FISH PASSAGE CENTER

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MEMORANDUM

TO: Ed Bowles, ODFW

FROM: FPC Staff

DATE: July 8, 2010

RE: Preliminary Reach survival estimates and transport probabilities for Spring migrant juvenile salmon from the Snake River Basin in 2010

In response to your request, the Fish Passage Center estimated survival of yearling spring/summer Chinook, steelhead and sockeye from Lower Granite Dam to McNary Dam and Lower Granite Dam to Bonneville Dam in 2010. We estimated survival in index reaches and compared those survival estimates to historic survivals in the same reaches. Based on our preliminary analysis it appears juvenile salmon survival through the Lower Granite to Bonneville Dam reach was similar to 2009 and as such at or above the historic average. We also estimated transport proportions for spring migrants. Our estimates show relatively low transport proportions particularly for sockeye but also for hatchery Chinook and steelhead. Flows in the Snake River were relatively low in 2010. However, spill was provided as mitigation for these anticipated low flows and it appears that it was effective in maintaining in-river survival at levels at or above those estimated for other recent years. The average spill percentage at the three transportation collection dams during April and May of 2010 was 38%, the highest in the past ten years. Spill percentage at Lower Granite Dam averaged 44% during April which was also the highest average in the past ten years. In addition spill at Lower Monumental Dam averaged 48% in April and May which was much higher than seen at that site in the past ten years for that two month period. As a result of high spill percentages transportation probabilities were relatively low in 2010 for yearling Chinook, steelhead and sockeye.

A summary of our preliminary findings are bulleted below followed by more detailed discussions of each point.

- Steelhead survival in the reach Lower Granite Dam to McNary Dam was estimated at 0.82 (standard error 0.07) which was high compared to historic average of 0.60 for the years 1998 to 2009 and similar to 2009 estimates.

- Steelhead survival from Lower Granite Dam to Bonneville Dam was estimated at 0.52 (s.e. 0.039) which was higher than the average of 0.45 for annual reach survival estimates by NOAA (2009) for the years 2003 to 2009.

- Hatchery yearling Chinook survival from Lower Granite Dam to McNary Dam was estimated at 0.79 (s.e. 0.024) compared to historic average of 0.74 for the years 1998 to 2009.

- Hatchery yearling Chinook survival from Lower Granite Dam to Bonneville Dam was estimated at 0.72 (s.e. 0.07) which would be considered very high compared to historic average. However the estimate is suspect due to an unusually high survival in the reach between McNary Dam and John Day Dam of 1.15.

- Wild yearling Chinook survival in the reach Lower Granite Dam to McNary Dam was estimated at 0.78 (s.e. 0.029) compared to historic average of 0.72 for the years 1998 to 2009.

- Wild yearling Chinook survival in the reach Lower Granite Dam to Bonneville Dam was estimated at 0.59 (s.e. 0.11) compared to historic estimates by NOAA (2009) for the years 2003 to 2009 that averaged 0.54.

- Hatchery sockeye survival from Lower Granite Dam to McNary Dam was estimated at 0.73 (s.e. 0.094) compared to historic average of 0.61 for the years 1998 to 2009.

- Sockeye transport proportion was estimated at 0.33 which was the lowest estimated proportion destined for transport in the past ten years.

- Steelhead transport proportions of 0.44 for hatchery origin fish, and 0.45 for wild fish were comparable to other recent years (2006 to 2009).

- Yearling Chinook transport proportions of 0.29 for hatchery origin fish and 0.44 for wild fish were low compared to all of the last ten years but most similar to more recent years (2006 to 2009).

Survival estimates

Seasonal reach survival was estimated from Lower Granite Dam to Bonneville Dam for time periods that corresponded to historic FPC index survival estimates for the reach. See the Fish Passage Center draft FPC 2009 Annual Report for the survival estimates used to calculate averages for the Lower Granite Dam to McNary Dam historic comparisons as well as details of dates for survival blocks compared. . Historic estimates in the Lower Granite Dam to McNary

Dam reach used for comparison to 2010 were weighted annual estimates (weighted by release size (n)) combining all weekly cohorts. For 2010 survival for yearling Chinook (hatchery and wild estimated separately) was estimated for fish detected at Lower Granite Dam between April 15 and June 2; for steelhead (hatchery and wild combined) estimates were calculated for fish detected between April 17 and May 28; and for hatchery sockeye the seasonal estimate was for fish detected at Lower Granite Dam between May 8 and June 4.

