FISH PASSAGE CENTER

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

MEMORANDUM

TO: FPAC

FROM: Michele DeHart

DATE: February 18, 2009

RE: Fish Passage Plan, transportation dates and spill

Transportation start dates

In response to your request, the FPC staff reviewed the effects of the April 20, transportation start dates proposed in the Fish Passage Plan draft versus the a May 1, start date implemented over the past two years, for transportation at Lower Granite Dam (LGR) on wild/hatchery steelhead and wild/hatchery Chinook. We compared these two start dates in terms of fish passage timing and where possible, within-season SAR information to indicate which date would be most beneficial for all stocks involved***. We found no evidence to support changing the start date of transportation at LGR from the May 1, protocol implemented over the past few years to April 20 as proposed in the Corps of Engineers Fish Passage Plan.***

In these analyses, we used passage timing data for wild/hatchery Chinook and wild/hatchery steelhead from 2006-2008. We also compared within-season SAR information for wild/hatchery Chinook from 1998-2006; this information for wild/hatchery steelhead was too sparse to make comparisons and support a valid analysis. The PIT tagged fish used here are all part of the Comparative Survival Study (CSS), are marked and released above LGR dam, and should be representative of the run-at-large. The CSS mark groups are considered the most representative of the run-at-large because of the significant bias introduced in tag groups collected, marked and bypassed at Lower Granite Dam. This bias was discussed and recognized at May 2, 2008 meeting among the Independent Scientific Advisory Board, NOAA and members of the Comparative Survival Study Oversight Committee. Review and discussion of results indicated that SARs for wild Chinook collected, marked and bypassed at Lower Granite were only 59% of those for wild Chinook marked above the hydrosystem and bypassed at Lower Granite (subset of the CSS C1 group), and 53% of those of wild Chinook not collected and bypassed at the Snake River transport dams (CSS C0 group). Similarly, the SARs of wild steelhead collected, tagged and bypassed at LGR were 62% of those for wild steelhead marked upstream of the hydrosystem and bypassed at Lower Granite and 60% those of the C0 group. The SARs of transport groups collected, tagged and transported from LGR were also somewhat less than for those tagged above the hydrosystem, but the magnitude of difference was less than for in-river groups. Consequently, TIRs of wild Chinook and steelhead from the LGR tagging study were likely inflated, and the date for transport benefit was artificially shifted earlier in the season. All participants in that meeting recognized the bias introduced by marking at Lower Granite Dam.

These analyses indicate that starting transportation on May 1 at LGR provides the most benefit while incurring the least risk. Our primary conclusions are:

1. Starting transportation before May 1, at Lower Granite Dam would likely result in transport of much more than 50% of outmigrating wild/hatchery Chinook.
2. At least 75% of wild/hatchery steelhead passing Lower Granite, pass the project after May 1.
3. Annual transportation SARs for wild/hatchery Chinook typically fall below the Northwest Power Council (NPCC) SAR objectives for recovery of these stocks (2% minimum, 4% average; CSS 10-year report).
4. Within-season transportation SARs after May 1, are usually at their highest for both Chinook stocks, and have the least risk of being detrimental for wild Chinook.
5. Passage distribution and SAR data indicate a May 1, start of transportation date at Lower Granite as the lowest risk and best balance among stocks at Lower Granite.
6. Utilizing recent fish travel time data, with spill in place at all projects, juvenile salmon passing Lower Granite prior to May 1, would be past Little Goose Dam by May 4, and Lower Monumental Dam by May 8. Recent juvenile fish travel time indicates a start of transportation date at Little Goose on May 4 and start of transportation at Lower Monumental on May 8.

Timing plots for wild/hatchery Chinook and steelhead

We created timing plots for Lower Granite, Little Goose, and Lower Monumental dams using wild/hatchery Chinook and steelhead that were PIT-tagged and released above LGR in the Clearwater, Grande Ronde, Salmon, Imnaha, and mainstem Snake rivers. In addition, wild Chinook and wild/hatchery steelhead released into the Tucannon River were included in the Lower Monumental Dam passage plots. The timing distributions included those PIT-tagged fish detected at these three dams between April 1 and June 30 of 2006, 2007, and 2008, respectively. A daily passage index adjustment (PI) was created using the Corps of Engineers powerhouse flow and spill data and the raw PIT-tag detections where the daily PIT-tag count was divided by proportion flow passing through the powerhouse. This adjustment helps account for changes in the daily spill proportion over the migration season, and provides a measure of the relative daily number of the PIT-tag fish arriving each dam. The cumulative distribution of the daily PI-adjusted PIT-tag detection data is plotted to show the temporal distribution of passage for each year and dam.

