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: Russ Kiefer

FROM: Michele DeHart

DATE: March 24, 2008

RE: Data Request

The FPC staff has prepared the following in response to your data request (emails dated 2/29/08 and 3/10/08). We understand that your request was prompted by the recent articles that appeared in the December 20, 2007 and February 28, 2008 editions of the Northwest Fishletter. The articles referred to the results of studies presented at the annual Corps of Engineers' research review, held Dec. 3-6 in Walla Walla and to the proposed operations to be implemented in 2008. We have reviewed the articles that you sent along with your request, as well as the powerpoint presentations pertaining to the studies discussed in the articles that were presented at the annual research review meeting. We were not present for the presentation of the studies at the research review, nor were we able to review reports of the studies findings. Consequently, we relied on the powerpoint presentations as the foundation for the information contained in the December 20th, 2008 NW Fishletter.

1. Does PIT-tagging at LGR reduce SARs compared to previously PIT-tagged smolts for both Transport and Bypass groups?

- Data in the NOAA and CSS annual reports indicate that a higher value SAR is produced when using fish tagged above LGR as compared to when using fish tagged at LGR (Table 1).

- When using only fish initially detected at LGR, we still see that a higher value SAR is produced when using fish tagged above LGR as compared to when using fish tagged at LGR (Table 2).

Table 1. Estimated smolt-to-adult survival rates (SAR) for wild Chinook and steelhead reported in NOAA and CSS project reports. Estimated transport and bypass SARs of NOAA are from Lower Granite Dam, while those of the CSS include first-time detected fish from Little Goose and Lower Monumental dams.

Wild Chinook

	Bypass		Transport	
Year	NOAA	CSS (C_1)	NOAA	CSS (T_0)
1995	0.22%	0.25%	0.38%	0.35%
1998	0.95%	1.07%	0.60%	1.18%
1999	1.35%	1.89%	2.10%	2.43%
2000	1.44%	2.33%	NA	1.43%
2001	NA	0.14%	0.95%	1.28%
2002	0.76%	0.99%	1.25%	0.80%
2003	0.13%	0.17%	0.34%	0.34%
2004	0.09%	0.22%	0.37%	0.52%

Wild steelhead

	Bypass		Transport	
Year	NOAA	CSS (C_1)	NOAA	CSS (T_0)
1999	0.54%	0.76%	1.42%	3.07%
2000	1.85%	1.81%	3.98%	2.79%
2001	NA	0.07%	2.33%	2.49%
2002	NA	0.94%	NA	2.84%
2003	0.27%	0.52%	2.22%	1.99%
2004	0.13%	0.06%	0.90%	0.88%

Table 2. Recalculated smolt-to-adult survival rates (SAR) for wild Chinook and steelhead. Estimated values included only fish detected at LGR and then either transported or returned to river on site (i.e. bypassed fish). Fish in the CSS category do not include the first time detected fish at LGS or LMN. The “ratio” column is the CSS SAR divided by the NOAA SAR.

Wild Chinook

	Bypass			Transport		
Year	NOAA	CSS	ratio	NOAA	CSS	ratio
1995	0.17%	0.26%	1.51	0.37%	0.41%	1.13
1998	0.66%	1.28%	1.94	0.63%	1.34%	2.13
1999	1.23%	1.88%	1.53	2.13%	2.71%	1.27
2000	1.42%	2.58%	1.81	**		
2001	*			0.93%	1.55%	1.66
2002	0.70%	1.05%	1.50	1.25%	0.73%	0.58
2003	0.12%	0.26%	2.24	0.34%	0.31%	0.93
2004	0.10%	0.15%	1.55	0.37%	0.55%	1.48

Wild steelhead

	Bypass			Transport		
Year	NOAA	CSS	ratio	NOAA	CSS	ratio
1999	0.79%	0.99%	1.26	1.41%	2.69%	1.90
2000	1.83%	3.46%	1.89	**		
2001	*			2.27%	3.09%	1.36
2002	0.63%	1.06%	1.69	2.63%	3.91%	1.49
2003	0.22%	0.49%	2.20	2.11%	1.73%	0.82
2004	0.052%	0.065%	1.26	0.90%	0.92%	1.02

* No NOAA bypass; transport only
** No NOAA transport; data unavailable

2. What is the average latent mortality of collection and bypass compared to uncollected?

- In the CSS reports, a measure of latent mortality between inriver smolts that were in study groups C_0 (undetected at the three Snake River collector dams) and C_1 (detected and bypassed at one or more of the three Snake River collector dams) has not been computed.