Survivals were estimated using the single-release-recapture estimation method described by Cormack (1964) – Jolly (1965) – Seber (1965) and (termed CJS) and estimates were calculated using program Mark (White and Burnham 1999). Estimates with high variability (standard errors greater than 0.25 in any individual reach) were excluded from analysis and reporting. Only the sockeye survival estimates in the reaches from McNary Dam to John Day Dam and John Day Dam to Bonneville Dam were excluded based on the criteria described. If those estimates were included the Lower Granite Dam to Bonneville Dam reach survival for sockeye would have been just above 1.0.

We compared reach survivals estimated for 2010 to historic estimates both by FPC (DeHart 2009) for the Lower Granite Dam to McNary Dam reach and by NOAA (2009) for the Lower Granite Dam to Bonneville Dam reach. Survival estimates for 2010 are provided in Table 1 below. Steelhead survival in the reach Lower Granite Dam to McNary Dam was estimated at 0.82 (standard error 0.07) which was high compared to historic average of 0.60 for the years 1998 to 2009 and similar to a weighted annual estimate for 2009. Steelhead survival from Lower Granite Dam to Bonneville Dam was estimated at 0.52 (s.e. 0.039) which was higher than the average of 0.46 for annual reach survival estimates by NOAA (2009) for the years 2003 to 2009. Hatchery yearling Chinook survival from Lower Granite Dam to McNary Dam was estimated at 0.79 (s.e. 0.024) compared to historic average of 0.74 for the years 1998 to 2009. Hatchery yearling Chinook survival from Lower Granite Dam to Bonneville Dam was estimated at 0.72 (s.e. 0.07) which would be considered very high compared to historic average. However the estimate is suspect due to an unusually high survival in the reach between McNary Dam and John Day Dam of 1.15. Wild yearling

Table 1. Preliminary reach survival estimates from Lower Granite Dam to Bonneville Dam for juvenile salmonids originating above Lower Granite Dam in 2010.

	Preliminary survival estimates			
Reach	**Hatchery yearling Chinook**	**Wild yearling Chinook**	**Combined H&W steelhead**	**Hatchery sockeye**
lgr to lgs	0.976	0.940	0.969	0.905
std. error	(0.028)	(0.023)	(0.024)	(0.084)
lgs to lmn	0.969	1.027	0.930	0.866
std. error	(0.081)	(0.071)	(0.068)	(0.155)
lmn to mcn	0.836	0.807	0.909	0.933
std. error	(0.070)	(0.059)	(0.073)	(0.186)
mcn to jda	1.159	0.826	0.821	NA
std. error	(0.105)	(0.083)	(0.059)	NA
jda to bon	0.785	0.923	0.775	NA
std. error	(0.102)	(0.186)	(0.073)	NA
LGR to MCN	0.79	0.78	0.82	0.73
LGR to BON	0.72	0.59	0.52	NA

Chinook survival in the reach Lower Granite Dam to McNary Dam was estimated at 0.78 (s.e. 0.029) compared to historic average of 0.72 for the years 1998 to 2009 (Table 2). Wild yearling Chinook survival in the reach Lower Granite Dam to Bonneville Dam was estimated at 0.59 (s.e. 0.11) compared to historic estimates for combined hatchery and wild Chinook by NOAA (2009) for the years 2003 to 2009 that averaged 0.54 (Table 3). Hatchery sockeye survival from Lower Granite Dam to McNary Dam was estimated at 0.73 (s.e. 0.094) compared to historic average of 0.61 for the years 1998 to 2009.

Table 2. Preliminary Lower Granite Dam to McNary Dam reach survivals for 2010 compared to 2009 and the average for 1998 to 2009. Historic estimates for steelhead and yearling Chinook were weighted annual estimates from weekly cohorts detected at Lower Granite Dam in April and May while for sockeye a single cohort was used from the first week of May to first week of June. The 2010 estimates for Chinook and steelhead span the full season corresponding to the same time period as previous years' weekly cohorts.

	Survival by species-rearing disposition			
Migration years	**ch1-h**	**ch1-w**	**st-hw**	**soc-h**
Avg 1998 to 2009[a]	0.74	0.72	0.60	0.61
2009[b]	0.79	0.77	0.80	0.76
2010	0.79	0.78	0.82	0.73

[a] Average of weighted annual estimates for yearling Chinook and steelhead.
[b] Weighted annual estimate of weekly cohorts for yearling Chinook and steelhead.

Table 3. Preliminary Lower Granite Dam to Bonneville Dam reach survivals for combined hatchery and wild steelhead and separately for hatchery and wild yearling spring/summer Chinook in 2010 compared to survivals reported by NOAA for the years 2003 to 2009 in the same reach.

