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: Russell Kiefer, IDFG

FROM: Michele DeHart

DATE: December 28, 2011

RE: Wild Chinook Lower monumental transport SARs

In response to your request the Fish Passage Center staff reviewed the transport SARs for Lower Monumental Dam (LMN) presented in the Comparative Survival Study (CSS) Annual Reports, and included here in Appendix Table 1. In addition, we explored developing transport SARs at LMN in terms of Lower Granite equivalents and using additional in-river PIT tagged fish from the NOAA transportation study marking at Lower Granite Dam (LGR). Your request asked us to determine if the additional in-river marks would allow us to determine SARs for the years marked N/A in the CSS reports where no adult returns had occurred. The results of our review are summarized below.

We also received and considered the estimates that were distributed to FPAC on 20 Dec, 2011 via an emailed excel spreadsheet from Bill Muir at NOAA. The Lower Monumental transport SARs for NOAA wild Chinook in that spreadsheet cover the 2000, 2002, and 2003 migration years and are slightly lower than the CSS+NOAA LMN transport SARs presented here. The NOAA spreadsheet estimates are slightly lower because they incorporate NOAA estimates of survival from LGR to LMN to expand the smolt population. The results from the NOAA spreadsheet do not change the results presented in this memo.

- **Wild Chinook SAR point estimates for transported smolts at LMN were typically lower than SARs for their counterparts transported at LGR.**
- **These results are consistent with past studies suggesting less benefits could be attributed to transportation at the further downriver sites, as summarized by NOAA Fisheries in their technical memorandum on the effects of the Federal**

Columbia River Power System (FCRPS) on Columbia River salmon stocks (Williams et al., 2005).

- **The SARs reported in Table B.1 of Appendix B in the 2011 CSS Annual Report are based solely on counts of smolts at LMN and adults at LGR. Because the smolt count at LMN does not include the mortality that has occurred to juvenile migrants before they reach LMN, this results in an underestimate of the smolt starting population, which results in an overestimate of the SAR. The SARs for LMN based upon lower granite equivalents using the expanded CSS smolts are reported in Figure 2 and Appendix Table 1 in this memo.**
- **The N/A in Table B.1 of Appendix B in the 2011 CSS Annual Report is associated with SARs with zero adults where it was not possible to generate a nonparametric bootstrap confidence interval.**
- **We would recommend against combining the NOAA and CSS marks for this application because of the difference in marking effects. However, to fulfill this data request we did combine these estimates at LMN.**
- **Typically the point estimates of transport SARS LMN are lower than transport SARs from LGR and transportation from LMN does not appear to be beneficial for wild Chinook. This is true based on four different versions of the LMN SAR:**
    1) **Unexpanded CSS tags**
    2) **Expanded CSS tags**
    3) **Unexpanded NOAA tags**
    4) **Unexpanded NOAA + CSS tags**
- **In all years except 2002 and 2003, the addition of the NOAA marks did not effectively change the sample size for the LMN transport SAR (Figure 1). The 2002 and 2003 combined LMN transport SARs were not statistically different than the LGR transport SARs.**

Methods

Lower Granite Equivalents

The current SARs presented for wild Chinook in the 2011 CSS annual report (Table B.1 in 2011 CSS Annual Report) are based on PIT tag counts of smolts at LMN and adult detections in the ladders at LGR. To properly compare a LMN transport SAR to a SAR of smolts transported at LGR, the smolt population for the LMN transport SAR should be expanded by the smolt survival from LGR to LMN:

$$SAR_{LMN} = \frac{adults_{LMN}}{smolts_{LMN} \div S_{LGRtoLMN}}$$

Use of PIT tagged groups marked at Lower Granite Dam

Potentially, additional wild Chinook transported at LMN, but PIT tagged at LGR by NOAA, may be incorporated to increase the sample size to address precision and power concerns. Wild Chinook smolts have been consistently PIT tagged by NOAA at LGR over the longest period of time as compared to other species; this began in 1995 (Table 1). We chose criteria to select the NOAA smolts that matched the CSS smolts presented in Table B.1 of Appendix B in the 2011 CSS Annual Report:

(1) Last smolt site of detection in the hydrosystem was LMN and the smolt was transported.
(2) No prior detects at LGS in years before 2006, prior detects at LGS allowed in years after 2005.
(3) All smolts were previously marked at LGR by coordinator DMM or WDM.
(4) No smolts were used with a last monitor site at a separator gate because the disposition (transported or return to river) is unknown.

