FISH PASSAGE CENTER

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MEMORANDUM

TO: FPAC

FROM: Michele DeHart

DATE: February 17, 2010

RE: COE proposal regarding increase smolt transportation at McNary Dam

At the February 9 Fish Passage Advisory Committee (FPAC) meeting, a proposal by the COE to increase smolt transportation at McNary Dam was discussed. The COE proposal to transport all fish collected at McNary Dam is based upon a NOAA Fisheries study entitled, *"Transportation of Columbia River Salmonids from McNary Dam: Final Adult Returns from Hatchery Spring Chinook of 2002-2004 and Hatchery Steelhead of 2003-2005"*. The proposal and upcoming discussion to modify preset operations at McNary to increase juvenile fish transportation are being presented within the "adaptive management" approach and process anticipated in the NOAA Biological Opinion. Adaptive management allows actions to be modified on the basis of information and analyses. The NOAA analysis clearly (Marsh et al. 2009) indicates that the bypass/collection/powerhouse passage route should be avoided at McNary.

The FPC staff reviewed the subject NOAA study, additional historical and recent studies and operations at McNary Dam in order to consider the COE proposal to increase transportation of smolts at McNary Dam. The FPC reviewed the NOAA analysis and the COE proposal within a management decision framework, which considers all species and all aspects of juvenile fish passage at McNary Dam. This is consistent with the recommendation of the ISAB (ISAB 2008). The FPC also reviewed historical and recent passage studies at McNary, in developing this review, to facilitate the FPAC adaptive management discussions of the COE proposal. This consideration is within the adaptive management approach included in the NOAA Biological Opinion. In addition the broader consideration of juvenile fish passage at McNary Dam is consistent with the Independent Scientific Advisory Board (ISAB) conclusions that transport decisions require a multi-species perspective (ISAB 2008). Our review conclusions are listed below, followed by detailed discussion.

- **The transport benefits for steelhead presumed by the 2003-2005 NOAA study results are unlikely in the present configuration of the hydrosystem.**
- **We agree with NOAA that the powerhouse/collection/bypass passage route at McNary is harmful.**
- **Turbine survival at McNary dam has been shown to be relatively low for Chinook and steelhead.**
- **We disagree with the assertion that there is an established size bias in the collection system at McNary Dam.**
- **Comparison of study results from RT studies conducted the same years as the McNary transport studies revealed differing results. The RT studies show a markedly higher relative benefit of bypass passage, for yearling spring summer Chinook, compared to the ratio of bypass SARs to spillway SARs. This suggests that short reach RT survival estimates may provide misleading data for passage management decisions.**
- **2009 data at McNary indicated poorer passage conditions for yearling Chinook than in 2008 based on the increased proportion of fish that passed via the bypass and turbines.**
- **Considering the subject NOAA study and other studies at McNary, it is clear that transportation, bypass or turbine passage routes are resulting in high level of juvenile mortality and or low adult returns. Studies indicate that the best passage alternative available for McNary Dam across all species is spill. Increasing spill to within the gas cap, 24 hours per day, would decrease the proportion of fish passage through the bypass/collection/powerhouse routes.**

The transport benefits for steelhead presumed by the NOAA study results are unlikely in the present configuration of the hydrosystem

The NOAA analysis concluded in regard to steelhead that "…transported fish performed better than any other migration treatment group, while in-river migrants performed better than bypassed fish" Marsh et al.(2009). However, as NOAA pointed out, there have been significant changes to the structure of the downstream dams, as well as McNary Dam, since the transport studies were conducted. Additionally, reach survivals have increased from McNary Dam to Bonneville Dam over the past few years especially for steelhead (Ferguson 2009). For Snake River origin steelhead, Ferguson(2009) has estimated reach survivals of 0.67 and 0.86 for 2008 and 2009. If transportation studies had been conducted during these more recent years instead of during the years 2003 to 2005, where reach survivals were lower, SARs for bypass fish might have been higher such that there may not have been any benefit to transport based on the ratio of transport to bypass SARs.