Migration years	**Steelhead-hw**	**Yearling spring/ summer Chinook-hw**
Avg 2003 to 2009	0.46	0.54
2009	0.69	0.56
2010	0.52	0.72(h)-0.59(w)

Transport Proportion Estimates

Based on timing at Lower Granite Dam derived from passage indices, as well as estimates of detection probability from PIT-tag survival estimates, FPC estimated the probability of fish arriving at the forebay of Lower Granite Dam being destined for transport (Table 4). Unlike other recent years when the delayed start to transport resulted in a significant proportion of fish being bypassed at collector dams prior to transport, in 2010 nearly all Spring migrant smolts passed after transport began. Collection for transport was initiated on April 23 at Lower Granite Dam; on May 1 at Little Goose Dam and on May 4 at Lower Monumental Dam. Based on passage indices at Lower Granite Dam we estimated that 98% of yearling spring/summer Chinook and steelhead passed the project after transportation began, while virtually all hatchery sockeye passed after that date. Table 4 reports the probability of fish

passing Lower Granite Dam during transport operations multiplied by the probability of being detected at any one of the transport dams. See the Fish Passage Center Annual Report: Appendix I (DeHart 2009) for a detailed description of the method FPC used to estimate the proportion destined for transport or transport probability. Due to high spill volumes throughout April and most of May, relatively low proportions of spring migrants were transported based on our analysis. The early start date of transportation in 2010 (collection for transportation began on April 23 at Lower Granite Dam) and relatively late timing of smolts assured that over 95% of all spring migrant yearling Chinook, steelhead and sockeye passed through the Snake River after the start of transportation. However, high spill volumes and the presence of surface passage routes contributed to the high spillway passage and thus low collection/detection probability for smolts migrating this year.

Table 4. Comparison of the preliminary 2010 estimates of the probability of Snake River Basin smolt population in Lower Granite Dam forebay that were "destined for transportation" and the corresponding estimates from 2002 to 2009. Results exclude transport at McNary Dam.

Species-age group	Transport Probability								
	2010	**2009**	**2008**	**2007**	**2006**	**2005**	**2004**	**2003**	**2002**
Yearling Chinook	0.29 (H) 0.44 (W)	0.36 (H) 0.40 (W)	0.49 (H) 0.49 (W)	0.24 (H) 0.17 (W)	0.61 (H) 0.58 (W)	0.92	0.87	0.63	0.68
Steelhead	0.44[a](H) 0.45 (W)	0.46 (H) 0.48 (W)	0.41 (H) 0. 45(W)	0.47 (H) 0.45 (W)	0.76 (H) 0.79 (W)	0.94	0.96	0.670	0.68
Sockeye	0.33 (H)	0.65	0.62	0.53	0.59	0.86	0.95	0.76	0.66

[a] Transport probability for hatchery steelhead used an aggregate of hatchery released PIT-tags instead of using SMP trap tags to provide a robust sample of both Snake River and Clearwater River origin fish for estimating detection probabilities.

River Conditions

As mentioned before survival estimates were relatively high compared to historic average and this was likely due to the provision of spill during what was a relatively low flow year. Flows at Lower Granite Dam during the spring of 2010 compared to historic years are summarized by month in Table 5 and by date in Figure 1. As can be seen flows in 2010 were quite low in the Snake River, particularly in April. Only 2001 had lower flow for April and May. Unlike 2001, spill at Snake River dams was provided according to levels set by court order. And flows increased well above the ten-year average in June of 2010. These factors likely both contributed to the high survivals seen in 2010.

Table 5. Monthly average flows at Lower Granite Dam in 2010 compared to recent years.

	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**10-YrAvg**
April	35	73	71	49	42	123	47	54	87	**42**	67
May	63	82	94	79	91	137	80	116	118	**67**	95
June	36	94	89	72	58	90	46	128	114	**128**	79