Additionally, in 2002 and 2003 the NOAA transport study specifically addressed transport at Lower Monumental and large mark groups were available for those years.

Table 1. Wild Chinook marked and barged at LGR (lines 1-3). Wild Chinook marked and released at LGR by NOAA and transported downstream at LMN (lines 4-6). The sum of smolts transported, sum of adult returns from these smolts, and point estimate of SAR % is shown for each. No wild Chinook smolts were marked and barged at LGR in 1994, 1997 and 2000. No wild Chinook smolts were marked at LGR and transported at LMN in 1994, 1997, and 2001.

NOAA Wild Chinook	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Smolts Transported LGR	21377	8699	*0*	5496	8128	*0*	17564	4964	7114	11203	12718	13559	11990	11497
Adults Returned LGR	78	10	*NA*	29	165	*NA*	139	54	24	39	29	90	94	264
LGR transport SAR %	0.36	0.11	*NA*	0.53	2.03	*NA*	0.79	1.09	0.34	0.35	0.23	0.66	0.78	2.30
Smolts Transported LMN	776	103	0	55	202	729	0	5363	2051	16	22	126	71	52
Adults Returned GRN	3	0	*NA*	0	2	7	*NA*	58	2	0	0	0	0	1
unexpanded LMN trans. SAR %	0.39	0.00	*NA*	0.00	0.99	0.96	*NA*	1.08	0.10	0.00	0.00	0.00	0.00	1.92

As noted above, the unexpanded LMN SARs reported in the CSS are likely biased high for comparisons with LGR SARs. In addition, the NOAA marked smolts may have a different marking effect than the CSS smolts because they are collected in the bypass at LGR and implanted with PIT tags during their juvenile emigration through the hydrosystem whereas the wild CSS Chinook smolts are marked upstream up to 9 months earlier than their arrival at the hydrosystem. Despite these concerns, to address your request we summed the NOAA and CSS wild Chinook to explore if these unexpanded estimates would be more precise than using only CSS fish.

The LMN transport SARS were calculated using four different groups/methods:

(1) Unexpanded CSS LMN transports
(2) Expanded CSS LMN transports
(3) Unexpanded NOAA transports (Table 1 above)
(4) Unexpanded CSS + NOAA transports

When zero adults return from a smolt release there is no variation in bootstrapping and a confidence interval can not be calculated. In these cases, an exact binomial confidence interval can be calculated for the unexpanded SARs but not the expanded SARs.

Results

The samples sizes required to make statistical comparisons between SARs can be calculated by assuming independence between SARs and a binomial distribution. The sample sizes required in both SARs are also the number of smolts in the denominator of the SAR. Using a two-tail test with Power =1- $\beta = 0.80$ and $\alpha = 0.10$ (Snedecor and Cochran, 1989, Statistical Methods, 8th edition), the sample size needed to statistically compare two SARs is 6,119 smolts in each SAR when the lower SAR is at least one percent and the higher SAR is at least 1.5 times higher than the lower SAR. With the addition of the NOAA fish, only two years show an increase in smolts near the number of smolts needed to compare these SARs (Figure 1). Those two years were the years when the NOAA transportation evaluations specifically included the objective of obtaining SARs at Lower Monumental Dam.