Timing plots for Chinook at LGR indicate that starting transportation at LGR on 20 Apr (with a staggered start date at LGS and LMN) would likely result in transport of much more that 50% of outmigrating wild/hatchery juvenile Chinook smolts (Figure 1 & 2). Conversely, the majority of wild/hatchery steelhead (which may benefit from transportation) usually pass LGR after May 1. Typically less than 25% of wild/hatchery steelhead passed any of the dams before May 1; this excludes the 2006 wild steelhead where the median date of passage was near May 1 (Figure 2 & 3; Table 1). The initiation of transport before May 1 at LGR is counter to a "spread the risk" approach. Passage data supports a transportation start date of May 1 at LGR.

Transportation is lagged at LGS and LMN to allow fish passing Lower Granite prior to May 1, to continue their migration downstream avoiding collection and transportation at downstream sites. An estimate of median inter-dam fish travel times was calculated as the difference in median dates of passage at each dam (*ie.* median[LGS] – median[LGR]). This was used to examine the magnitude of lag for transportation start date between projects. The average fish travel time (rounded to the nearest day) across all species and years was 3 days and 4 days from LGR to LGS, and LGS to LMN respectively. This is similar to the current lag between LGS & LMN and substantially lower than for LGR to LGS. Visually, this lower fish travel time can be seen in Figures 1-4 as the space between cumulative passages at each dam. It is possible that this lower travel time is due to higher levels of court ordered spill in more recent years. Recent average juvenile fish travel time data between projects suggests a 3 or 4 day lag time between projects.

Table 1 Proportion of PI-adjusted PIT-tag detection distribution occurring from May 1 through June 30 for hatchery Chinook (5 CSS hatcheries), wild Chinook, wild steelhead, and hatchery steelhead originating above Lower Granite Dam.

Year	Dam	Hatchery Chinook	Wild Chinook	Hatchery Steelhead	Wild Steelhead
2006	LGR	0.70	0.53	0.73	0.54
	LGS	0.79	0.65	0.78	0.56
	LMN	0.83	0.62	0.83	0.48
2007	LGR	0.75	0.52	0.88	0.87
	LGS	0.83	0.56	0.88	0.88
	LMN	0.95	0.87	0.98	0.96
2008	LGR	0.91	0.78	0.82	0.88
	LGS	0.97	0.90	0.83	0.91
	LMN	0.99	0.96	0.97	0.97

