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MEMORANDUM

TO: Russ Kiefer, IDFG

Michele Dehart

FROM: Michele Dehart

DATE: January 10, 2013

RE: Factors that could have affected the return of migration year 2011 A-Run Steelhead

We have compiled the following in response to your data request for data or information that might help to explain the lower than expected adult A-Run steelhead return in 2012. We have focused on presenting the juvenile migration conditions that occurred in 2011, since most A-Run steelhead returning in 2012 would have migrated as juveniles in 2011.

Flow and Spill in 2011

Steelhead adults that are from the A-run generally spend one year in the ocean before returning to spawn. This means that most of the A-run adults returning in 2012 would have migrated to the sea as juveniles during the spring of 2011. Snowpack and runoff volume throughout the Columbia Basin was considerably above average in 2011. The observed runoff volume at Lower Granite (January-July) in 2011 was 41.5 MAF, which was the 9th highest in the 83-year record (1929-2011). Due to the high runoff volumes, Dworshak Dam was operated under a flood control deviation, which allowed for the project to refill above its end of March elevation target. In summary, Dworshak was 18.1 feet above the end of March flood control elevation and 17.2 feet above its April 10th Biological Opinion (BiOp) target elevation. These high elevations resulted in about 1 MAF that needed to be released above minimum flows (approximately 1.5 Kcfs). The combination of Dworshak being above the BiOp target elevations and the high runoff volume resulted in flows at Lower Granite Dam (LGR) that were much higher than the BiOp targets for both the spring and summer migration period (2011 FPC Annual Report) (Figure 1).

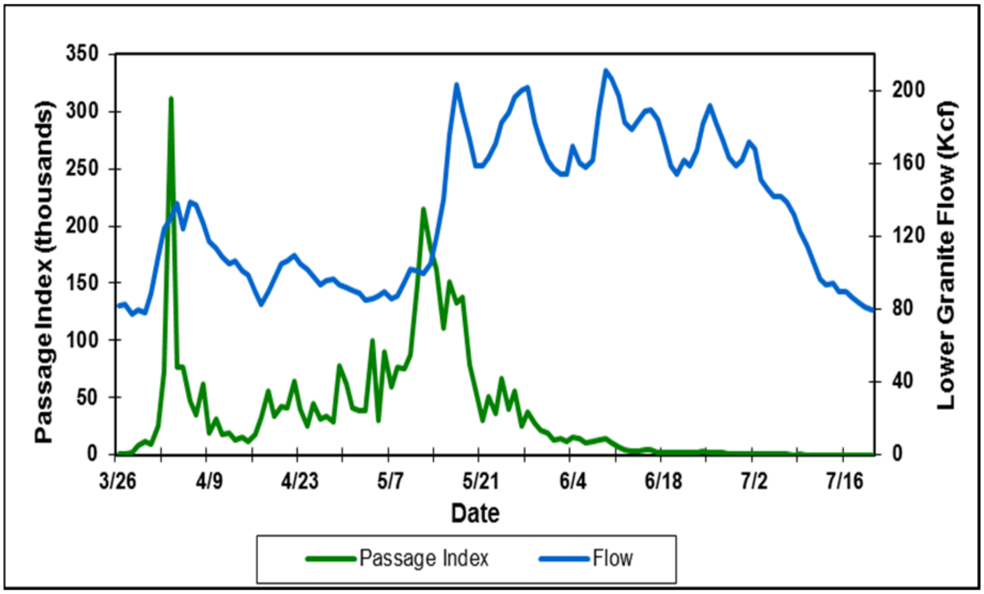

Figure 1. Daily flows and migration timing of Snake River steelhead at Lower Granite Dam in 2011.

Spill for fish passage in the Columbia Basin was implemented according to the Court Order as part of ongoing litigation. High flows, coupled with unit outages, resulted in spring spill that generally exceeded spill levels that were prescribed in the 2011 Fish Operations Plan through most of the juvenile steelhead migration period.

