FISH PASSAGE CENTER

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MEMORANDUM

TO: Ron Boyce, ODFW
Tony Nigro, ODFW

FROM: Michele DeHart

DATE: December 10, 2007

RE: NOAA proposal for Snake River summer spill for fish passage

In response to your request the Fish Passage Center staff reviewed the NOAA proposal for managing summer spill for juvenile fall Chinook passage against the historical fish passage and operations data. We developed the following points from our review of passage and operations data for your consideration. The NOAA proposal is presented without any biological basis. Our overall conclusion is that **the NOAA proposed operation which greatly limits summer spill for fall Chinook is premature until additional data on the benefits of spill to adult returns and wild/natural fish passage is developed. The data collected thus far indicates that spill is beneficial to adult returns.** It is too soon to have a full life cycle return on the first year of spill for fish passage implemented in 2005. However the incomplete results presently available indicate that spill for fall Chinook may be the most beneficial measure implemented in recent years. The NOAA proposal does not capture the full range of actions that has affected fall Chinook and therefore does not address the full range of mitigation measures that that may be required. The NOAA proposal does not recognize the limitations associated with the use of present PIT tag groups to determine timing and survival of wild /natural fall Chinook in particular. A coordinated fall Chinook PIT tagging effort to mark proportionally over hatchery and natural groups that are representative of the population as a whole has not been implemented. The implementation of spill for juvenile fall Chinook passage is only one of many factors have changed in recent years, which has impacted fall Chinook. Changes in reservoir operations, hatchery programs, passage operations and project operations have occurred in recent years which have impacted fall Chinook. Determining the best passage operation for the future requires a decision framework which addresses all of these factors and concludes in the best suite

of operations to benefit adult returns of both Snake River and Clearwater components of the population.

- **The NOAA proposal is not related to a biological basis, or decision framework that is related to adult return information or impact on wild/natural components of the migration. It is difficult to assess the impact of the NOAA proposal on wild/natural fall Chinook because of limited data.**
- **The available data, although limited, indicates that fall Chinook that are bypassed in August contribute to adult returns. Fish that return as adults from in-river migration in spill or through turbines in August are not detected and could contribute significantly to adult returns. At the present time smolt to adult return data for in-river migrants passing the projects in spill or through turbines is not available.**
- **Historic data indicates that the 90% point of passage for wild fall Chinook occurred on August 31 and sometimes extended into September. Increased releases in the hatchery production supplementation program in particular after 2000 has, because of its magnitude, shifted the average passage timing of the run-at-large to an earlier period. The magnitude of the hatchery releases could mask the wild/natural migration timing.**
- **The available data, although limited, indicates that since 2000 when hatchery releases increased dramatically Snake River natural fall Chinook juvenile migrants have outmigrated at a smaller size and at earlier dates, and that marking of juveniles has also been earlier. This could introduce a bias in the PIT tag data towards the earlier portion of the outmigration.**
- **The first spill for fish passage provided for Snake River fall Chinook was implemented in 2005. Prior to 2005 fall Chinook only received excess hydraulic capacity spill and those fall Chinook that migrated in June received spill planned for spring migrants.**
- **For actively migrating subyearling Chinook, increased spill and decreased water transit time (higher flows) appear to improve survival, while higher temperatures decrease survival.**
- **In 2007 Lower Granite adult fall Chinook returns were notable because while fall Chinook adult returns to Bonneville Dam and to McNary Dam were well below their ten year average and the 2006 return, returns to Lower Granite were above the 2006 return and the ten year average for Lower Granite. The adults returning in 2007 are comprised of juvenile out migrants primarily from 2004 and the first year of spill in 2005 giving an indication that summer spill for fish passage and reduction in proportion of fish transported is beneficial.**
- **The fall Chinook population above Lower Granite Dam is comprised of two components, Snake River and Clearwater groups, which have different passage timing characteristics. The recent operation of Dworshak Reservoir may be changing passage timing of this group to later in the fall. Provision of spill for this later timing has not been considered by NOAA and may be beneficial.**
- **Whether or not to continue spill for fish passage in August should be based upon a decision framework which is based upon 1) the benefits of smolt transportation relative to in-river survival during August 2) the contribution of August in-river migrating fall Chinook to adult returns 3) migration timing, adult contribution and**

other characteristics of wild/natural produced fall Chinook. The decision framework should include consideration of spill for the later component of juvenile passage.

Available historic data indicates that juvenile wild/natural fall Chinook that outmigrated in August were a significant part of the outmigration and made a significant contribution to adult returns.

This data portrays the subyearling emigration timing of natural/wild fall Chinook that later returned as adults. The long term PIT tag data on natural fall Chinook spans 16 years for Snake River operations and 14 years in the Clearwater River. Adult returns for the fall Chinook out-migrating in 2005, 2006 and 2007 are not complete. We did not utilize adult return data from 2006 for this reason and there is no adult return information for 2007 out-migrants. Although adult return data from the 2005 out-migration are not complete, historic age class returns indicate that at least half of the expected adult return form the 2005 out-migration has occurred by 2007. Returning adults were defined as fish that were detected at Lower Granite Dam (LGR).

Of the 7,727 PIT natural/wild PIT tagged fish in the Clearwater River from 1993 to 2005, 19 returned as adults. In the Snake River, 126 fish returned from 37,998 natural/wild PIT tagged fish.

To express historic timing information "bypassed" fish from all years were grouped for the Snake River and the Clearwater River. There were 68 adult wild/natural fall Chinook from the Snake River and 10 from the Clearwater River that had been bypassed as juveniles. Passage detection information was grouped by dam and month (e.g. June LGR passage includes subyearling detections from all years at LGR during June for a particular river origin). Figure 1 shows histograms for these data shown in one "year" post tagging for the Snake River. In each panel, there are two distributions of fish suggesting that there is a population of fish that outmigrate as juveniles and a smaller population that holdover either within or above the hydrosystem. However, these observations do not include all outmigrating PIT tagged fish. Fish that pass through the system undetected, either because they passed the projects through spill or through the turbines or during the November to March period when PIT tag detection is not operational.