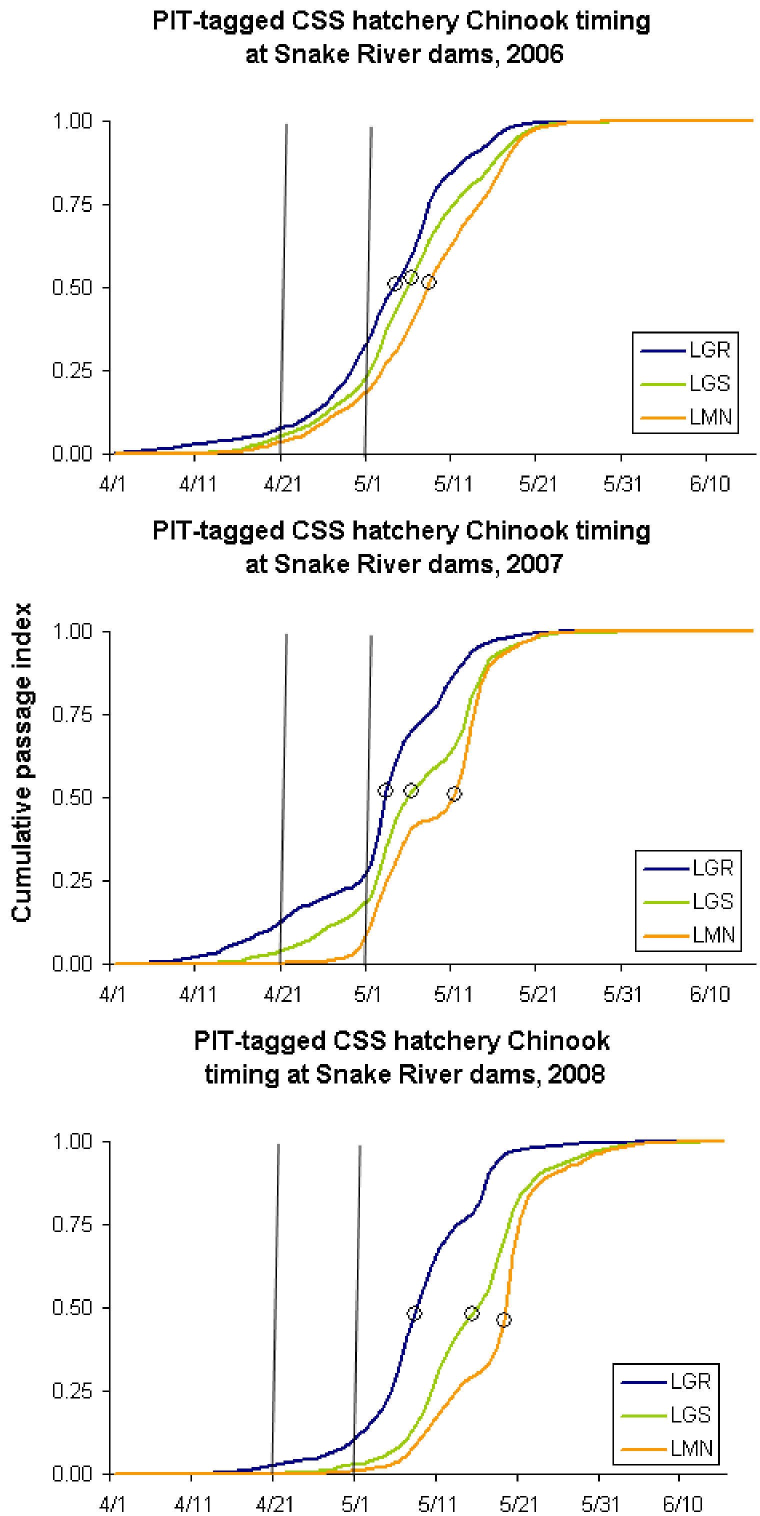

Figure 1. Hatchery Chinook daily timing plots for 2006, 2007, and 2008. The date most near 50% passage is circled for each dam.