- The CSS does report, as discussed in response to Question 3, that there exists a differential in the estimated SARs between smolts in study groups C_0 and C_1, with SAR(C0) > SAR(C1) in most cases.

3. Does the data support NMFS's conclusion that the SARs of smolts bypassed at LGR are just as high as those spilled at LGR?

There is not evidence to support this conclusion. Several years of smolt-to-adult survival rates (SAR's) are available for bypassed and spilled smolts as part of the Comparative Survival Study (CSS). During an 11 year period (1994-2004), the SAR for bypassed wild Chinook averaged approximately 32% lower than the SAR for spilled fish (Table 3). During 1997-2003, the SAR for bypassed wild steelhead averaged approximately 27% lower than for spilled fish.

Table 3. Estimated $SAR_{LGRtoLGR}$ (%) for PIT-tagged wild spring/summer Chinook and wild steelhead in annual aggregate for each study category from 1994 to 2004 (with 90% confidence intervals). [from CSS 2006 Annual report]

	Wild Chinook SAR's		Wild steelhead SAR's	
Mig. Year	**Spill (C_0)**	**Bypass (C_1)**	**Spill (C_0)**	**Bypass (C_1)**
1994	0.28 (0.11 – 0.51)	0.09 (0.02 – 0.17)		
1995	0.37 (0.19 – 0.56)	0.25 (0.18 – 0.32)		
1996	0.26 (0.10 – 0.47)	0.17 (0.08 – 0.27)		
1997	2.35 (1.39 – 3.50)	0.93 (0.59 – 1.29)	0.66 (0.0 – 1.35)	0.23 (0.10 – 0.39)
1998	1.36 (1.05 – 1.75)	1.08 (0.94 – 1.23)	1.07 (0.51 – 1.69)	0.23 (0.13 – 0.35)
1999	2.13 (1.76 – 2.53)	1.90 (1.76 – 2.04)	1.35 (0.79 – 1.93)	0.77 (0.60 – 0.95)
2000	2.39 (2.08 – 2.72)	2.39 (2.12 – 2.52)	1.92 (1.40 – 2.51)	1.82 (1.60 – 2.04)
2001	Assume = SAR(C_1)	0.14 (0.10 – 0.18)	Assume = SAR(C_1)	0.07 (0.03 – 0.10)
2002	1.22 (0.99 – 1.45)	0.99 (0.84 – 1.14)	0.67 (0.46 – 0.90)	0.94 (0.77 – 1.11)
2003	0.33 (0.23 – 0.43)	0.17 (0.12 – 0.24)	0.48 (0.30 – 0.68) [2]	0.52 (0.38 – 0.66) [2]
2004 [1]	0.31 (0.13 – 0.52)	0.18 (0.13 – 0.24)		
AVERAGE (Std Error)	**1.10** (0.28)	**0.75** (0.24)	**0.89** (0.231)	**0.65** (0.228)

[1] Migration year 2004 is incomplete with Age 2-salt adult returns through 8/9/2006.
[2] Migration year 2003 is incomplete until 3-salt adult returns occur at GRA.

In the table above, bypassed and spilled SAR's from the CSS 2006 annual report are shown. The CSS defines bypassed fish (C_1) as fish with one or more PIT tag detections in the lower Snake River dams; this does not include transported fish. The spilled fish group refers to fish with no detection in the lower Snake River dams and is designated C_0. The C_0 group would include fish passed primarily in spill but also via turbines and boat locks.

4. Does the observed patterns in PIT tag SARS fit the culling hypothesis, the cumulative stress hypothesis, or a combination?