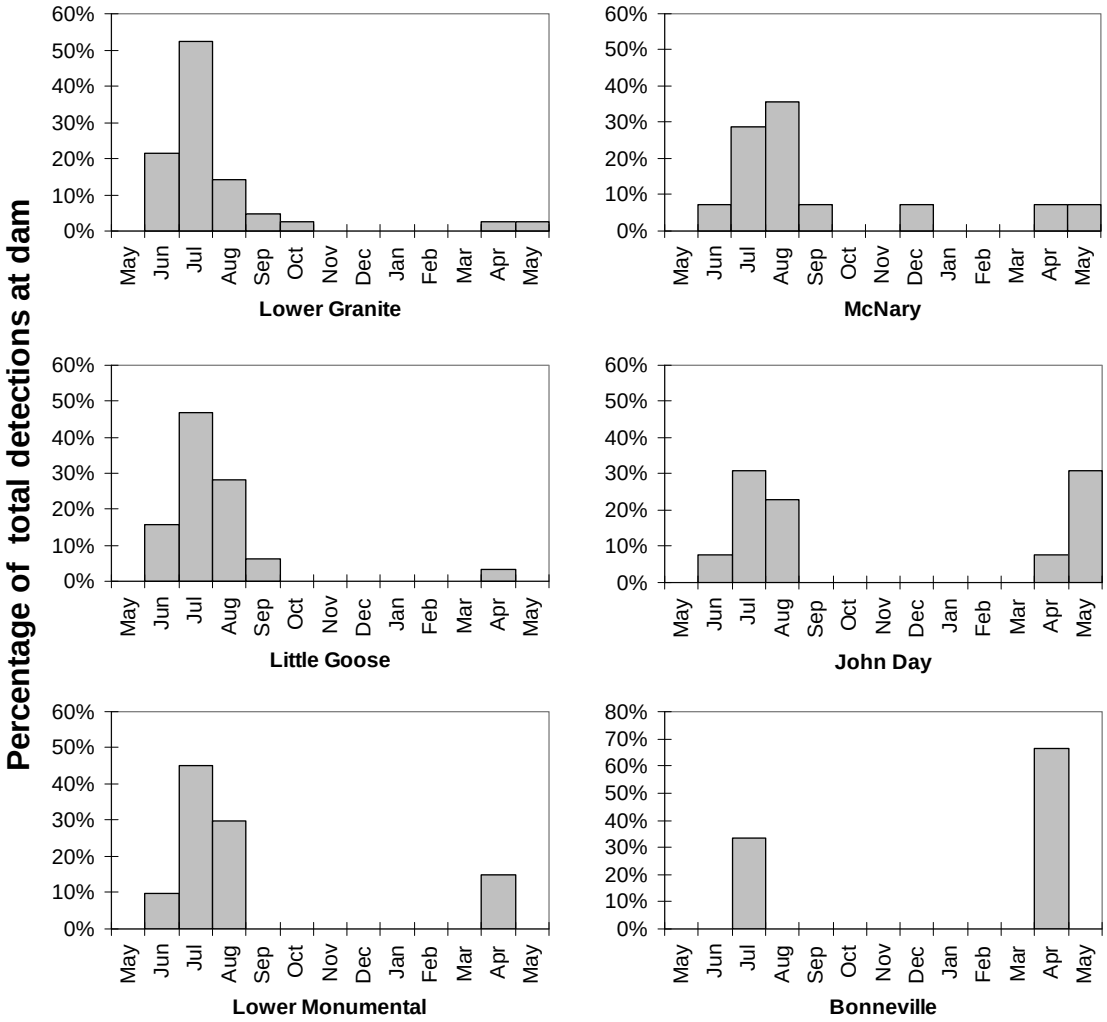

Figure 1. Monthly percentage of juveniles for PIT tagged natural/wild fall Chinook adults that returned to Lower Granite Dam from Snake River releases from 1994 - 2005.[1]

1. No PIT tag adults that were detected as juveniles returned from 1991 and 1993

June, July, and August had the three highest numbers of detections at the first 5 dams within the hydrosystem. The month of August ranged from 14% to 36% of the detections at each of these five dams. This suggests that historically, fish that returned as adults emigrated through the hydrosystem over the entire summer.

The Clearwater River data contains few fish, in part because so few fish returned. Of the 10 fish in the "bypassed" category, there were two or fewer detections at all the dams below LGR and

Little Goose (LGS). Of the 13 detections at LGR and LGS, 5 were during July and August suggesting a later summer passage than for Snake River subyearlings (Figure 2).