To investigate the question of how increased reach survivals might affect the transport benefit for steelhead, we used the NOAA transport study SARs Marsh et al.(2009) and reach survivals to determine what increases in reach survival would have resulted in transport/bypass SAR ratios less than 1. We used Marsh et al.(2009) transport study estimates of in-river survivals from

McNary to Bonneville to determine the post-hydrosystem survival to return (BON to McN SAR). We divided the McN to McN SAR by the McN to BON survival to derive the BON to McN SAR. Then we added different values to the existing in-river survival (0.1 to 0.2) and multiplied that by the BON to McN SAR to determine what SARs would have resulted from higher in-river survival (Table 1). As illustrated in Table 1, an increase in reach survival of 0.2 in all years resulted in T/B's below 1 for all years, while an increase of 0.15 resulted in T/B's nearly at or below 1 for all years.

Table 1. Effects of changing McN to BON survival on SARs and T/B's for bypassed steelhead migrants.

	SAR		Marsh (2009) T/B	T/B with change in reach survival of		
Year	**Transport**	**Bypass**		+0.10	+0.15	+0.20
2003	2.34	1.94	1.21	1.07	1.01	0.96
2004	2.00	1.51	1.32	1.05	0.96	0.88
2005	2.14	1.98	1.08	0.94	0.88	0.82

Then we compared reach survivals estimated for different groups of fish by Ferguson (2009) and our own estimates (FPC) to determine the change in survival that had occurred in the years since the transport study Ferguson (2009) estimated survivals during the study years of between 0.50 and 0.53, while FPC estimated survivals of 0.40 to 0.63 for those same years (Table 2). The transportation study Marsh (2009) showed different survival estimates still and those are shown for reference in Table 2.

Survival in the years after the transportation study (2006 to 2009) ranged from 0.39 to 0.86 according to Ferguson (2009) estimates for Mid-Columbia and Snake River steelhead, while FPC estimated survivals ranging from 0.50 to 0.87 (Table 2). Of particular interest are the relatively high survivals in the past two years (2008 and 2009) and the low estimates for 2007. Based on the average survival for the years during and after the NOAA transportation study, Marsh et al.(2009) we estimated differences in survival for those time periods. Excluding the NOAA transportation estimates (since there were no estimates for years after the study concluded to compare), the average increase in reach survivals ranged from 0.04 to 0.22 and averaged 0.14 (Table 2).

These differences in reach survival suggest that if the average increase in reach survival in the past 4 years of 0.14 were applied to the bypass SAR groups in the transport study, the T/B's would have been below 1 for two of the three years and at 1.02 for the other year (likely not significantly greater than 1). As such the transport study may not have shown any benefit even for bypassed fish. If the poor survival year of 2007 were ignored, the increases in reach survival from McNary Dam to Bonneville Dam would have been greater than 0.2 for both NOAA and FPC steelhead estimates. Such an increase in survival for bypassed fish would result in T/B's below 1 for all three years of the NOAA study.

Table 2. Survival estimates for steelhead in the McNary Dam to Bonneville Dam reach and average improvement in survival from transport study years 2003 to 2005 compared to 2006 to 2009 based on survival estimates from various studies.

	Survival Data Source				
MigrationYear	Marsh (2009)Transport Study	FPC Estimates	NOAA Mid-Columbia	NOAA Snake River	Average
2003	0.77	0.63		0.52	
2004	0.39	0.40	0.50		
2005	0.64	0.46	0.53		
2006				0.65	
2007		0.50	0.39	0.52	
2008		0.77		0.67	
2009		0.87	0.73	0.86	
2003 to 2005 average	0.60	0.50	0.51	0.52	0.51
2006 to 2009 average	NA	0.71	0.56	0.68	0.65
Survival Difference		**0.22**	**0.04**	**0.16**	**0.14**

This analysis suggests that the small benefits as measured by transport/bypass and transport/in-river SARs would likely disappear given improved survivals in the reach below McNary. Furthermore, recent improvements in passage conditions for steelhead at McNary Dam, such as increased spillway passage proportion, decreased forebay delay and lower turbine passage proportions, would likely also improve SARs for the spill/turbine passage group.