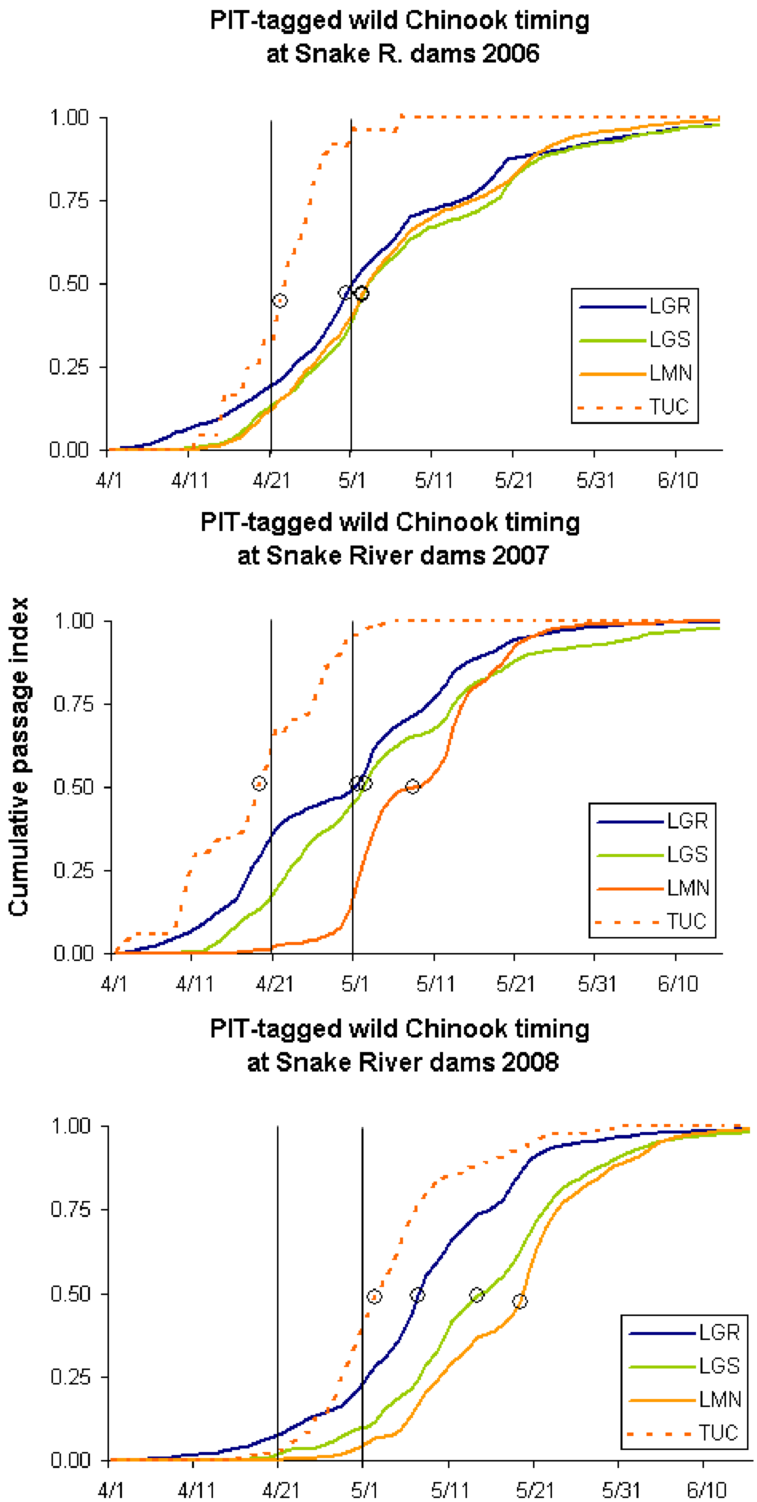

Figure 2. Wild Chinook daily timing plots for 2006, 2007, and 2008. The date most near 50% passage is circled for each dam. Also show (dashed line) is the passage for stocks from the Tuccanen River at LMN.

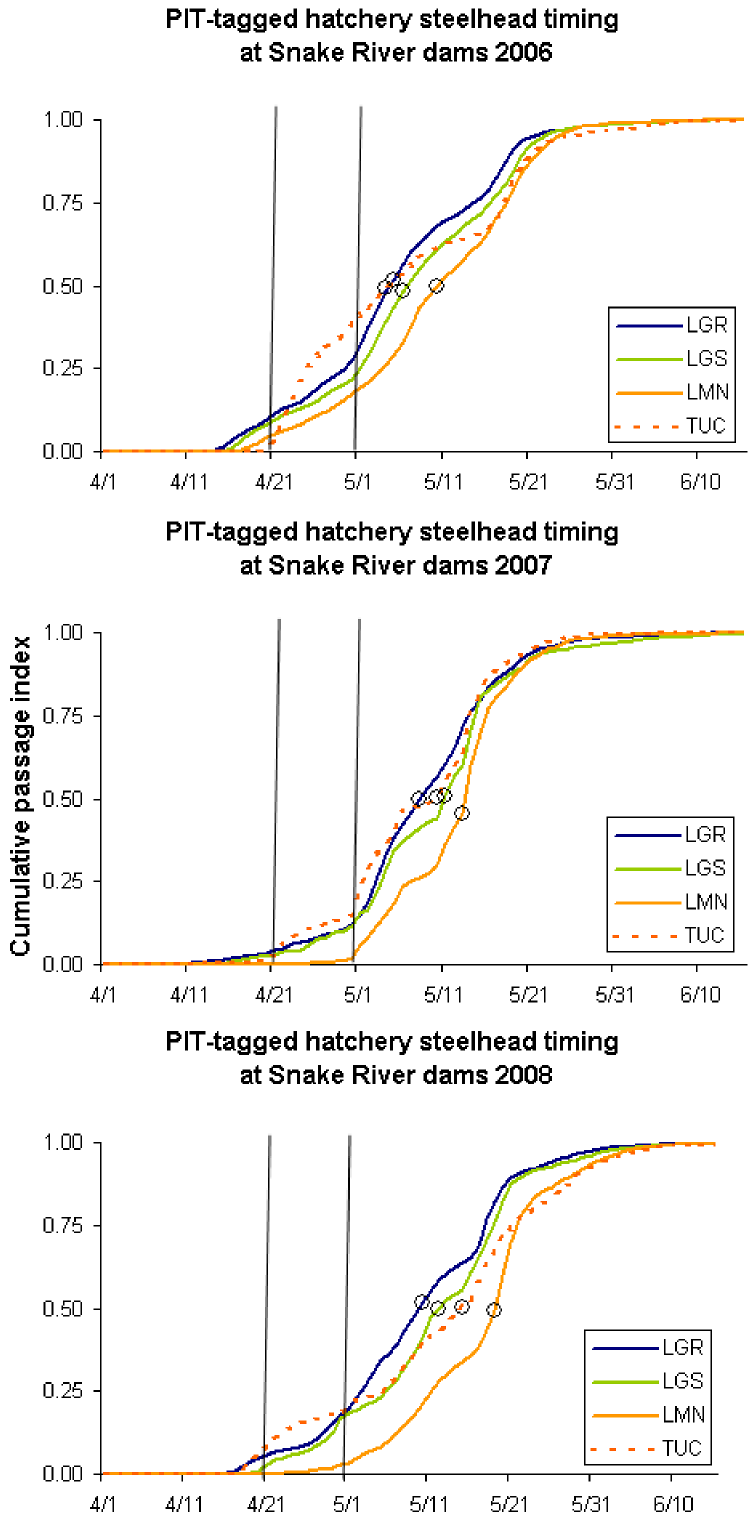

Figure 3. Hatchery steelhead daily timing plots for 2006, 2007, and 2008. The date most near 50% passage is circled for each dam.