Hatchery Releases:

For migration year 2011, the release total for hatchery steelhead to the Snake River Zone was approximately 9.47 million, of which 9.22 million (97.4%) were released above Lower Granite Dam. The 2011 release total was the highest since 2003. Table 1 below provides hatchery release totals of A-run and B-run steelhead to the Snake River Zone (above Lower Granite Dam) over the past five years (2008-2012). Release totals for migration year 2012 are still preliminary, as not all of these releases have been finalized in the FPC Hatchery Database. In 2011, A-run steelhead made up approximately 54% of the total hatchery steelhead released above LGR. It does not appear that the proportion of A-run hatchery steelhead in 2011 was any different than what has occurred in past years, except 2010 when 700,000-900,000 B-run steelhead were lost at Dworshak NFH (Table 1).

Table 1. Total hatchery release of A-run and B-Run steelhead to the Snake River Zone, above Lower Granite Dam, in migration years 2008-2012.

Migration Year	Run	Release Total	Proportion
2008	A	4,866,228	0.54
	B	4,160,428	0.46
2009	A	4,914,501	0.58
	B	3,577,417	0.42
2010	A	4,838,318	0.61
	B	3,048,785	0.39
2011	A	4,942,685	0.54
	B	4,285,758	0.46
2012	A	5,065,817	0.54
	B	4,294,085	0.46

Juvenile Timing:

The Smolt Monitoring Program (SMP) provides data on the passage timing of the various salmonid species that pass Lower Granite Dam. Although data from the SMP at LGR are not specific to A-run steelhead (i.e., all steelhead are combined), these data are still useful when evaluating when steelhead were passing the project. Based on SMP data, the 10% passage date for steelhead in 2011 was much earlier than what has occurred over the past 10-years (Figure 2). This earlier timing was mostly due to the release of about 2.2 million hatchery steelhead juveniles to the Clearwater River in late March. Although the 10% passage date in 2011 was earlier than the current 10-year average, the estimated 50% and 90% passage dates for 2011 at LGR very similar to the 10-year average (Figure 2).

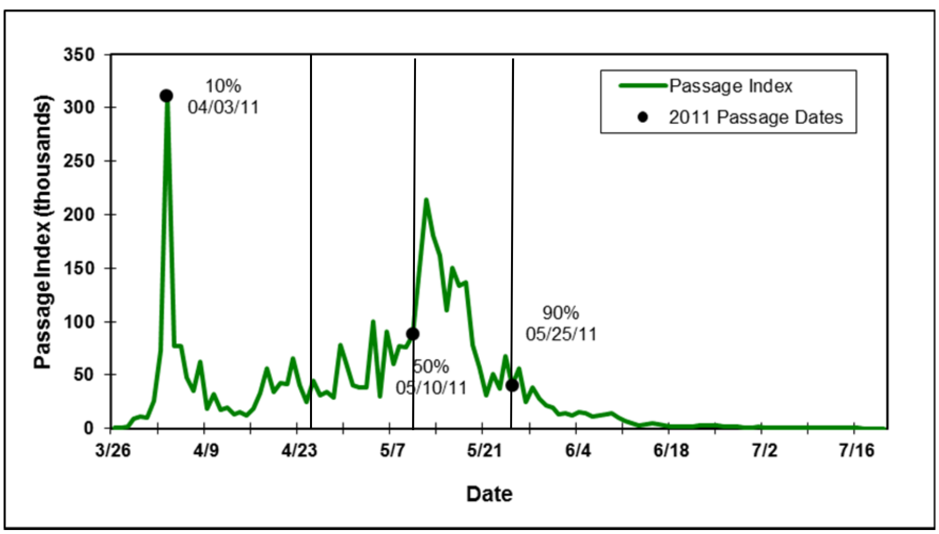

Figure 2. Migration timing and 10%, 50%, and 90% passage dates of Snake River steelhead at Lower Granite Dam in 2011. Vertical lines represent 10-year average 10%, 50%, and 90% passage dates of April 25, May 10, and May 25, respectively.