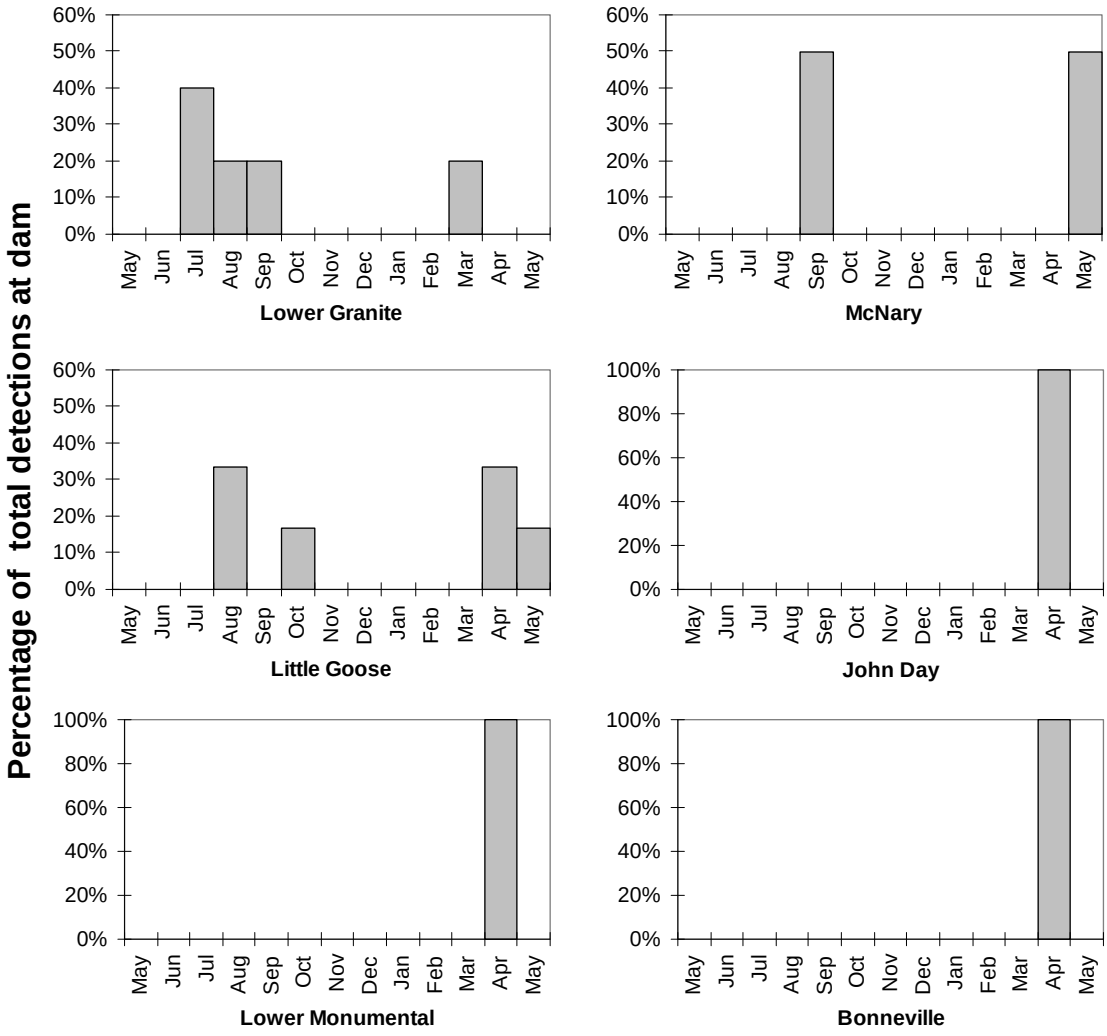

Figure 2. Monthly percentage of juveniles detected for the PIT tagged natural/wild fall Chinook that returned to Lower Granite Dam from releases in the Clearwater River[1].

1. Clearwater River PIT tag releases of natural/wild fall Chinook juveniles occurred in 1993, 1998, 2001, 2003-2005. No PIT tagged adults that returned in 1994-1996 and 2002 were detected as juveniles.

Historically juvenile outmigration PIT tag timing data indicates that fall Chinook which were bypassed through the hydrosystem in August contributed to adult returns. FPC staff considered the PIT tag data to determine whether subyearling fall Chinook passing Lower Granite Dam (LGR) in August contribute to adult returns to the Columbia River Basin. The observations included hatchery and wild subyearling fall Chinook that were detected at Lower Granite as juveniles (in the year of their out-migration) and later detected at Bonneville, McNary, and/or Lower Granite dams as adults for migration years 1995-2005. This analysis does not include fall Chinook that returned as jacks or mini-jacks because coincident with the recent increases in supplementation hatchery releases the proportion of jacks in the adult return has increased greatly compared with historic years and wild production. The observations are divided into juveniles that were bypassed versus those that were transported (from LGR, LGS, LMN, or MCN). Finally individual fish that may have held over below LGR after passing LGR in the year of their out-migration were included.

From the PIT tag observations, it is clear that historically subyearling fall Chinook juveniles that pass Lower Granite Dam in August contribute to adult returns in the Columbia Basin (Table 2; Figures 3 and 4). This is true for both bypassed and transported juveniles. It appears that, in recent years (MY 2003-2005), subyearling juveniles passing Lower Granite in August represent a smaller proportion of the adult returns (Table 1). However, the majority of PIT-tagged subyearling fall Chinook are production fish, which have been released earlier and over a shorter time period in recent years. It is likely that the decline in the proportion of adult returns represented by August passing juveniles is due to these earlier release schedules and thus, lower numbers of juveniles passing in August. What is still unclear is what proportion of the wild subyearling Chinook juveniles pass Lower Granite in August and return as adults. Although this analysis included PIT-tagged wild subyearling Chinook, tagging of these wild subyearlings has also occurred earlier and at smaller sizes in recent years compared to past years.

Table 1. Percent of adults (jacks not included) returning that had juvenile detections at Lower Granite Dam in August (MY 1995-2005).