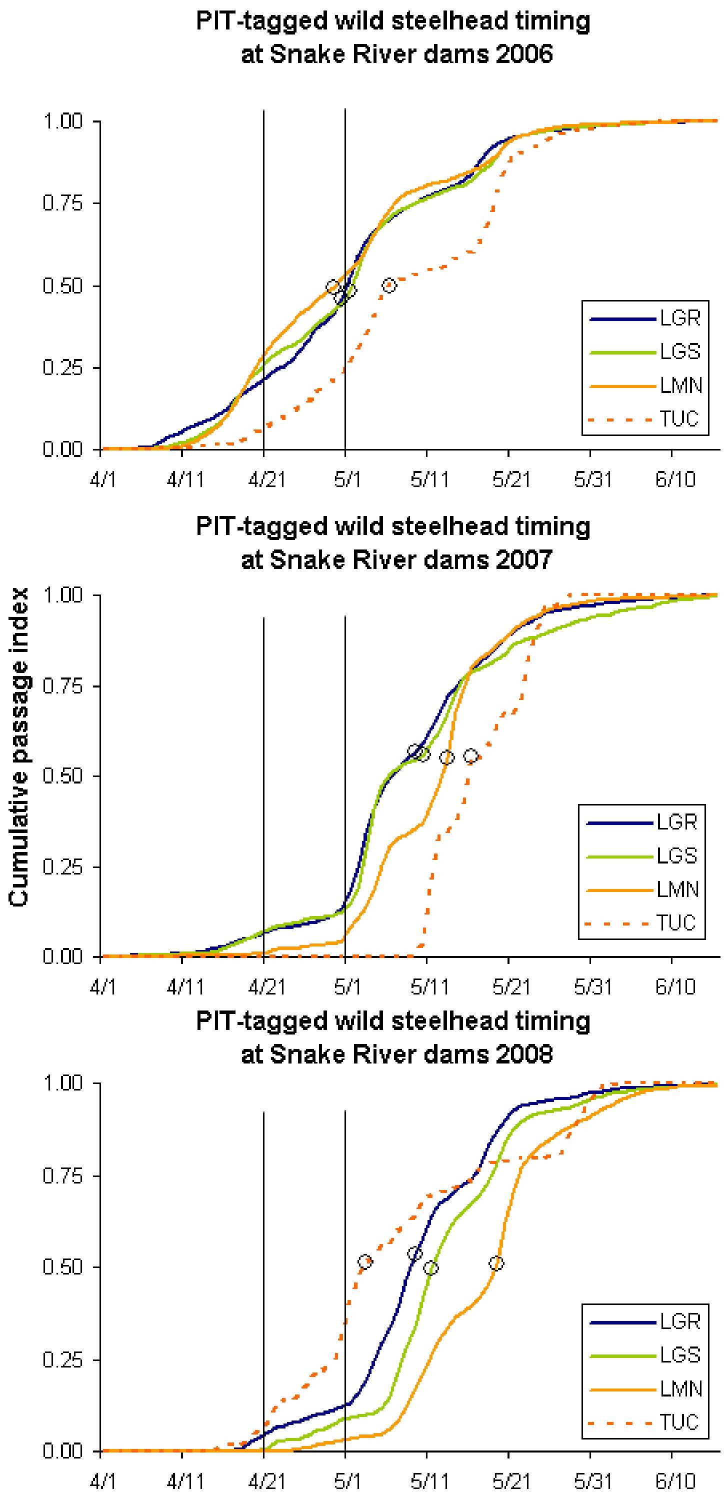

Figure 4. Wild steelhead daily timing plots for 2006, 2007, and 2008. The date most near 50% passage is circled for each dam.

Within-season SARs for wild/hatchery Chinook

The CSS has established a long-term data set for survival rate of annual generations of salmon from their outmigration as smolts to their return to freshwater as adults to spawn (smolt-to-adult return rate; SAR). The results from this study have shown that overall, the SARs for wild spring/summer Chinook and wild steelhead have fallen short of the Northwest Power Council (NPCC) SAR objectives for recovery of these stocks (2% minimum, 4% average; CSS 10-year report). When evaluating transportation during 1994-2003 for Wild Chinook, it was found that, "transportation as currently implemented is not of benefit for wild Chinook, regardless of transportation project" (CSS 10-year report, chapter 4). For wild steelhead during 1997-2002, transportation did appear to provide a benefit at LGR with a decline in benefit at lower projects. This work evaluated migration years where transportation started about the same time that the bypass facility was operational.