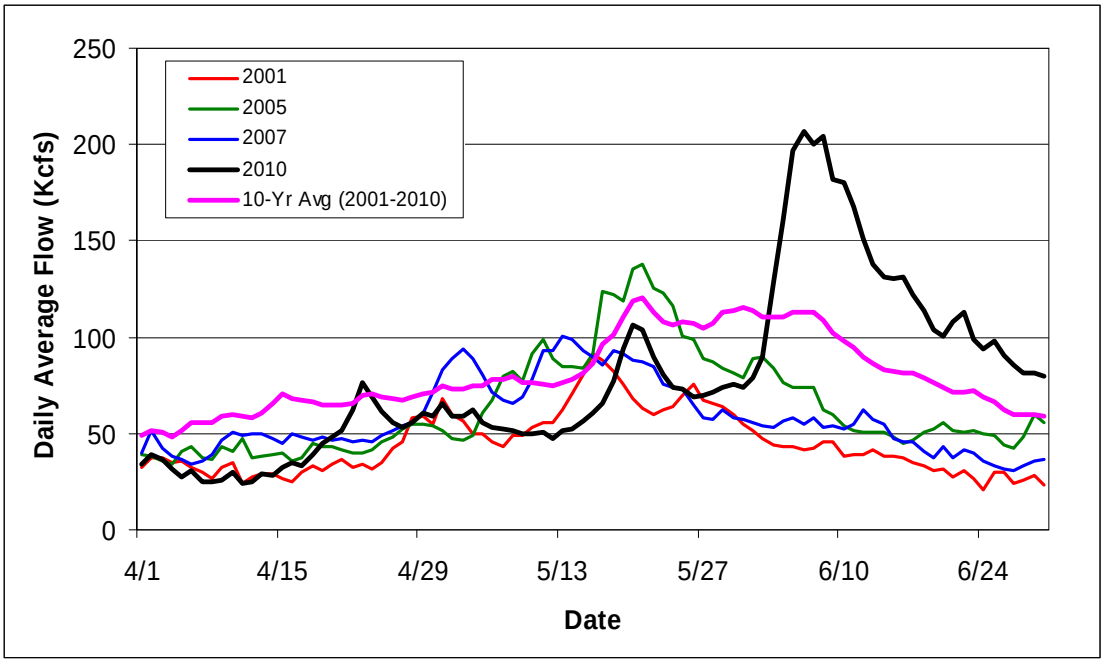

Figure 1. Average Discharge at Lower Granite Dam during 2010 compared to ten-year average and other recent low flow years.

Spill percentages during Spring smolt passage were relatively high at the collector dams in 2010 (Table 6). As can be seen from table 6, at Lower Monumental Dam spill percentages were relatively high during April and May at 48%, while Lower Granite Dam spill averaged 38% for the same period--which was well above the average of 2001 to 2009 (24%) and similar to 2008. With the recent completion of a surface bypass systems at Little Goose Dam all three of the collector dams have surface spillways and are more efficient at passing fish via spill at low flows.

Table 6. Average spill percentage at Lower Granite (LGR), Little Goose (LGS) and Lower Monumental (LMN) dams during April and May of the past ten years.

	Average 2-month spill percentage			
Years	**LGR**	**LGS**	**LMN**	**ALL 3**
2001	0	0	0	0
2002	34	36	0	24
2003	29	27	38	31
2004	14	10	12	12
2005	6	1	5	4
2006	35	27	25	29
2007	33	30	38	33
2008	38	34	40	37
2009	25	28	31	28
Average 2001 to 2009	24	21	21	22
2010	**38**	**29**	**48**	**38**

Discussion and Conclusions

The low transport probabilities we estimated in 2010 were due to high spill percentages that occurred because of low flows. We found a high (negative) correlation between average spill percentage at the Snake River collector dams and the probability of transport for all three groups we analyzed for the years 2001 to 2010. For hatchery yearling Chinook and hatchery steelhead we compared the average spill at each dam during April and May and then combined the time periods and dams for a seasonal average spill percentage at all three collector dams during April and May. The highest correlation was between the transport probability and the 2-month average spill percentage at all three dams. For yearling Chinook the correlation was -0.89 and for steelhead the correlation was – 0.91. Yearling Chinook and steelhead pass through the Snake River mostly in April and May, while sockeye pass typically beginning in May and into June. For this reason we compared spill percentages in May and June to transport probability for sockeye. Similar to steelhead and yearling Chinook, for sockeye we found the highest (negative) correlation -0.86 between the overall average 2-month spill percentage at all three dams and transport probability. We plotted the data used in this analysis in Figure 2 below. Arrows point to 2010 preliminary transport probability estimates for each species in the figure.