A study was presented at the Annual Corps'of Engineers research review in December, 2007 by F.J. Loge of the University of California at Davis. From the information presented in the NW Fishletter, and from our review of the powerpoint presentation, it appears that this study concludes that differential delayed mortality is solely a function of fish health status when they entered the barges. The Loge study showed that barged fish from Dworshak Hatchery had significantly greater mortality when placed in net pens below Bonneville Dam, than transported fish from the Rapid River Hatchery. The study concludes that the differential delayed mortality is expressed by barged fish in the estuary due to natural culling, whereas, the in-river fish have already been culled by the time that they reach the estuary.

The culling hypothesis has been raised several times over the years. The hypothesis relates to the assumption that there are fish within the population that are destined to die that at the point at which fish are all together when transportation is initiated. The hypothesis assumes that no additional impact to smolt viability due to the collection and transport process occurs. This hypothesis is contrary to the reduction in smolt viability, potentially due to the stress, injury, and disease exposure associated with the "collection" process discussed in several papers (Budy et *al.* 2002; Marmorek et.al.2004). However, since this question has been raised again we will attempt to provide information here relative to the CSS study using both the information from the CSS workshop and the 10 Year Report.

I. The CSS Workshop addressed the culling hypothesis in 2004. The following was excerpted from the workshop proceedings document (pp. 49-51).

Culling/selection (fixed mortality/day) (Hypothesis 2.4)

Hypothesis 2.4: *The hydrosystem **indirectly** affects smolt-to-adult survival (SARS) by shifting the timing of mortality of transported fish to post Bonneville Dam, based on the hypothesis that fish experience a fixed rate of mortality.* Subgroup A participants developed a novel alternative hypothesis (2.4) for explaining observed patterns in D and SARs. The basis of this hypothesis is the idea that fish migrating in-river experience an inherent mortality rate per day that will be expressed in the SARs. Transported fish collected at the upper most dam don't have the opportunity to be culled from the population. Therefore, the transport fish SARs could include the unfit fish that were destined to die anyway, but because of the short duration of transport these fish were not exposed to the challenges of inriver migration (i.e., transported fish have experienced only 1.5 days of mortality pre-Bonneville, whereas in-riverfish have had 12–22 days of pre-Bonneville mortality).

3.8.1 Initial workshop assessment of the culling hypothesis *(H. Schaller and C. Petrosky)*

Fish transported lower down in the hydrosystem should have experienced more culling from the fixed rate of mortality prior to transport. Therefore, the transport SARs and D values from projects lower in the system should increase. The transport SAR would increase proportionally to the inriver survival from the upper collector dam to the lower collector dam. In the example below (Table 3.7) the D value should be about 40% higher at the downstream collector dam relative to fish transported at LGR.

To evaluate whether existing information on D was consistent with a culling hypothesis Tom Berggren undertook a further analysis using computed D's existing for wild and hatchery yearly chinook in the recent NOAAF draft white paper (Williams et al. 2003), as well as new analyses employing CSS data.

3.8.2 Post-workshop assessment of the culling hypothesis for explaining observed patterns in D *(Tom Berggren)*

Upstream-downstream differences in D

As discussed above and as shown in Table 3.7, the "culling hypothesis" implies that if continual "culling" of weak smolts is occurring as they migrate downstream through the hydro system, then D values should also be increasing for fish collected and transported at dams lower in the river. The continual "culling" would be incorporated in the in-river survival estimate, whereas, it would occur after release below Bonneville Dam for the transported fish. Based on the assumptions in Table 3.7, if continual "culling" were the primary cause for the in-river mortality experience through the hydro system, then the SAR for transported smolts after leaving the barge (or truck) below Bonneville Dam could be expected to be as low as 2% (0.5*4%) for fish transported from Lower Granite Dam and as low as 2.8% (0.7*4%) for fish transported from Lower Monumental Dam. Under this scenario, the parameter D would be 0.5 (2%/4%) for the Lower Granite Dam transported fish and 0.7 (2.8%/4%) for the Lower Monumental Dam transported fish. The ratio of these two D values (0.7/0.5) is 1.4.