Finally, the NOAA study used PIT-tagged fish that were barged without run-at-large fish. Thus barge loading densities were lower than what would typically occur under full transportation operations. Therefore, the applicability of these results to run-at-large migrants is questionable. Changes to the downstream dams that resulted in increased survival, as well as increases in spillway passage and decreased turbine passage for steelhead, have altered the river in such a way that benefits measured by previous studies are not likely to apply to current conditions.

Turbine survival at McNary Dam has been shown to be relatively low for all species

Studies at McNary Dam over the past ten years continually show poor turbine survival at McNary Dam Ham et al.(2009). Turbine survivals have ranged as low as 0.68 for steelhead, but mainly have been estimated between 0.80 and 0.83 in recent studies. For yearling Chinook, turbine survivals have been higher, ranging from 0.88 and 0.90. For subyearling Chinook, turbine survivals have been quite similar to those reported for steelhead.

Comparison of study results from RT studies conducted the same years as the McNary transport studies revealed differing results. The RT studies show a markedly higher relative benefit of bypass passage, compared to route-specific SAR ratios for yearling spring summer Chinook. This suggests that short reach RT survival estimates may provide misleading data for passage management decisions.

Short reach survival estimates, such as telemetry studies of juvenile fish passage, do not capture the full effects of bypass systems on juvenile salmon. Radio telemetry studies estimate bypass survival to be nearly equal to that of spill survival. However, adult return data show that bypassed fish do not return at as high a rate as fish that pass through non-bypass routes (i.e. spill/turbines). For example, from the NOAA transport study, Marsh et al.(2009) Chinook bypass/in-river SAR ratios were reported as 1.02, 0.62 and 0.52 for the years of the study. But radio telemetry studies during these same years estimated the bypass/spillway survival ratios of 0.93, 0.93 and 0.99 Ham et al. (2009). The telemetry studies suggest very little bypass effect and yet adult returns show a much greater impact. Since the "in-river" SAR group also included turbine passed fish, it is likely that the bypass/in-river SAR ratio would have been even lower in those years (suggesting even greater bypass effects) if spillway passed fish could have been separated from turbine passed fish for the ratio calculation, as was the case with the telemetry data.

We agree with NOAA that the powerhouse/collection/bypass passage route is adverse

For the majority of smolt groups analyzed in the Comparative Survival study (CSS) across species and wild and hatchery production, the SAR for fish bypassed at LGR, LGS or LMN (C_1), was less than the SAR for fish that were not detected at LGR, LGS, and LMN (C_0), indicating that the process of being "collected" to the point necessary for PIT-tag detection and subsequently migrating in-river compromised smolt survival (CSS 2009 annual report). This reduction in smolt viability is potentially due to the stress, injury, and/or disease factors associated with the "collection" process (Budy et al. 2002; Marmorek et al. 2004). Improving SARs for bypassed and transported salmonid smolts would appear to require a reduction in the detrimental effects of the "collection" process. Alternatively, operations could be implemented which reduced the proportion of in-river migrating fish that experience the collection process, such as increasing spill and/or flow levels, thereby increasing the SARs of in-river migrants through reducing the number of collection and bypass experiences of smolts.

We disagree with the assertion that there is an established size bias in the collection system at McNary Dam.

Of the three sources cited (Zabel et al. 2005; Zabel and Williams 2002; Williams et al. 2005) only the last studied whether or not there was a size bias in the bypass at McNary. Williams et al. (2005) used wild and hatchery Chinook and wild steelhead marked and released at LGR during migration years 1998, 1999, 2000, and 2002. According to PTAGIS records, these fish would have experienced a travel times that were often in the range of 5-15 days (Figure 1). The problem with this approach is that growth is assumed to be zero over this period for measurements at LGR to be applicable to detections at MCN. Additionally, in the 2008 CSS report this issue was addressed at LGS and LMN where there was no evidence of a size bias for hatchery and wild Chinook. Steelhead size distributions generally appeared similar for detected vs. non detected with some differences in the median length of the seasonal distribution. The median length of the seasonal distribution of non-detected was, at times, 2-4 mm larger than for the detected fish at LGS and LMN, where both groups had a distribution of lengths from approximately 120 to 300mm.