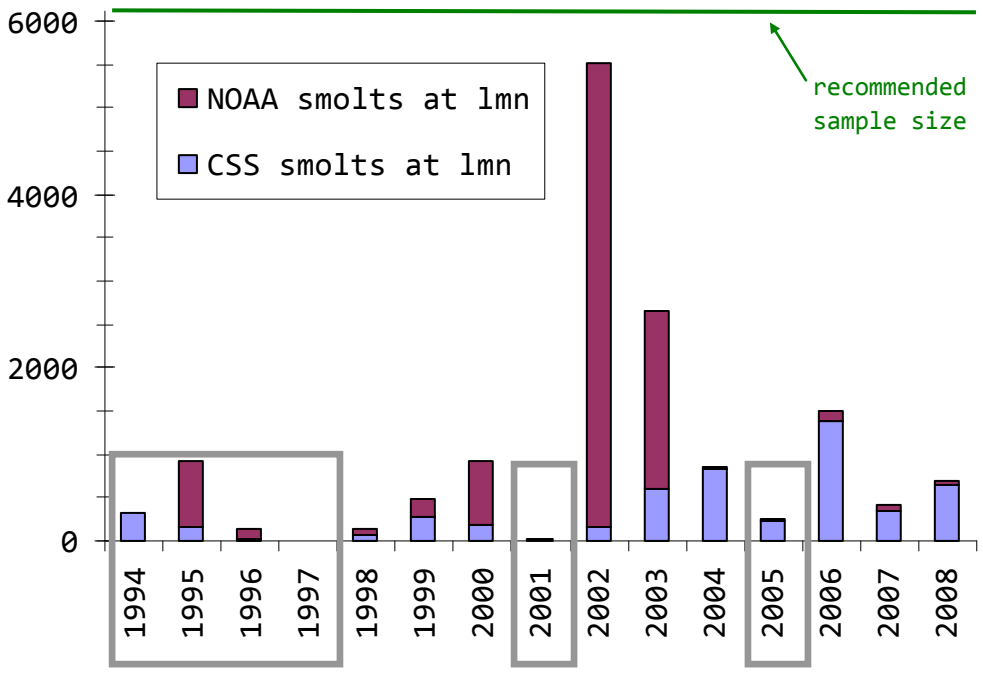

Figure 1. Wild Chinook Smolts detected and transported at LMN for two studies. CSS smolts are blue and NOAA smolts marked at LGR are red. Years where zero adults returned for CSS fish are highlighted by the grey boxes. The reference line denotes the recommended samples size of smolts to do statistical comparisons.

Using only CSS fish, the point estimates for the SARs in terms of Lower Granite equivalents are lower (Figure 2, panel A) than the unexpanded SARs reported in the CSS annual reports, with both having a high degree of uncertainty due to low sample sizes. When including NOAA fish for 2003 and 2004, the unexpanded LMN SARs are similar

the CSS unexpanded SARs when either is compared to the CSS LGR SARs (Figure 2, top and bottom panel).

When including NOAA fish for those years where no adults returned from CSS smolt releases (1994-1997, 2001, 2005), there is still a high degree of uncertainty (Figure 2, panel B) in the SAR estimates. In general, the highest degree of uncertainty around these estimates is in years 1994, 1996, 1997, 1998, and 2001 where upper confidence intervals ranged from ~ 1-24. Given that few smolts are transported at LMN, the bias associated with the unexpanded SARs, and the unknown effects of combining two groups of study fish, the SAR estimates of transported groups did not improve with the addition of the NOAA tags. The estimates used to generate Figure 2 can be found in Appendix Table 1 at the end of this memo.