Tables 21D (wild yearling chinook) and 22D (hatchery yearling chinook) in the NMFS draft technical memorandum (Williams et al. 2003) can be used to examine the "culling" hypothesis. Their data shows that the computed annual D's tend to decrease at downstream transportation sites for PIT tagged hatchery chinook and increase at Little Goose Dam before decreasing again at Lower Monumental Dam for PIT tagged wild chinook. The data presented by NMFS makes no case for continual "culling" of hatchery chinook and, on the surface, only a weak case for continual "culling" of wild chinook. But only one to two adult returns from Little Goose Dam transportation were available per year from migration years 1994 to 1997, followed by only 3 to 9 adult returns from the migration years 1998 to 2000. Basically there were too few PIT tagged wild chinook smolts transported from Little Goose Dam (and even fewer from Lower Monumental Dam) to obtain enough adult returns to properly conduct this type of analysis with the available data on PIT tagged wild chinook.

Between year differences in D

If continual "culling" is occurring the entire time that smolts are migrating in-river throughout the hydro system, then in-river smolts migrating in low flow years should have lower pre-Bonneville Dam and higher post-Bonneville Dam survival than do smolts migrating in high flow years. This scenario would lead to lower D's in low flow years and a higher D's in high flow years.

This question may be addressed by comparing the high flow year of 1999 with the low flow year of 2001 (Table 3.8). The pre-Bonneville Dam survival in the hydro system from Lower Granite Dam tailrace to Bonneville Dam tailrace in 2001 was 37 to 63% lower than in 1999 for the PIT tagged CSS hatchery groups and aggregate wild chinook group. To compare the post-Bonneville Dam survival rates between the two years, a modified D* value was computed using fish from study Category C1. This approach was needed because there were negligible numbers of PIT tagged smolts passing the three Snake River dams undetected (Category C0 fish) in 2001 due to maximum transportation at Snake River collector dams. PIT tagged fish transported only from Lower Granite Dam were used as the reference to simplify the computations in the comparison since the goal was to look for patterns across the two years. Contrary to the hypothesis, the D* values were much higher in the low flow year, which simply reflects the extreme difference in survival in the estuary between these two years rather than any continuous “culling” mechanism. The SAR for Lower Granite Dam transported chinook was 3 to 4 times higher in the high flow year than in the low flow year. Interestingly, in both the low flow and high flow years, D* was similar between the Dworshak Hatchery chinook and aggregate wild chinook groups, and much lower than what was measured for hatchery chinook from Rapid River, Imnaha, and McCall hatcheries. The management strategy at Dworshak Hatchery has been to raise hatchery fish of a smaller size more in line with that of wild chinook, and so it may be more than just a coincidence that the relative effect of transportation versus in-river migration on post-Bonneville Dam survival rates is similar between Dworshak Hatchery chinook and the aggregate of wild spring/summer chinook.

II. CSS Ten Year Report

The question of the Loge study was brought up by the COE in their comments on the CSS Ten Year Report. Their comment was as follows:

“CSS estimates of "D" have assumed a transport-to-release below Bonneville Dam survival rate of 98%. In light of new research data indicating that a high proportion of fish transported are in poor health prior to being collected (Loge et. al 2007), previous estimates of "D" may not reflect the true benefit of transportation. A proportion of the transported fish likely die below Bonneville for reasons unrelated to barging, and yet these mortalities are reflected in the transportation SAR used in the calculation of D. Conversely, the same fish of poor health that remain in-river do not get included into inriver "D" estimates as they likely die prior to passing Bonneville Dam which is the starting point to estimate the in-river SAR used in the calculation of "D". Transport to In-River SAR (TIR) ratios do reflect the true benefit of barging as this comparison includes the poor-health juvenile fish in both the transport and in-river SAR estimates. The T/I ratio thus gives us a valid (less biased) comparison of in-river to transportation outmigration life-histories.”

The response to this comment was:

The statement that “The T/I ratio thus gives us a valid (less biased) comparison of inriver to transportation outmigration life-histories” is not generally true. *TIR* alone is sufficient for comparing *some* management actions to each other. *TIRs* do reflect the overall benefit of transportation, compared to in-river migration, under the current operation and configuration of the hydrosystem. We estimate and report *TIR*s. However, the overall value of transportation in avoiding jeopardy and promoting recovery depends on hydrosystem survival, which is sensitive to the amount of delayed mortality of both transported and untransported fish. *D* is a frequently used metric that reflects any latent mortality specific to transported fish. See, e.g., Kareiva et al. (2000); Peters and Marmorek (2001); Wilson 2003, Zabel et al. (*in press*).