Juvenile Survivals and Environmental Conditions:

In its Annual Report, the FPC evaluates the reach survivals of PIT-tagged juveniles through the Snake, Upper Columbia, and Lower Columbia rivers. In addition, environmental conditions that these juveniles experience during their out-migration are also evaluated. Although the estimates for steelhead are not specific to A-run steelhead (i.e., all steelhead are combined), they do provide insight into what the survivals and environmental conditions were in particular migration years, relative to the historic average. Estimates of survival and environmental conditions from 2011, and historic years, are available in Chapter 4 of the 2011 FPC Annual Report. Below is a summary of the 2011 estimates of survival and environmental conditions (Table 2).

In migration-year 2011, steelhead survivals in the Lower Granite to McNary reach were relatively high, but similar to 2009 and 2010 (Table 2A). In addition, fish travel times and water transit times were also similar or faster and spill percentages were higher in 2011 (Table 2A). These patterns were also true for steelhead in the McNary to Bonneville reach (Table 2B). Finally, for the Rock Island to McNary reach, steelhead survivals were similar or slightly above average while fish travel times and water transit times were generally faster than average (Table 2C). However, spill percentages in this reach were below average for the first cohort but above average for the second and third cohorts (Table 2C).

Table 2. Median Fish Travel Time (FTT) and Survival ($\hat{S}$) of combined hatchery and wild steelhead for various river reaches for fish migrating in 2011.

A) LGR-MCN Reach.

MY	Release dates	Median FTT	$\hat{S}$	Var($\hat{S}$)	WTT	avg Spill	temp. C
2011	4/17-4/23	8.5	0.727	0.0006	9.2	39.5	9.0
2011	4/24-4/30	8.0	0.728	0.0017	9.9	40.6	9.8
2011	5/1-5/7	6.8	0.742	0.0057	9.1	39.1	10.7
2011	5/8-5/14	5.2	0.674	0.0033	6.1	50.4	11.5
2011	5/15-5/21	4.4	0.786	0.0071	5.2	53.8	11.3

B) MCN-BON Reach.

MY	Release dates	Median FTT	$\hat{S}$	Var($\hat{S}$)	WTT	avg Spill	temp. C
2011	4/27-5/17	4.3	0.743	0.0266	5.0	40.1	11.1

C) RIS-MCN Reach.

MY	Release dates	Median FTT	$\hat{S}$	Var($\hat{S}$)	WTT	avg Spill	temp. C[a]
2011	4/21-5/4	7.4	0.568	0.0113	5.9	23.3	9.7
2011	5/05-5/18	5.5	0.739	0.0105	4.3	45.3	11.3
2011	5/19-6/01	4.2	0.632	0.0131	3.2	61.4	11.8

Smolt-to-Adult Ratios (SARs):

The Comparative Survival Study (CSS) provides analyses of smolt-to-adult ratios for many groups of Snake River hatchery Chinook, steelhead, and sockeye. However, given that steelhead returns are not considered complete until two years in the ocean, and that adult Snake River steelhead often overwinter and do not return to Lower Granite until the following spring, SARs reported by the CSS are generally three years behind. For example, the 2012 CSS Report provides SAR estimates for steelhead through migration year 2009. ***Complete estimates of SARs for Snake River steelhead from the 2011 out-migration will not be available until the 2014 CSS report.*** However, for purposes of this request, we have estimated Lower Granite to Bonneville SARs for hatchery A-run Snake River steelhead for migration years 2008 through 2011. Due to limitations in PIT-tagging efforts for hatchery steelhead, we could not estimate SARs for A-run steelhead prior to 2008. In order to compare the 2011 SARs to previous years, these SAR estimates were limited to 1-ocean steelhead only, for all migration years. 1-salt SAR estimates for this request were conducted using the same bootstrap methodology that is used in the CSS (see 2012 CSS Report for methods). ***However, it is important to note that estimating 1-salt SARs is different from what the CSS typically does and, thus, these SAR estimates are not comparable to what is presented in the CSS Annual Report.*** Furthermore, the 1-salt SARs for migration year 2011 should be considered a minimum, as they only include adult returns of hatchery A-run steelhead to BON through September 10, 2012.