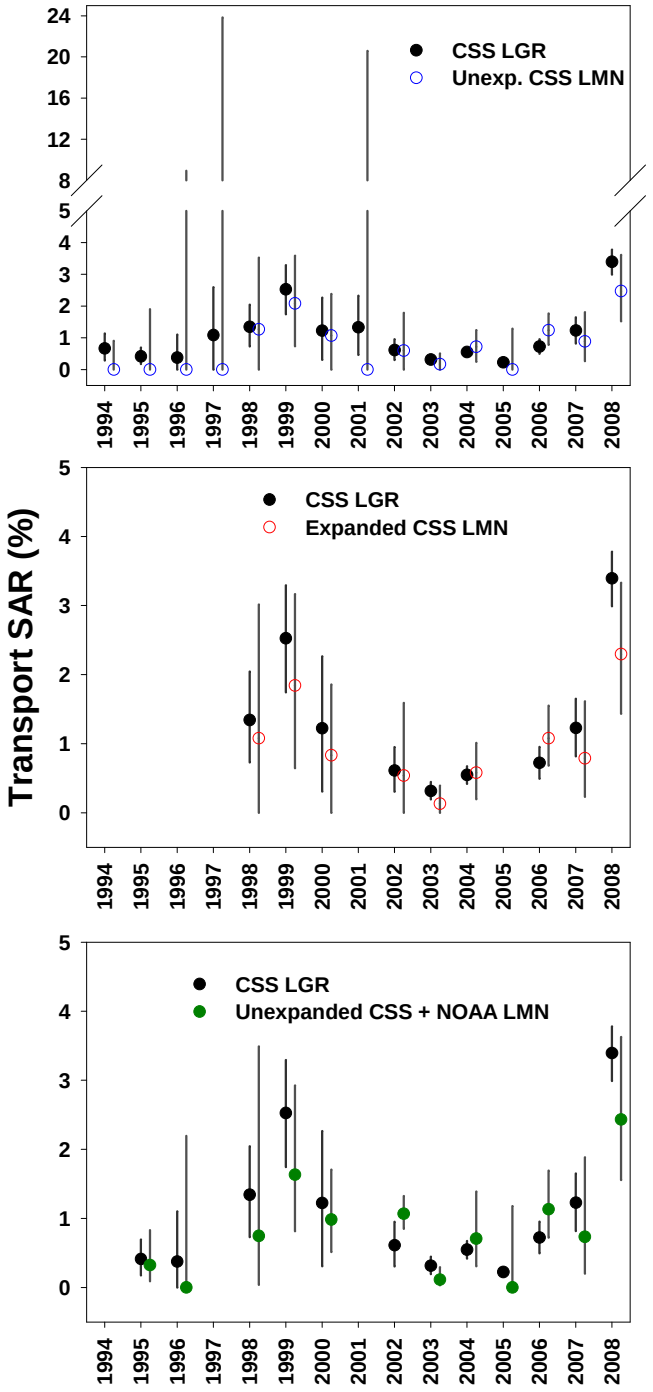

Figure 2. Transport SARs from LGR (using CSS PIT-tags) and LMN (using CSS and CSS + NOAA). The top panel compares CSS unexpanded at LMN vs. CSS at LGR. The middle panel compares CSS expanded at LMN vs. CSS at LGR. The bottom panel compares unexpanded CSS + NOAA at LMN vs. CSS at LGR. Either non parametric bootstrapped 90% CI's or 90% exact binomial CIs are shown for all estimates. In some cases confidence intervals could not be calculated or no smolts were available (see appendix table 1 for details); no estimates are shown for these cases.

In summary, wild Chinook SARs for transported smolts at LMN were typically below SARs for their counterparts transported at LGR. The addition of the NOAA marks, or expanding the CSS marks to LGR equivalents, lead us to this same conclusion. These results are consistent with past studies suggesting fewer benefits could be attributed to transportation at the further downriver sites, as summarized by NOAA Fisheries in their technical memorandum on the effects of the Federal Columbia River Power System (FCRPS) on Columbia River salmon stocks (Williams et al., 2005). Few fish are transported at LMN and a scant number return as adults making it difficult to perform statistical tests on the SARs. The addition of a small number of NOAA marks in most years did not improve our ability to conduct these statistical tests.

References

Snedecor, GW, and WG Cochran. 1989. The binomial distribution. In Statistical methods, 8th ed. Iowa State University Press, Ames, IA, 107-130.

Tuomikoski, J., J. McCann, T. Berggren, H. Schaller, P. Wilson, S. Haeseker, J. Fryer, et al. Comparative Survival Study (CSS) of PIT-tagged Spring/Summer Chinook and Summer Steelhead, 2011 Annual Report. BPA Contract # 19960200. http://www.fpc.org/documents/CSS/2011%20CSS%20Annual%20Report--Final.pdf.

Williams, J.G., S.G. Smith, R.W. Zabel, W.D. Muir, M.D. Scheuerell, B.P. Sandford, D.M. Marsh, R.A. McNatt, and S. Achord. 2005. Effects of the federal Columbia River power system on salmonid populations. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-63, 150 p.