The start date of transportation at LGR has been changed from May 1 (as in 2007 and 2008) to April 20 for 2009. However, there is evidence that a transportation program that starts in April is not beneficial to wild Chinook. The SARs for bypassed Chinook have a seasonal pattern with relatively high values early in the migration season and relatively lower values later; the result is that transportation of collected fish over the entire migration season is likely not optimizing the overall wild Chinook SAR (CSS 10-year report, chapter 4).

Within season SARs , often have large confidence intervals that overlap and should be considered cautiously in management considerations; this is due to the relatively small sample size. In addition within season SARs only allow comparison of bypassed fish 9i.e. detected) fish and transported fish. Fish that are bypassed at one or more collector dams have a consistently lower SAR than fish passed that passed in spill CSS Ten Year Report) So when comparing transported fish to bypassed fish this artificially inflates the benefits of transportation.. This bias will artificially inflate the benefits of transportation. As a result within season SARs by themselves do not provide a valid basis for evaluating the benefits of transportation as a mitigation measure. Within season SARs are being provided to managers in addition to the primary passage timing/distribution data for their consideration of transportation start dates. We have calculated SARs for fish tagged above LGR as part of the CSS study in seasonal time blocks. We calculated SARs for transport and bypassed routed fish for wild/hatchery Chinook (1998-2006). These were calculated for three specific date ranges: April 20 (early), April 20-May 1 (mid), May 1- June 30 (late). Then we tested for a difference in each specific SAR between the two routes of passage (transported or bypassed at LGR). This comparison artificially inflates the benefits of transportation. The objective of this exercise was to weigh the risk of transport versus bypass, however realizing that passing in spill is likely the most beneficial for juvenile migrating salmon and steelhead.

We first calculated the point estimate of transport or bypass SARs within the above dates for each year and group of fish. Next, we used a non-parametric bootstrap approach (*e.g.* resampling with replacement) and calculated a new test statistic θ where, $\theta = SAR_{transport} - SAR_{bypassed}$. The 90% confidence interval around this statistic in relation to the value zero was used to indicate whether the transport SAR was greater than the bypassed SAR (*benefit*), less than the bypassed SAR (*no benefit*), or whether there was no statistical difference between the two routes of passage (*no difference).* Since, the CSS was designed to establish annual SARs, and these are subdivisions of those, these data have broad confidence intervals. For this reason, cases where less than 100 fish were available were not used (this approach was attempted for wild/hatchery steelhead but the sample sizes were too sparse). The point estimates for the transport SARs, and the results of the significance tests are summarized in Figures 5 and Table 2.

Transport SARs are most often below a level that would be required for recovery of listed stocks (The 2-4% target SAR for recovery established by the NPCC). For Chinook during 2002-2006 this is never achieved in any time period for hatchery or wild stocks. The late time period (transportation after 01May) yielded the value SAR within a year (8 of 9 years for hatchery Chinook and 5 of 9 years for wild Chinook; Figure 5).

The value of transporting hatchery and wild Chinook can be ascertained from the results of the significance tests where transport SAR is compared to in-river SAR. Where we were able to statistically test for a difference, there was no clear benefit to transportation during the early period for either stock (*i.e.* < 20Apr). Hatchery Chinook did benefit from transportation during the late period and less clearly during the middle period (20Apr – 01 May). However, there was no clear benefit of transportation for wild Chinook during the middle period (20Apr – 01 May). During the late period there did appear to be a benefit to wild Chinook but more often there was no detectable difference or no benefit (5 of 9 years). The effects of delaying transportation until 01May could maximize the efficacy of transportation for both stocks because this is the period with the highest transport SAR (within a year) for wild/hatchery Chinook and the period with the least risk of being detrimental for wild Chinook.