Overall, the 1-salt SARs (LGR-to-BON) for 2011 out-migrants were much lower than that for migration years 2008-2010 (Table 3). It appears that this same pattern of lower SARs in 2011 was true for both transported A-run steelhead and those that migrated in-river (Table 3, Figure 3). Based on these results, it appears that there is some common year effect that results in transported and in-river migrants to have similar patterns in SARs over the four years we analyzed. For example, both transported and in-river migrants had the highest SARs in migration year 2008. SARs for these groups have consistently decreased since migration year 2008. The 1-Salt TIR for migration year 2011 was 1.62, which is the highest among the four years we analyzed. This TIR is consistent with the intent of the altered protocol for transportation operations that was implemented beginning in 2006. The start dates of transportation at LGR, LGS, and LMN were delayed from what had been implemented in past years. The goal of this change in protocol was to improve the overall SARs by allowing more early run-at-large migrants to out-migrate entirely in-river when historically transport SARs tended to be low (NOAA 2008). Finally, the proportion transported estimate for migration year 2011 hatchery A-run steelhead was 0.427, which was higher than that for 2010 but lower than 2008 and 2009 (Table 3).

Table 3. Estimated 1-salt SARs (LGR-to-BON), route specific 1-salt SARs (T_0, C_0, and C_1), TIRs (for 1-salt returns), and proportion transported ($Pr(T_X)$) of PIT-tagged hatchery A-run Snake River steelhead. Numbers in parentheses are 90% confidence intervals.

Migration Year	Overall SARs	Transport (T_0) SAR	In-River (C_0) SAR	In-River (C_1) SAR	*TIR*	*$Pr(T_X)$*
2008	5.62 (5.43-5.81)	6.54 (6.27-6.81)	4.93 (4.65-5.20)	4.90 (4.48-5.34)	1.33 (1.24-1.42)	0.452 (0.446-0.458)
2009	1.96 (1.87-2.06)	2.29 (2.15-2.44)	1.68 (1.53-1.82)	1.66 (1.49-1.82)	1.37 (1.23-1.52)	0.476 (0.472-0.480)
2010	2.08 (1.98-2.18)	2.20 (2.04-2.37)	1.97 (1.87-2.08)	1.92 (1.54-2.35)	1.12 (1.02-1.22)	0.351 (0.346-0.356)
2011	0.76 (0.70-0.82)	1.05 (0.94-1.15)	0.65 (0.57-0.73)	0.42 (0.34-0.51)	1.62 (1.38-1.90)	0.427 (0.423-0.431)

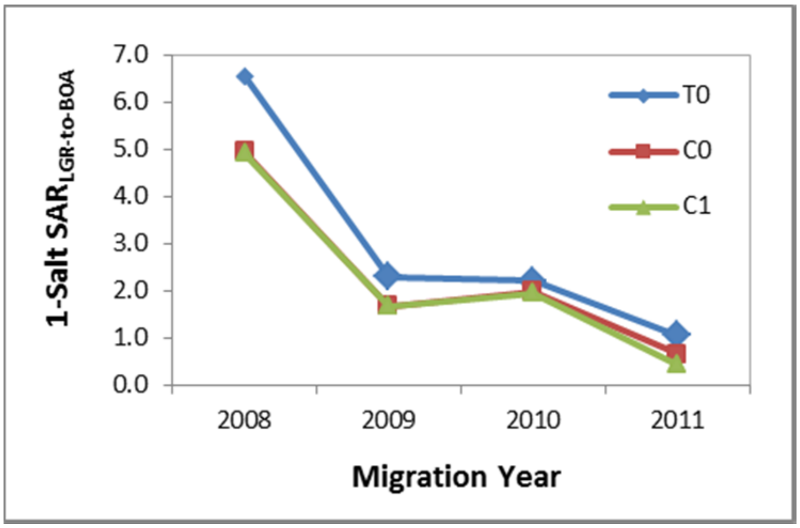

Figure 3. Estimated LGR-to-BON 1-salt SAR for PIT-tagged hatchery A-run steelhead in transport (T_0) and in-river (C_0 and C_1) study categories for migration years 2008 to 2011.