	Percent of Adults that Passed LGR in August as Juveniles	
Migration Year	**Bypassed**	**Transported**
1995	45.8	20.0
1996	46.7	66.7
1997	14.3	N/A
1998	25.0	0.0
1999	22.6	85.7
2000	16.7	40.0
2001	30.0	34.1
2002	18.2	29.1
2003*	6.7	13.8
2004**	0.0	0.0
2005***	11.1	16.7

* 5-year ocean fish from MY 2003 have not yet returned
** 4 and 5-year ocean fish from MY 2004 have not yet returned
*** 3, 4, and 5-year ocean fish from MY 2005 and not yet returned

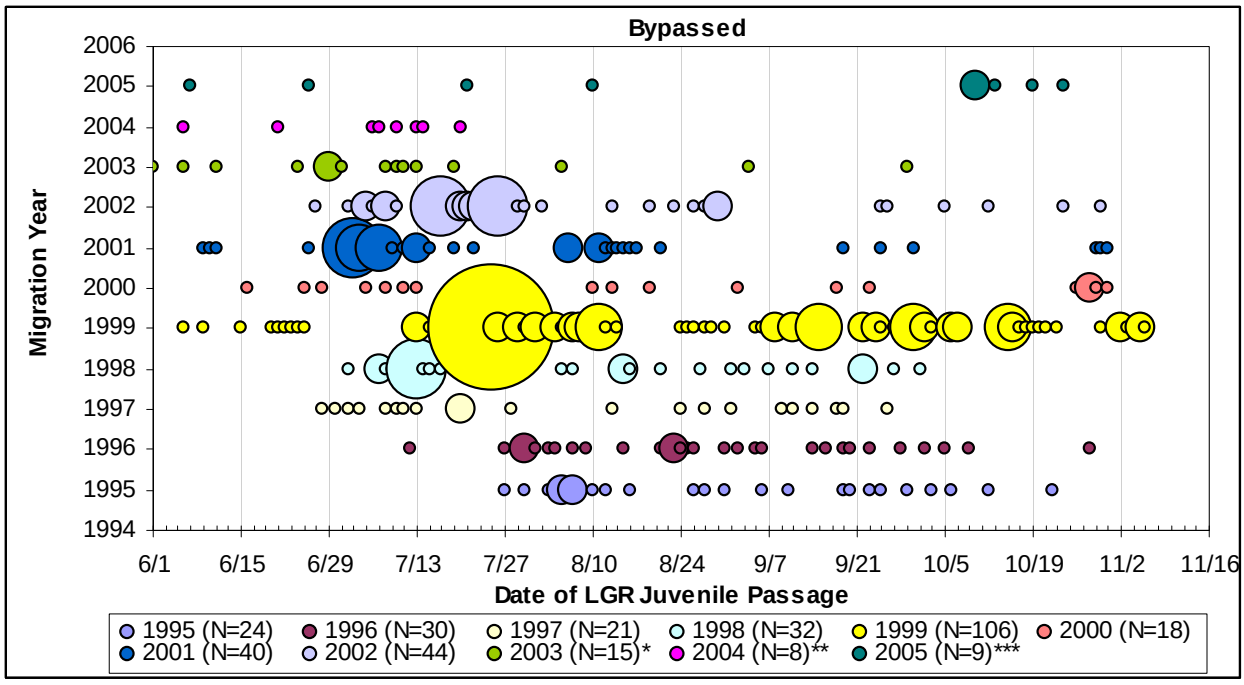

Figure 3. Juvenile passage timing at Lower Granite Dam for bypassed subyearling fall Chinook that survived to adulthood (jacks not included) for migration years 1995-2005. Numbers of PIT-tagged adults returning for each migration year are shown in the figure legend in parentheses. Larger circles reflect larger number of PIT-tags passing on a particular date. This figure may include any holdovers that held over below LGR and were detected the following year as yearlings, below LGR.

* 5-year ocean fish from MY 2003 have not yet returned

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*** 3, 4, and 5-year ocean fish from MY 2005 and not yet returned

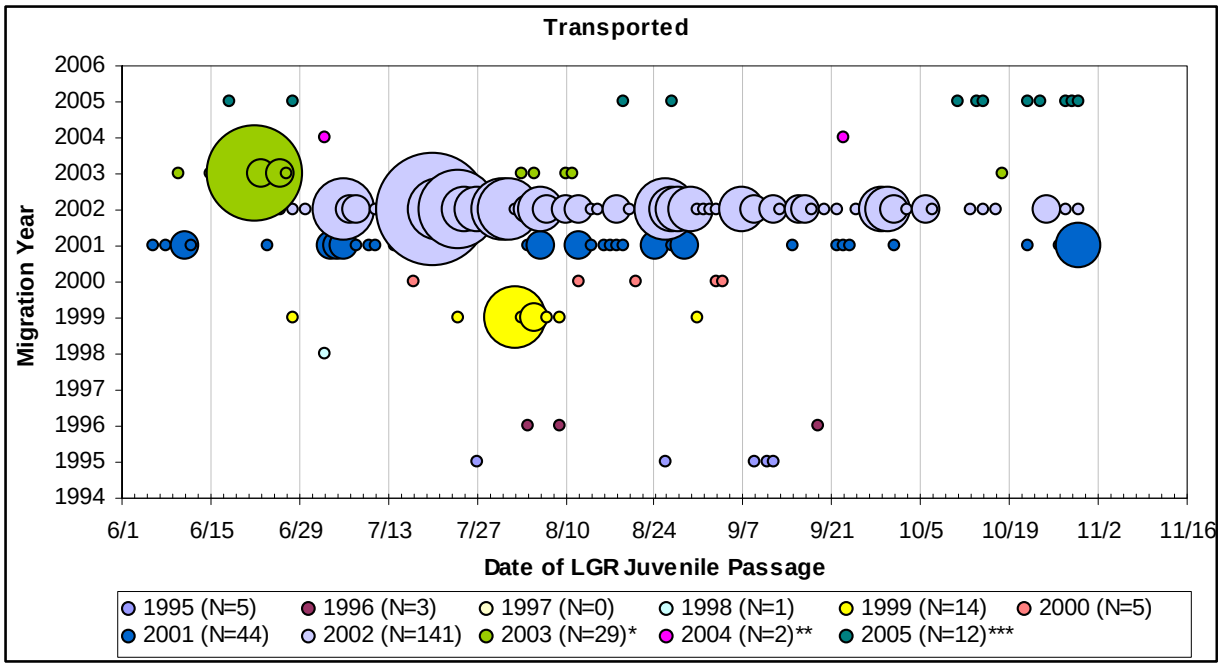


Figure 4. Juvenile passage timing at Lower Granite Dam for transported subyearling fall Chinook that survived to adulthood (jacks not included) for migration years 1995-2006. Numbers of PIT-tagged adults returning for each migration year are shown in the figure legend in parentheses. Larger circles reflect larger number of PIT-tags passing on a particular date. This figure may include any holdovers that held over below LGR and were detected the following year as yearlings, below LGR.