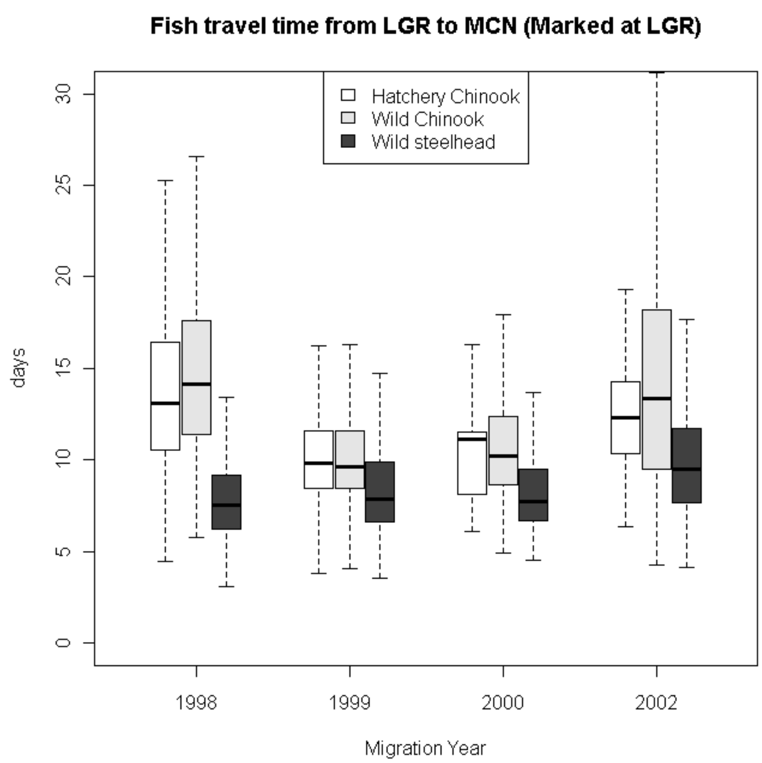

Figure 1. Boxplots, of days between releases at Lower Granite Dam (LGR) and detection at McNary. All fish were marked at LGR had “LGRRRR” as their release site.

Telemetry data collected at McNary Dam indicated that poorer passage conditions occurred for yearling Chinook in 2009 compared with 2008, based on the increased proportion of fish that passed via the bypass and turbine route in 2009.

Based on preliminary telemetry results reported for 2009 it appears that passage conditions for yearling Chinook were poorer than in 2008 (Adams et al. 2008 and Adams et al. 2009). Less than

60% of Chinook passed via the spillway in 2009 compared to approximately 70% in 2008. A larger portion of yearling Chinook passed via the powerhouse than was reported in 2008 telemetry results. It may be that the newer TSW configuration in 2009 did not draw Chinook away from the powerhouse as well as the 2008 configuration. Whatever the cause, a greater portion of the population passed via the powerhouse, which adult return data suggest is not the best route of passage, although telemetry data would suggest equal survival via bypass and spillway.

Considering the subject NOAA study and other studies at McNary, it is clear that transportation, bypass or turbine passage routes are resulting in high level of juvenile mortality and or low adult returns. Studies indicate that the best alternative option for McNary Dam across all species is to increase spill, within the gas cap, 24 hours per day, to decrease the proportion of fish passage through the bypass/collection/powerhouse routes.

A variety of spill studies have been conducted at McNary Dam over the past several years. The results were summarized in “Synthesis of Biological Research on Juvenile Fish Passage and Survival 1990-2006: McNary Dam”, by Ham et al. (2009). Although study design and conditions varied among years, data from the studies have consistently shown (2002 – 2006) that spillway survival was higher than other passage routes for yearling Chinook and, with the exception of an equivocal number with the juvenile bypass system in 2005, for steelhead.

Relative dam survival rates also varied across the range of spill proportions included in the studies conducted over the years. The spill programs implemented ranged from 12 hours to 24 hours, at various percentages and volumes dependent on flow, and the planned spill program. The following tables (Tables 3 and 4) were taken directly from Tables 6.1 and 6.2 of Ham et al. (2009). There are few data points available over the years, but Ham et al. (2009) conclude that “the general trend across all species was an increase in survival with increasing spill proportion”. At similar overall spill proportions, survival estimates for 24-hour spill appeared to be slightly higher than survival estimates for 12-hour spill.