The claim of bias in *D* due to poor fish condition is a non sequitur. Any culling of weak in-river fish is properly reflected in *D*. High survival in barges due to shielding from mortality that results in later mortality is a consequence of barging, and is properly reflected in *D*. *D* measures the relative survival of transported fish, post-Bonneville, to the survival of untransported fish, post-Bonneville. The reasons for this differential mortality is irrelevant in its estimation. Reasons for *D* being less than one can be postulated; some causes may be addressable but others, such as the shielding of weaker fish from mortality they would otherwise experience leading to those fish dying at a higher rate once they are exposed to estuarine or ocean challenges, are an unavoidable feature of transportation.

5. Does the data support NMFS's conclusion that size/health selectivity of bypass systems explains the observed patterns of lower bypass SAR?

No. In response to NOAA Fisheries comments, the 2006 Comparative Survival Study Annual Report included analysis of the NOAA contention that transportation/bypass systems have size/health selectivity. Chapter 9 of the 2006 CSS Annual Report presents the analysis of smolt size and detection probability relationships for CSS study group comparisons. Chapter 9, evaluated the magnitude and likely influence of size-collection efficiency, detection probability relationships on CSS outcomes for wild Chinook salmon. The findings of this analysis are:

1. For Lower Granite Dam, the bypass site where the majority of CSS Chinook are collected and assigned to their respective groups, estimated size collection efficiency relationships were weak to non-existent. At Little Goose and Lower Monumental, relationships were quite variable across the five-year record and of comparable magnitude to those estimated by NOAA-Fisheries.
2. Based on a comparison of realized size distributions remaining in-river or going into a barge, there were no clear differences between detected and undetected fish, across projects and years. This was especially true at Lower Granite where sizes were virtually identical for the study groups.

5.5 Does the information presented on transport effects on fish survival in the NW Fishletter represent the best available science?

Yes and no. The facts they quoted in February 28, 2008 article on transportation were correct. However, the statement that 2008 operations could kill a lot if fish was a confusion of the facts. The authors used resulting transport benefit ratio from a transportation study in 2004 and transport proportion information from another year 2007 to come to an unsupportable conclusion about the potential effects of operations in 2008.

The NW Fishletter reported that operating the hydro-system in 2008 in a way similar to 2007 could "kill a lot of fish". The Fishletter reported that only 25 percent of yearling Chinook were transported in 2007. And then the Fishletter used results of a NOAA fisheries 2004 migration year transportation study, to suggest that transporting such a small proportion would be bad for fish. However, as shown in the table below, in 2004 the year when transport fish returned at a much higher rate than in-river fish a very large proportion of fish were transported.

In part the high transport proportion in 2004 was due to very limited spill during that relatively poor flow year. Spill was ended April 23 at Lower Granite and Little Goose dams in 2003, resulting in a small proportion of fish passing those projects in spill. Spill at Lower Monumental Dam began in May and was only conducted for 18 days, for research. Most fish would have been collected and transported at Lower Granite or Little Goose dams during that time period.

Table 1. Comparison of the 2007 estimate of the proportion of Snake River Basin smolt population in Lower Granite Dam forebay that are "destined for transportation" and the corresponding estimates from 2000 to 2006. For yearling chinook and steelhead the results exclude transport at McNary Dam.

Species-age group	Transport Proportion[1]							
	2007	**2006**	**2005**	**2004**	**2003**	**2002**	**2001**	**2000**
Yearling Chinook	0.29 (H) 0.26 (W)	0.611 (H) 0.579 (W)	0.92	0.870	0.629	0.683	0.980	0.71
Steelhead	0.46 (H) 0.42 (W)	0.76 (H) 0. 793(W)	0.94	0.964	0.670	0.677	0.986	0.81
Subyearling Chinook	0.56 (H) 0.52 (W)	0.521 (H) 0. 562(W)	0.809	0.972	0.895	0.929	0.962	0.93

[1]Estimates of collection efficiency based on PIT tag data was used to generate a single annual estimate of proportion transported.