* 5-year ocean fish from MY 2003 have not yet returned

** 4 and 5-year ocean fish from MY 2004 have not yet returned

*** 3, 4, and 5-year ocean fish from MY 2005 and not yet returned

Fish that return as adults from in-river migration in spill in August are not detected and could contribute significantly to adult returns. At the present time smolt to adult return data for in-river migrants passing the projects in spill is not available.

For subyearling fall Chinook released above Lower Granite Dam (LGR) as juveniles, the proportion of the adult returns (including jacks) that out-migrated through the hydrosystem undetected was estimated. Both hatchery and wild subyearling fall Chinook that were detected as adults at Bonneville, McNary, and/or Lower Granite dams for migration years 1995-2006 were included. This analysis does not include fall Chinook that returned as jacks or mini-jacks. Juvenile detections in the adult facilities were also removed from this analysis.

On average, approximately 28.6% of PIT-tagged Snake River fall Chinook adults returning out-migrated through the hydrosystem undetected as juveniles (Table 2). This is of importance because it is impossible to determine when these juveniles migrated through the hydrosystem. It is worth noting that a portion of these undetected individuals may have passed the hydrosystem later in the season when PIT-tag detectors are no longer running. However, a portion of these undetected individuals could have passed the hydrosystem when spill may have been occurring or through turbine units.

Table 2. Percent of PIT tagged adult fall Chinook (jacks not included) that were released above LGR as juveniles and out-migrated undetected through the hydrosystem (MY 1995-2005).

Migration Year	Number Returned	Number of Returned Who Were Undetected as Juveniles	Percent Returned Who Were Undetected as Juveniles
1995	108	52	48.1
1996	78	28	35.9
1997	59	13	22.0
1998	93	20	21.5
1999	286	178	62.2
2000	63	7	11.1
2001	254	78	30.7
2002	426	112	26.3
2003*	81	6	7.4
2004**	19	1	5.3
2005***	102	45	44.1
Average	**142.6**	**49.1**	**28.6**

* 5-year ocean fish from MY 2003 have not yet returned
** 4 and 5-year ocean fish from MY 2004 have not yet returned
*** 3, 4, and 5-year ocean fish from MY 2005 have not yet returned

Increased releases in the hatchery production supplementation program in particular after 2000 has, because of its magnitude, shifted the average passage timing to an earlier period. The magnitude of the hatchery releases could mask the wild/natural timing.

As part of the hatchery production supplementation program, there has been a marked increase in the number of hatchery subyearling fall Chinook released into the Snake River above Lower Granite Dam since 2000 (Figure 5). Releases of supplementation fish to the Snake River have begun to occur earlier in recent years (Table 3). For example 1995 and 1996 had releases ending well into July and August, whereas releases from more recent years have ended by June 21. The schedule for supplementation releases on the Clearwater River have not changed as dramatically as those to the Snake River (Table 3). However, both Clearwater and Snake river supplementation releases have been decreasing in their time span. Long volitional releases have become less common, while shorter release spans are the norm in more recent years.

The combination of larger releases of hatchery subyearling Chinook and those releases occurring earlier in the season (late May – early June in recent years) could have shifted the overall passage timing of subyearling fall Chinook to an earlier period, thus masking the timing of wild/natural Snake River fall Chinook. It is still unknown whether this shift in timing has affected the passage timing of wild/natural Snake River fall Chinook.

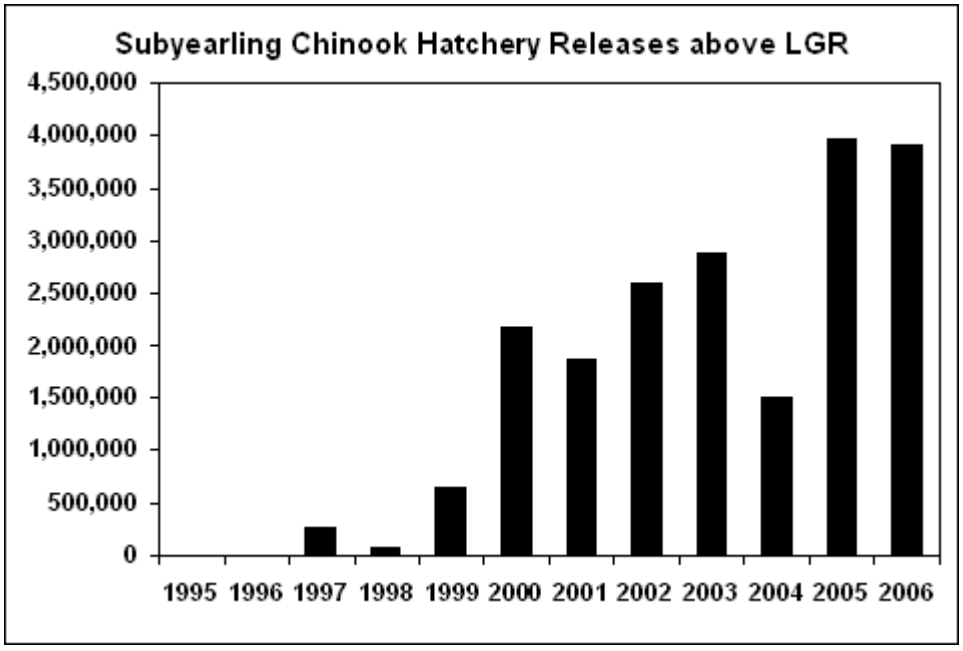


Figure 5. Hatchery releases of subyearling fall Chinook above Lower Granite Dam (MY 1995-2006).