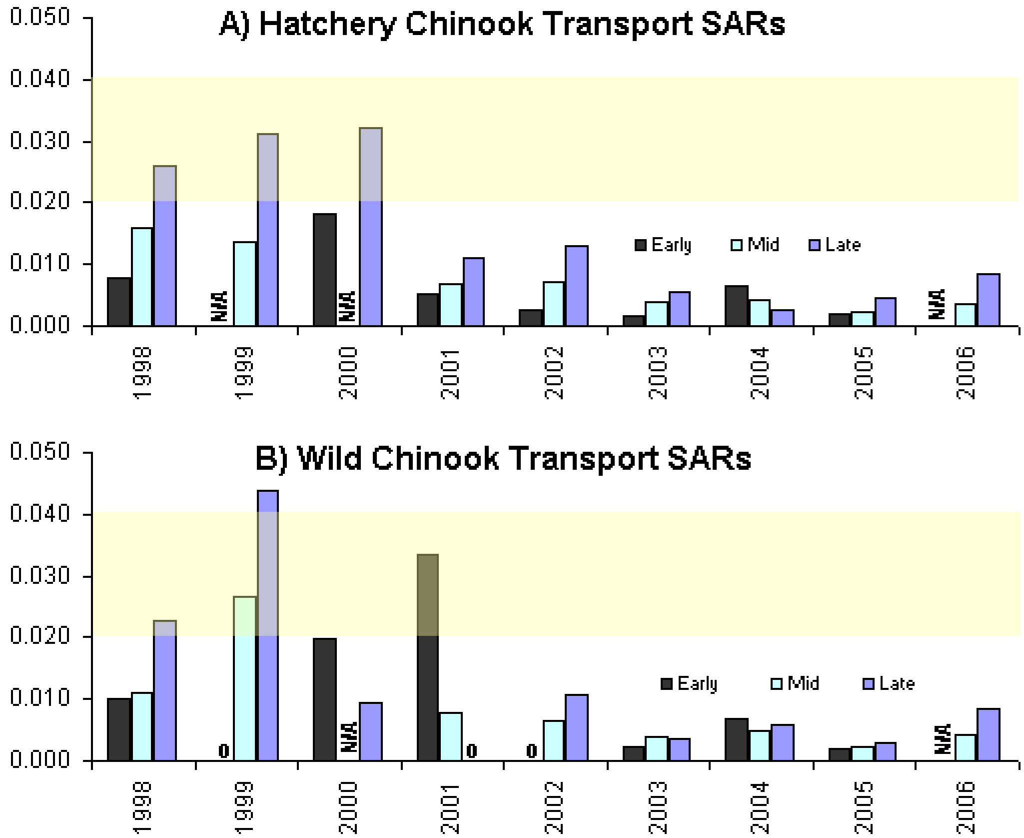

Figure 5. Chinook transport SARs for 3 time periods (< 20Apr, 20Apr-01May, > 01 May) at Lower Granite Dam. Panel A and B are hatchery and wild Chinook respectively. N/A denotes occasions with fewer than 100 smolts, a zero denotes occasions where no adults returned. The yellow shaded portion of each plot denotes the 2-4% SAR required for recovery of these stocks (Northwest Power Council).

Table 2. A summary transportation SARs for Chinook compared with bypass SARs over 3 time periods (< 20Apr, 20Apr-01May, > 01 May) at Lower Granite Dam. If the transport SAR was statistically greater than , less than or equal to the bypass SAR, then "Benefit", "No benefit", or "No difference" is shown respectively. N/A denotes occasions with fewer than 100 smolts transported from LGR.

	Hatchery Chinook			Wild Chinook		
	early	Mid	Late	early	Mid	Late
1998	**No benefit**	Benefit	Benefit	**No benefit**	No difference	Benefit
1999	N/A	Benefit	Benefit	**No benefit**	No difference	Benefit
2000	Benefit	Benefit	Benefit	No difference	N/A	No difference
2001	Benefit	Benefit	Benefit	Benefit	No difference	**No benefit**
2002	**No benefit**	No difference	Benefit	**No benefit**	No difference	No difference
2003	No difference	Benefit	Benefit	No difference	No difference	No difference
2004	Benefit	Benefit	Benefit	No difference	Benefit	Benefit
2005	No difference	No difference	Benefit	No difference	No difference	Benefit
2006	N/A	No difference	Benefit	N/A	No difference	No difference

Potential spill for fish passage operations

At this time there have been discussions occurring in various forums such as the Fish Facility Design Review Work Group (FFDRWG) relative to the amount of spill that will occur in 2009 at Ice Harbor and McNary dams. The spill levels being discussed would be included in the presently being developed Fish Operations Plan, which will be Attachment E of the 2009 Fish Passage Plan. These changes will impact the volume of water spilled, which may affect fish survival a these projects.

Historically, significant changes in spill have occurred at both Ice Harbor and McNary dams over the past several years in attempts to achieve increased survival of salmonids past these two projects. Table 1 below tracks those changes related to the different Biological Opinions through the 2005 Court Order. The 2008 Biological Opinion calls for the same spill amounts to be implemented as the 2005 Court Order, but changes the date of implementation of summer spill to 6/1 at Ice Harbor and 6/16 at McNary Dam. Spill can also be terminated after August 1 based on fish numbers collected.

Table 1. Spill levels as recommended by the Biological Opinion or Court Order in place at the time.