Appendix Table 1. Three types of LMN and one type of LGR dam-specific transportation SARs (%) for PIT-tagged wild Chinook in juvenile migration years 1994 to 2008 (with 90% confidence intervals). Transported smolts include only first-time detected fish from total PIT-tag release through 2005 and both first-time and prior detected fish beginning in 2006. Both expanded and unexpanded LMN SARs are shown for CSS fish and unexpanded LMN SARs are shown for CSS + NOAA fish.

year	Unexpanded LMN SAR (CSS)*		smolts	adults	LGR SAR*		smolts	adults	Expanded LMN SAR (CSS)□		smolts	adults	Unexpanded LMN SAR (CSS + NOAA)●		smolts	adults
1994	0.00	(0.00-0.90)	330	0	0.67	(0.28-1.14)	1052	7	NA		NA	NA	NA		NA	NA
1995	0.00	(0.00-1.90)	156	0	0.41	(0.17-0.69)	1702	7	NA		NA	NA	0.32	(0.09-0.83)	932	3
1996	0.00	(0.00-8.94)	32	0	0.37	(0.00-1.10)	268	1	NA		NA	NA	0.00	(0.00-2.19)	135	0
1997	0.00	(0.00-23.84)	11	0	1.08	(0.00-2.59)	185	2	NA		NA	NA	NA		NA	NA
1998	1.27	(0.00-3.53)	79	1	1.34	(0.73-2.04)	820	11	1.08	(0.00-3.01)	93	1	0.75	(0.04-3.49)	134	1
1999	2.08	(0.73-3.58)	288	6	2.52	(1.74-3.29)	1109	28	1.84	(0.65-3.16)	325	6	1.63	(0.81-2.93)	490	8
2000	1.07	(0.00-2.38)	187	2	1.22	(0.31-2.27)	327	4	0.83	(0.00-1.86)	240	2	0.98	(0.51-1.71)	916	9
2001	0.00	(0.00-20.58)	13	0	1.33	(0.46-2.33)	452	6	NA		NA	NA	NA		NA	NA
2002	0.60	(0.00-1.79)	167	1	0.61	(0.30-0.95)	1640	10	0.54	(0.00-1.59)	186	1	1.07	(0.85-1.32)	5530	59
2003	0.17	(0.00-0.50)	599	1	0.31	(0.19-0.45)	5098	16	0.13	(0.00-0.39)	763	1	0.11	(0.03-0.29)	2650	3
2004	0.72	(0.25-1.24)	834	6	0.55	(0.42-0.67)	8951	49	0.58	(0.20-1.01)	1037	6	0.71	(0.31-1.39)	850	6
2005	0.00	(0.00-1.29)	231	0	0.22	(0.16-0.29)	12064	27	NA		NA	NA	0.00	(0.00-1.18)	253	0
2006	1.24	(0.78-1.77)	1376	17	0.72	(0.49-0.96)	3884	28	1.08	(0.68-1.55)	1575	17	1.13	(0.72-1.69)	1502	17
2007	0.89	(0.26-1.81)	338	3	1.23	(0.82-1.65)	2119	26	0.79	(0.23-1.61)	380	3	0.73	(0.20-1.88)	409	3
2008	2.47	(1.52-3.61)	647	16	3.39	(2.99-3.78)	5158	175	2.30	(1.43-3.33)	697	16	2.43	(1.56-3.63)	699	17

* Reproduced from CSS 2011 Annual Report except where zero adults returned.
Confidence intervals are exact binomial CI's in these cases.

□ Smolt population expanded to LGR equivalents.
NA's shown where zero adults returned and a bootstrap confidence interval could not be calculated.

● Unexpanded SAR with NOAA and CSS fish. NA's shown where zero NOAA smolts were transported from LMN.
CI's are exact binomial confidence intervals.

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

DATA REQUEST FORM

Request Taken By: JACK Iwamikoski **Date:** 12 DEC 2011

Data Requested By:
Name: Russ Kiefer **Phone:**
Address: **Fax:**
Email:

Data Requested:
Actual NOAA marked Smolts @ LGR To
CSS marked Smolts & compare LMN Transport
Smk to LGR transport SAR

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

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

Comments:

Data Compiled By: JACK Iwamikoski **Date:** 28 DEC 2011

Request # 93