Table 3. Snake and Clearwater River hatchery sub-yearling Chinook release dates and release time spans from 1995-2006.

Migration	Snake River Hatcheries				Clearwater River Hatcheries			
Year	PLAP	CJRAP	HCD	GRR	BCCAP	NPTH	CLWR	LAPW
1995	5/18-8/17							
1996	6/6-7/10						6/6-7/10	
1997	5/28-7/8				6/3-7/8 6/10-6/13			
1998	5/14-7/7				6/2-7/8			
1999		5/30-6/5			6/2-6/3			
2000	5/24-5/26	5/20-5/31 6/15-6/23			5/30-6/1 6/20-6/26			
2001	5/28 6/1-7/6	5/26	5/16-6/19		5/29 5/29-7/4 6/13			
2002	5/27-5/29	5/28 6/20	5/21		5/27-5/28 6/18-6/19			
2003	6/4	5/28 6/9-6/16 6/12	5/1-5/16 5/22		6/3	6/3-6/5 6/19-6/21		5/28-5/31
2004	5/24 5/31	5/26-6/1	5/28		5/31-6/3	6/4-6/11		
2005	5/23-5/24	5/16-5/30 5/23 5/23-5/27 5/26	4/28 5/13	5/24-5/25	5/30-5/31 6/21-7/8	5/7		
2006	5/24	5/15-6/2 5/26-5/29 5/30	5/2 5/8-5/10	6/19-6/21	5/25-5/26 6/19-7/9	6/8-6/15	5/17	6/13 6/13

Natural/wild fall Chinook juvenile migrants have migrated at a smaller size and at earlier dates since 2000, when hatchery releases increased dramatically in the Snake River. Coincidently, the mean date of PIT tag marking of natural/wild fall Chinook juveniles has also been earlier.

The PIT tag groups for natural/wild juvenile fall Chinook in the Snake River shows a shift in mean tagging date after 1999 (Figure 6) concurrent with the large increase in the subyearling hatchery releases in the Snake River after 1999 (Figure 5 above). When data for 1991-1999 is pooled and compared with 2000-2007 the mean tagging date is 11.5 days earlier (May 23rd versus June 4th) The mean fork length of fish tagged has also decreased from 74 mm +/- 0.10 SE 1991-1999) to 69 mm +/- 0.04 SE (2000-2007).

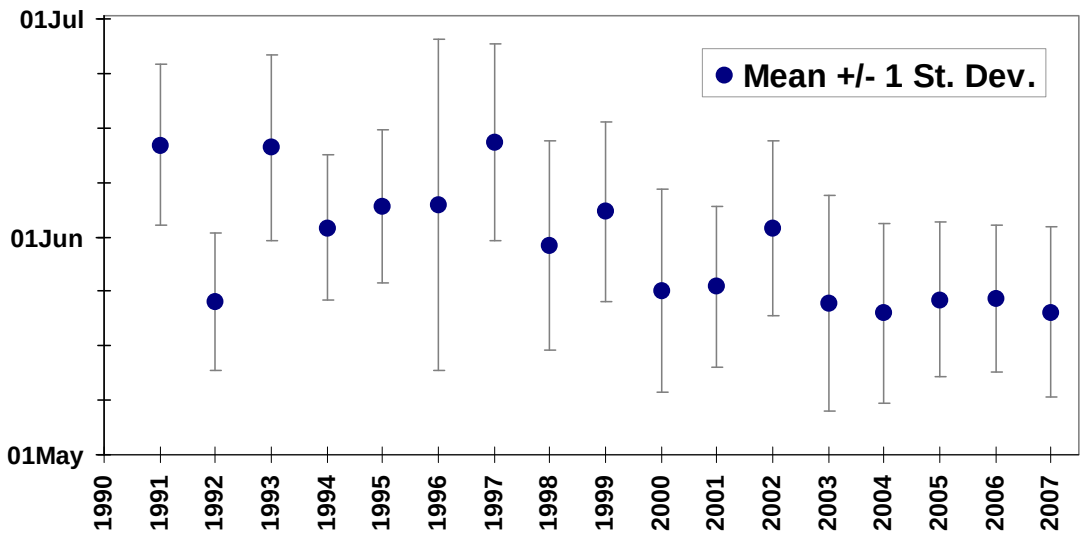


Figure 6. Date of PIT tagging for sub-yearling natural/wild fall Chinook in the Snake River (1991-2007). The mean date for each year is shown +/- 1 standard deviation.

In addition to the changes in the mean date of tagging and size at tagging, the mean date of arrival at LGR for bypassed fish is approximately19 days earlier for the 2000-2007 group (June 26th versus July 16th). This earlier arrival time at LGR for bypassed fish was not expected given that smaller sized fish should take longer to develop and start their outmigration.

The travel time for bypassed fish from their release to granite also appears to be decreasing. Fish travel time is often expressed as a median value instead of a mean. These data show a decreasing trend in the median fish travel time from release to LGR (Figure 7).