Project	1995 BIOP	1998 BIOP	2000 BIOP	2004 BIOP	Court Order 2005
IHR	27%/27% (25Kcfs)	45K/GC (75Kcfs)	45K/100Kcfs	45K/GC (105Kcfs)	45K/GC v 30%/30%
MCN	0/50% (120Kcfs)	0/GC (150Kcfs)	0/120-150Kcfs	0/GC (170Kcfs)	40%/40% spring 40%/40% vs 60%/60% summer

At Ice Harbor Dam the Court Order has been in effect with a comparison between operating the project at 45 Kcfs spill during daytime hours and spilling to the gas cap at night versus spilling a continual 30% spill for 24 hours. There has been some discussion that the yet to be released Fisheries Operation Plan (FOP) for 2009 operations will call for a flat spill of between 30 and 35%. This flat spill will represent a decrease from the Court Order in the overall volume spilled. Based on data collected between 2006 and 2008, using actual operations and accounting for excess generation spill we would predict that a 30%/30% operation for spring and summer at IHR would result in a 25-35% decrease in the total spill volume over what has been seen in recent years (Table 2).

While changing the operation at IHR to 35%/35% spill for the entire season has a smaller effect, this operation would still result in a 17-29% decrease in the total spill volume at IHR (Table 2). We will model the actual operations when the Draft FOP is released.

Table 2. Spill volumes at IHR under 2005 BiOP (Actuals) and estimated spill volumes under operations being discussed for the 2009 FOP.

Water Year	Actual Spill Volume (KAF)	Estimated Spill Volume (30%/30% Spring & Summer) (KAF)	Estimated Spill Volume (35%/35% Spring & Summer) (KAF)
2006	11,571	8,695	9,612
2007	7,904	5,188	5,601
2008	12,277	7,929	8,780

The situation for McNary Dam is a little more complex. The testing conducted since the Court Order in 2005 has compared a 40% spill level for 24 hours at different spill configurations during the spring, and a 40% for 24 hours versus a 60% for 24 hours during the summertime. The discussions have centered on continuing the 40% spill in the spring and adopting a 50% spill level during the summer, which is a reduction from the 40 to 60% spill summer operation that has occurred for the past two years. For the historic summer period of July 1 to August 31, adopting a summer spill operation of 50% (24 hours) at MCN would result in a slight increase in total spill volume over what has been seen in recent years (Table 3). This slight increase is likely due to those periods in August where flows are sufficiently low where maintaining the ordered 60% spill level was not possible, given project minimums of 50 Kcfs. However, it is important to note that this analysis assumed spill continued through August 31, which may or may not occur.

Table 3. Summer spill volume (July 1-August 31) under 40%/40% vs. 60%/60% tests and estimated summer spill volume under proposed 50%/50% at McNary Dam.

Water Year	Actual Summer Spill Volume (40%/40% vs. 60%/60%) (KAF)	Estimated Summer Spill Volume (50%/50% Summer) (KAF)
2006	10,066	10,225
2007	10,000	10,028
2008	10,412	10,580

The spring studies at McNary Dam have shown that 40% spill does not achieve the performance standards adopted in the 2008 Biological Opinion. Actual river operations during 2008 when flows were higher showed that spill in excess of 40% (about 55%) got closer to the performance standards for Chinook. Consequently, it does not make sense to continue the 40% spill during the spring period. The 2009 Fish Operations Plan should include, at a minimum, the operation of McNary testing 40% vs 60% during the spring migration. Assuming these spill levels would alternate in 2-day blocks and run through June 30, this operation would result in a 2-22% increase in total spring spill volume over what has been seen in recent years under the 40%/40% operation (after accounting for over-generation spill) (Table 4).

Table 4. Spring spill (Apr. 10-June 30) under 40%/40% spring operation and estimated spring spill under 40%/40% vs. 60%/60% test proposal.

Water Year	Actual Spring Spill Volume (40%/40%) (KAF)	Estimated Spring Spill Volume (40%/40% vs. 60%/60% in Spring) (KAF)
2006	22,731[A]	23,094
2007	15,898	19,426
2008	19,132	20,800

[A] 2006 spring operations at McNary Dam called for a test of 0/gas cap versus 40%/40% spill. However, due to high flows, the 0/gas cap operation was often not possible, as powerhouse capacity was exceeded during most of this period. In most days, at least some spill provided during the daytime hours.

Berggren, T., H. Franzoni, L. Basham, P. Wilson, H. Schaller, C. Petrosky, E. Weber, and R. Boyce. 2005. Comparative Survival Study (CSS) of PIT-tagged Spring/Summer Chinook and PIT-tagged Summer Steelhead. 2005 Annual Report, BPA Contract # 19960200.

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Schaller, H., Wilson, P., Haeseker, S., Petrosky, C., Tinus, E., Dalton, T., Woodin, R., Weber, R., Bouwes, N., Berggren, T., McCann, J., Rassk, S., Franzoni, H., and P. McHugh. 2007. Comparative Survival Study (CSS) of PIT-Tagged pring/Summer Chinook and Steelhead In the Columbia River Basin. Ten-year Retrospective Analyses Report, BPA Contract # 25247.