2007[A]	4/18	1,177,568	20.0	13.0
Cle Elum	2000	3/15-6/2	589,683	18.0	8.5
	2001	3/15-6/6	758,789	15.0	3.7
	2002	3/15-5/24	834,285	22.7	20.7
	2003	3/14-5/15	370,236	18.0	31.1
	2004	3/15-4/30	836,904	28.3	16.9
	2005	3/9-4/27	824,692	25.0	15.6
	2006[A]	3/15-5/15	785,448		22.6
	2007[A]	3/15-5/15	860,002		33.7
Carson NFH	2000	4/20	1,430,022	15.6	1.2
	2001	4/19	1,608,684	14.9	1.3
	2002	4/16	1,449,361	15.6	3.2
	2003	4/16	1,673,255	17.1	0.0
	2004	4/14	1,417,986	17.3	4.1
	2005	4/15	1,470,134	14.5	2.2
	2006[A]	4/10	1,209,384	17.3	4.6
	2007[A]	4/12	1,158,425	17.2	13.0

[A] Incomplete returns through June 11, 2009 at BOA

Table A-4Estimated jack rates (percent jacks) of returning Snake River, Yakima River, and John Day River PIT-tagged wild Chinook adults detected at the Bonneville Dam adult fishway.

Migration Year	Snake River Wild[†]	Yakima River Wild	John Day River Wild
2000	1.5	0.6	2.1
2001	3.8	20.8	6.2
2002	7.9	4.6	5.0
2003	2.2	10.4	3.9
2004	1.3	13.0	5.4
2005	4.7	7.1	7.6
2006[A]	6.4	23.5	4.2
2007[A]	11.3	0.0	14.9

[A] Incomplete returns through June 11, 2009 at BOA

[†] Snake River wild Chinook are a combination of both spring and summer stocks released throughout the basin. Therefore, jack return rates for MY 2007 may be change as more adult summer Chinook return later in the summer.

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