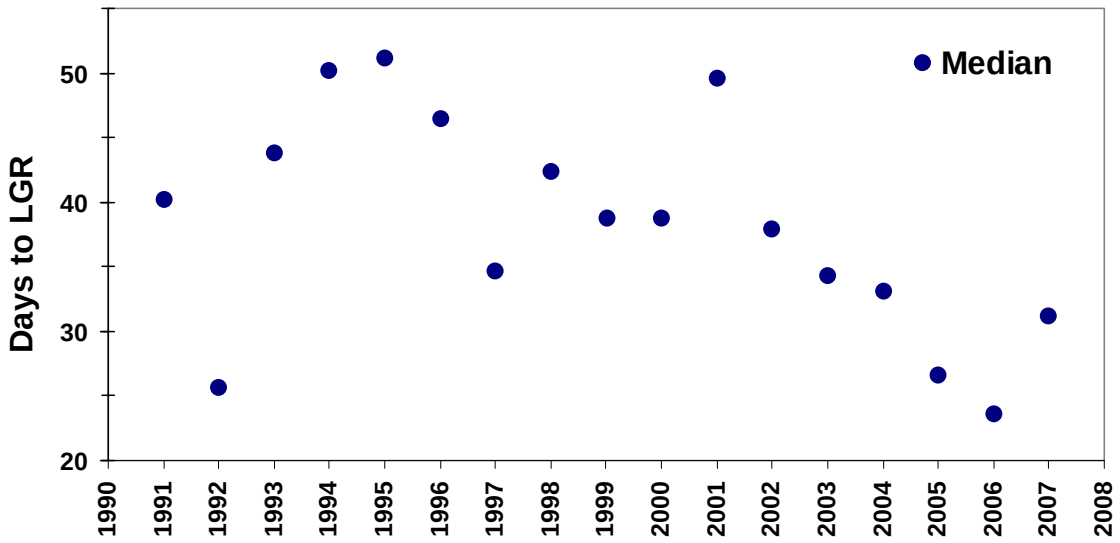


Figure 7. PIT tagged Snake River natural/wild median fish travel time from tagging date to LGR (1991-2007). Each filled circle is the median value for fish bypassed at LGR in a particular year.

The driving factors for these changes in fish size at marking, arrival time at LGR, and travel time to LGR in the Snake River across the historic data are unknown. However, with the concurrent increase in subyearling hatchery releases it is possible that population density factors and/or competition for resources may play a role. It also could be possible that a portion of the untagged subyearling Chinook hatchery releases are being marked as natural/wild Chinook and confounding the monitored natural/wild population.

Recent improvements to river operations for fall Chinook including improved flow and spill for fish passage has improved survival.

In order to characterize the migration characteristics of subyearling fall Chinook the PIT-tag data from hatchery/production subyearling fall Chinook releases above Lower Granite Dam were analyzed to estimate survival and travel time in the reach Lower Granite Dam to McNary Dam. Fish were grouped into two-week blocks based on their detection date at Lower Granite Dam. Survival and travel time were estimated, as well as downstream timing past Little Goose, Lower Monumental, Ice Harbor, and McNary dams. Timing data was used to estimate the average in-river conditions the fish experienced passing through the river reach; such as water transit time, discharge, spill percentage and water temperatures at the dams and reservoirs. The relationship between survival through the reach Lower Granite Dam tailwater to McNary Dam tailwater was compared to in-river conditions in a series of bi-variate weighted regressions. Generally, survival was highest during periods of high flow and spill and cooler temperatures (Figures 8 to 10). Court ordered summer spill appeared to improve survival in recent years when flows were lower and temperatures warmed, compared to prior years when spill ended June 20. For actively

migrating subyearling Chinook, increased spill and decreased water transit time (higher flows) appear to improve survival, while higher temperatures decrease survival.

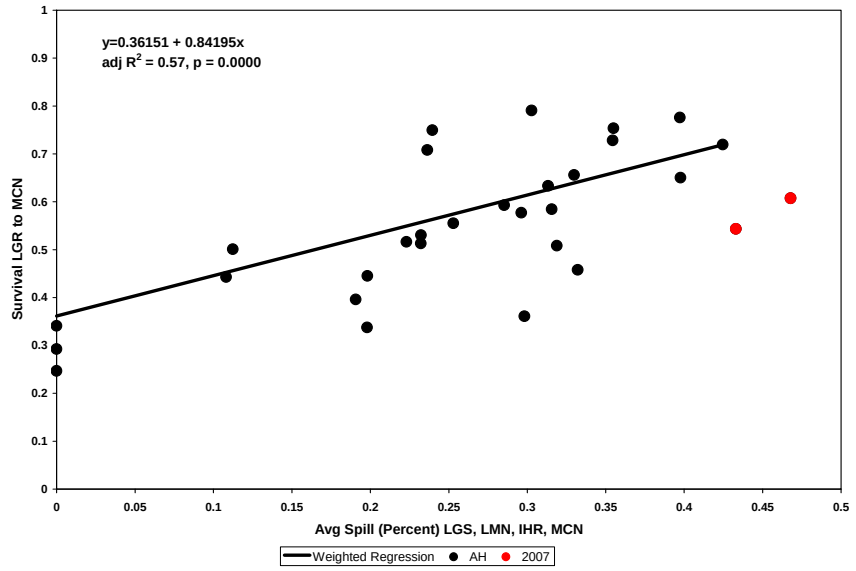


Figure 8. Subyearling Chinook survival LGR to McN plotted against average spill proportion at LGS, LMN, IHR and McNary dams from 1998 to 2007. Data points for 2007 are in red.