This common year effect is also evident when comparing the overall SARs of wild Snake River yearling spring/summer Chinook to those of wild Snake River steelhead, as reported in the 2012 CSS Annual Report (Figure 4). In general, as the SARs for yearling Chinook increase, so do the SARs for wild steelhead. In fact, for the years where estimates are available for both species, the SARs of wild yearling Chinook and wild steelhead are correlated (Pearson correlation coefficient = 0.66). A similar common year effect in spawner-recruit patterns has been demonstrated for Snake River wild spring/summer Chinook and Mid-Columbia wild spring Chinook (e.g., Deriso et al. 2001; Schaller and Petrosky 2007).

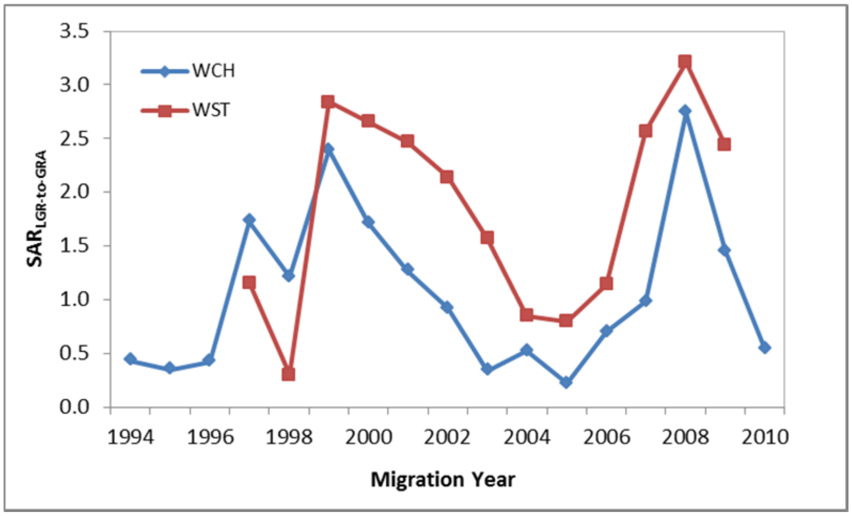

Figure 4. Overall SARs (LGR-to-GRA) for wild Snake River yearling spring/summer Chinook and wild Snake River steelhead. Data for these figures can be found in Chapter 4 of 2012 CSS Report.

Ocean Conditions:

NOAA Fisheries Northwest Fisheries Science Center has been assembling information on ocean indices for the last 15 years (http://www.nwfsc.noaa.gov/research/divisions/fed/oeip/g-forecast.cfm). These data are used annually to describe the ocean conditions that are experienced by growing salmon during their years in the ocean. Of particular importance to future survival are the condition experienced during early ocean entry. In 2011 the ocean conditions that existed when A-Run steelhead were primarily entering the ocean were intermediate. The 2011 year was ranked 7 out of the 15 years for which data are available. The lower the number in the 15 year record the better the ocean ecosystem conditions were for salmon growth and survival.

Summary

The 2011 juvenile Snake River steelhead migration experienced high flows. With these high flows, survivals in 2011 were generally higher than average, fish travel times and water transit times were faster than average, and spill percentages were higher than average. The juveniles then entered the ocean and were presented with ocean conditions for survival that were intermediate in rank, when compared to the past 15 years. Based on CSS analyses of SARs for yearling Chinook and steelhead, it appears that SARs in more recent years are in a downward cycle. This downward trend appears to be true for both yearling spring/summer Chinook and steelhead. Finally, estimates of 1-salt SARs for Snake River A-run steelhead indicate that the 1-salt SARs for 2011 out-migrants were the lowest among the four years analyzed. The same decreasing trend in 1-salt SARs is evident for juveniles that were transported and those that migrated in-river.

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