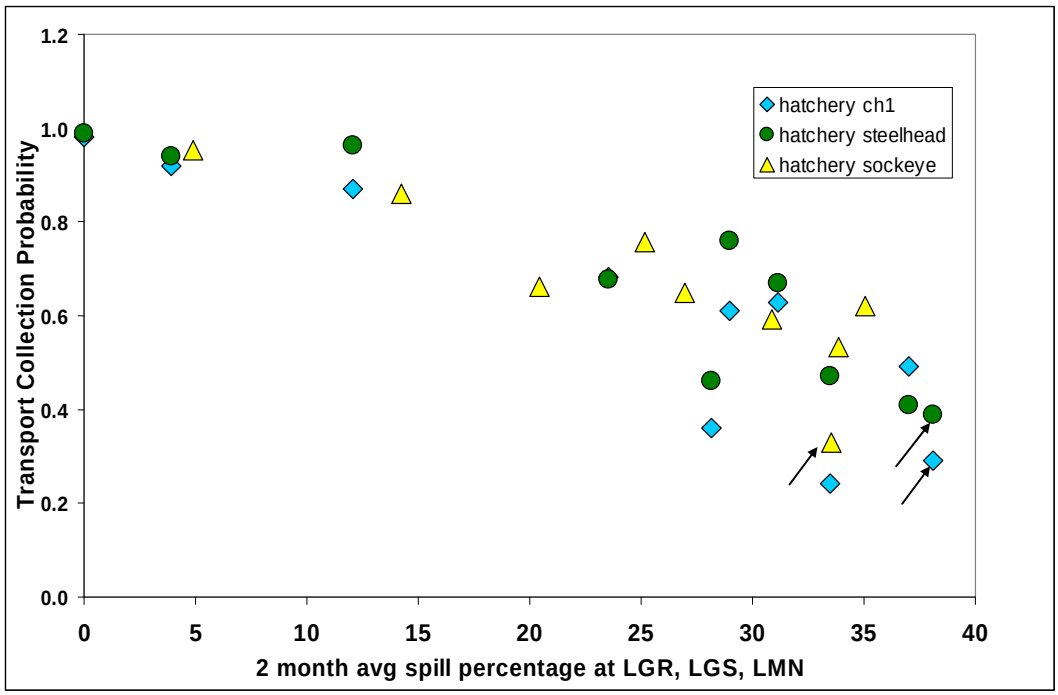

Figure 2. The proportion of each species of smolts destined for transport in the years 2001 to 2010 compared to 2-month average spill percentage at collector dams. Yearling Chinook and steelhead transport probability was plotted against average spill for April and May while for sockeye spill was averaged for May and June.

Despite low flows in 2010, reach survivals for juvenile salmonid migrants passing through the hydro-system in the spring appeared to be relatively high in relation to historic estimates through

the reach. Other analyses (FPC annual reports and CSS annual reports) have shown the importance of spill passage for migrating smolts. It is likely that the high spill percentages at dams were responsible for the relatively high survivals seen in 2010 given relatively low flows in April and May. It appears that spill has been shown to mitigate to some extent for low flows at least when that mitigation was measured by impacts on reach survivals as seen in 2010.

References

Cormack, R.M. 1964. Estimates of survival from the sighting of marked animals. Biometrika 51:429-438.

DeHart, M. 2009. Draft Fish Passage Center 2009 Annual Report. **BPA CONTRACT #45525; BPA PROJECT #1994-033-00.**

Jolly, G.M. 1965. Explicit estimates from capture-recapture data with both death and immigration – stochastic model. Biometrik 52: 225-247.

NOAA 2009. NOAA Technical Memorandum for Bruce Suzumoto from John W. Ferguson entitled "Preliminary survival estimates for passage during the spring migration of juvenile salmonids through the Snake and Columbia River reservoirs and dams, 2009".

Seber, G.A.F. 1965. A note on the multiple-recapture census. Biometrika 52: 249-259.

White, G.C. and K. P. Burnham. 1999. Program MARK: Survival estimation from populations of marked animals. Bird Study 46 Supplement, 120-138.

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DATA REQUEST FORM

Request Taken By: Michele DeHart **Date:** 6-30-2010

Data Requested By:
Name: ED Bowles, ODFW **Phone:**
Address: **Fax:**
Email:

Data Requested:
preliminary survival estimates 2010 spring migrants

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

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

Comments:

Data Compiled By: Jerry McCann **Date:** 7-8-2010

Request # 45

Michele Dehart

From: Ed Bowles [ed.bowles@state.or.us]

Sent: Wednesday, June 30, 2010 2:23 PM

To: Michele Dehart

Cc: Rick Kruger; Anthony Nigro

Subject: Information request

Hi Michele… As we head into the summer, please have the FPC provide an update on how our juvenile spring migrants fared this year. As you know, NOAA and the AA wanted to shut off spill at the collector projects during the peak of the outmigration in order to max transport due to low flow conditions. The ISAB concurred with OR and others that maintaining spill and a spread-the-risk approach was the best choice. Although full evaluation will not be possible until adults return, please provide any update you can regarding the survival and characteristics of the spring outmigration. Thanks… Ed

Ed Bowles
Fish Division Administrator