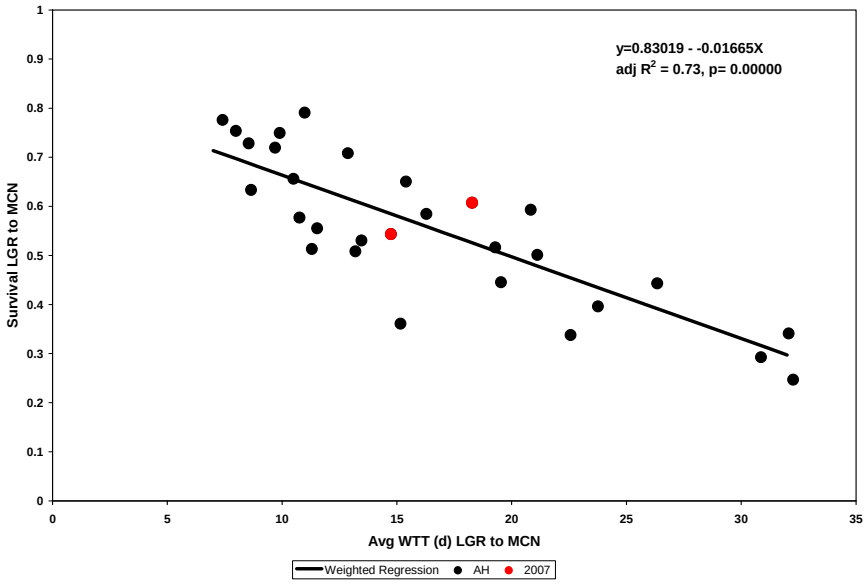


Figure 9. Subyearling Chinook survival LGR to McN plotted against water transit time from LGR tailwater to McNary Dams from 1998 to 2007. Data points for 2007 are in red.

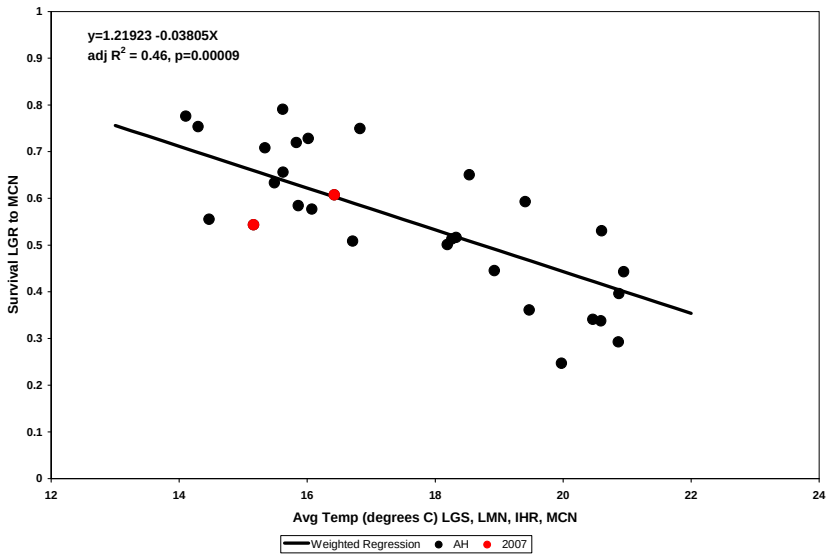
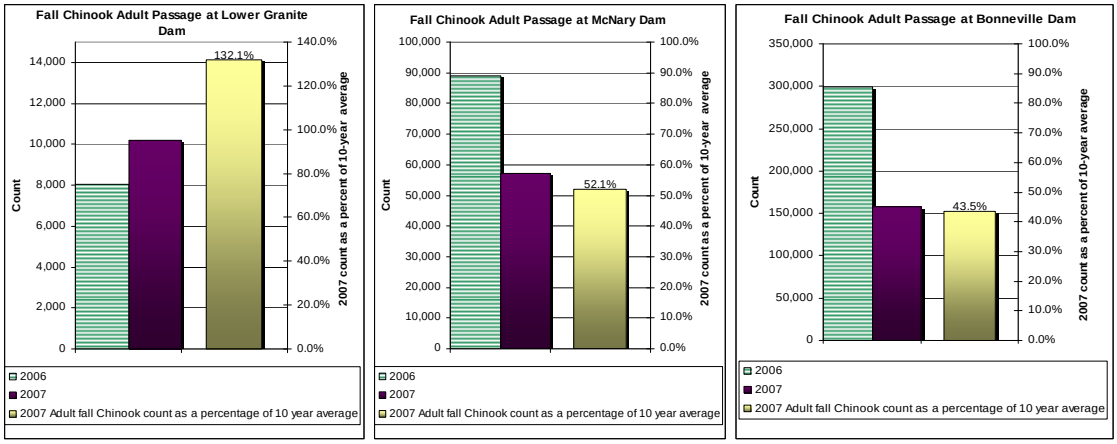


Figure 10. Subyearling Chinook survival LGR to McN plotted against average temperature (degrees C) measured at tailwater TDG monitors at LGR, LGS, LMN, and IHR dams from 1998 to 2007. Data points for 2007 are in red.

In 2007 Lower Granite adult fall Chinook returns were notable because while fall Chinook adult returns to Bonneville Dam and to McNary Dan were well below their ten year average and the 2006 return, returns to Lower Granite were above the 2006 return and the ten year average for Lower Granite. The adults returning in 2007 are comprised of juvenile out migrants primarily from 2004 and the first year of spill in 2005 giving an indication that summer spill for fish passage and reduction in proportion of fish transported is beneficial.

Reservoir operation changes such as shifting flow augmentation from August to September, decreasing water temperature of flow augmentation from Dworshak reservoir, implementing a spill for fish passage operation at transportation collector projects and large increases in the fall Chinook hatchery production releases above Lower Granite Dam have all had an impact on fall Chinook. The fall Chinook adult return is an indicator that these changes or some combination of these changes, are providing a significant benefit to fall Chinook adult returns. The full affect of implementation of spill for fall Chinook and reduction of transportation has not yet been observed. It is clear that implementing the NOAA proposed trigger will eliminate spill for fall Chinook migrating in August and it is clear that eliminating spill will be detrimental to those migrants. The following graphs show that fall Chinook adults have returned at levels higher than their ten year average and higher than 2006 while Bonneville and McNary returns are depressed.



Lower Granite McNary Bonneville

Figure 11. The 2007 adult returns of fall Chinook at Lower Granite, McNary and Bonneville dams compared to the 2006 returns and the 10 year average returns.