In-river survival from LGR to BON in 2004 was relatively low (0.395) based on NOAA annual reach survival estimates, likely reflecting the low flows and lack of spill in the Snake River. By comparison NOAA estimated relatively high reach survivals (0.594) for yearling chinook in 2007. The 2004 result showed a much lower reach survival than 2007 and Fish Passage Center has shown that a relation exists between reach survival and adult returns, so that it is likely the poor in-river conditions in 2004 resulted in relatively poor returns for in-river migrants, while for 2007 juvenile out-migrants the adult return rates would likely be much higher if the adult returns from the 2007 out-migration follow the relation between juvenile LGR to BON survival versus adult returns that FPC has shown. The return rates from 2007 are not known, nor are the transport benefit ratios. But it is not appropriate to assume that 2004 transport benefit ratios will apply to 2007 fish given the very different in-river conditions, especially spill proportions seen in the Snake River and survival in 2007.

6. What is the relative impact on management decisions for transport, bypass or spill of size/health selectivity compared to turbine passage included in the uncollected group?

If collection/bypass systems were actually shown to have size/health selectivity, the prudent management decision would be to optimize in-river migration conditions, increase spill and maximize the proportion of fish passing through spillways. If collection/bypass systems were size/health selective, reducing spill would increase turbine passage of larger healthier fish, therefore increasing mortality on the larger healthy portion of the migration. Size/health selectivity of bypass systems would logically argue for maximizing spill passage and reducing the proportion of fish passing via bypass or transportation.

Recent analysis by Zabel et al[1], NOAA Fisheries presents the hypothesis that bypass passage increases the travel time of juvenile migrants and that multiple bypass increases travel time and causes a later arrival time at Bonneville Dam. NOAA Fisheries hypothesizes that arrival timing at Bonneville Dam is related to subsequent adult returns. Later arriving fish have lower SAR. If bypass systems were size/health selective prudent management would reduce the proportion of fish bypassed and transported.

7. Does the SARs of smolts collected, tagged, bypassed at LGR, and then transported at Little Goose Dam (LGS) differ from the SARs of smolts tagged above LGR, not collected and bypassed at LGR, but instead collected as first-time detected fish at LGS and then transported?

- In the three years of direct comparison, a higher value SAR of transported wild Chinook at LGS (as well as at Lower Monumental Dam, LMN) is produced when using fish tagged above LGR as compared to when using fish tagged at LGR.

- Due to low numbers of wild steelhead smolts tagged above LGR and transported before 2003, it is less clear if a similar pattern exists for wild steelhead as was observed for wild Chinook.

Table 3. Recalculated smolt-to-adult survival rates (SAR) for wild Chinook and steelhead. Estimated values included only fish detected at LGR, and bypassed at LGR, and then either transported at LGS or undetected at LGS and transported at LMN. The "ratio" column is the CSS SAR divided by the NOAA SAR.

Wild Chinook

	Transport LGS			Transport LMN		
Year	NOAA	CSS	ratio	NOAA	CSS	ratio
2000	1.70%	2.46%	1.45	0.96%	1.07%	1.11
2002	1.10%	1.19%	1.08	1.08%	0.60%	0.55
2003	0.23%	0.51%	2.26	0.10%	0.17%	1.71

Wild steelhead

	Transport LGS			Transport LMN		
Year	NOAA	CSS	ratio	NOAA	CSS	ratio
2000	4.40%	3.37%	0.77	5.67%	2.73%	0.48
2002	2.03%	0.78%	0.38	1.51%	4.84%	3.19
2003	1.07%	2.75%	2.57	0.61%	2.20%	3.58

NOAA fish are tagged and released at LGR and first-time detections downstream transported.
CSS fish are tagged and released upstream of LGR and first-time detections downstream transported.

[1] Scheuerell and Zabel. Seasonal differences in migration lead to changes in the smolt-to-adult survival of two anadromous salmonids