Table 3. Estimates of route specific survival for yearling Chinook at McNary Dam (reproduced from Table 6.1 of Ham et al. (2009).

Table 6.1. Estimates of Route-Specific Survival for Yearling Chinook Salmon at McNary Dam

Year	Spill Treatment	Dam Survival (95% CI)	Spillway Survival (95% CI)	JBS (95% CI)	Turbine (95% CI)	Source
2002	Zero spill Day/Gas Cap Night (BiOp)	87.7 (84.9-90.5)	97.6 (95.2-100)	92.7 (88.9-96.5)	–	Axel et al. 2004a
2003	Zero spill Day/Gas Cap Night (BiOp)	89.3 (84.9-93.7)	92.8 (87.4-98.2)	86.5 (80.3-92.7)	–	Axel et al. 2004b
2004	Zero spill Day/Gas Cap Night (BiOp)	93.0 (90.3-95.8)	97.3 (94.1-100.3)	90.2 (85.3-94.7)	87.2 (80.7-92.9)	Perry et al. 2006
	Low Turbine Discharge	–	–	92.0 (±12.2)	89.0 (±12.4)	
	High Turbine Discharge	–	–	90.6 (±10.1)	81.3[a] (±17.7[a])	
2005	Zero spill Day/Gas Cap Night (BiOp)	93.6 (91.0-96.0)	95.5 (91.7-98.5)	94.6 (91.0-97.7)	89.7 (83.6-94.6)	Perry et al. 2007
	Gas Cap	96.1 (94.7-97.5)	97.2 (95.5-98.8)	95.7 (93.4-97.6)	93.3 (88.7-96.8)	
2006[c]	Fish Passage Plan[a]	92.5	97.2/93.7[d]	94.7	78.2	Adams et al. 2008
	Test Spill[b]	94.9	96.1/96.0[d]	94.3	90.2	

(a) "Fish Passage Plan" emphasized spill on the north end (bays 1–3) of the spillway and generally higher discharge through the north powerhouse.
(b) "Test Spill" emphasized spill on the south end (bays 18–20) of the spillway and relatively less discharge through the north powerhouse.
(c) Acoustic telemetry study
(d) South spill bays/north spill bays

Table 4. Estimates of route specific survival for steelhead at McNary Dam (reproduced from Table 6.2 of Ham et al. (2009).

Table 6.2. Estimates of Route-Specific Survival for Steelhead at McNary Dam

Year	Spill Treatment	Dam Survival (95% CI)	Spillway Survival (95% CI)	JBS (95% CI)	Turbine (95% CI)	Source
2004	Zero spill Day /Gas Cap Night (BiOp)	98.5 (96.2-100.9)	99.6 (97.2-102.1)	97.6 (93.1-101.3)	89.4 (78.2-97.6)	Perry et al. 2006
	Low Turbine Discharge	–	–	95.8 (±16.5)	91.0) (±27.5)	
	High Turbine Discharge	–	–	94.3[a] (±9.2[a])	107.4 (±44.2)	
2005	Zero spill Day /Gas Cap Night (BiOp)	91.3 (86.9-94.7)	97.9 (94.7-99.6)	90.1 (81.6-95.8)	68.9 (51.9-83.1)	Perry et al. 2007
	Gas Cap	91.7 (88.7-94.0)	92.1 (88.6-94.9)	92.7 (88.4-95.8)	88.5 (76.8-95.9)	
2006[c]	Fish Passage Plan[a]	95.3	94.1/98.0[d]	94.9	85.9	Adams et al. 2008
	Test Spill[b]	98.7	100.0/100.6[d]	1.004	85.0	

(a) "Fish Passage Plan" emphasized spill on the north end (bays 1–3) of the spillway and generally higher discharge through the north powerhouse.
(b) "Test Spill" emphasized spill on the south end (bays 18–20) of the spillway and relatively less discharge through the north powerhouse.
(c) Acoustic telemetry study
(d) South spill bays/north spill bays

From the studies conducted at McNary Dam over the years, it is clear that spillway survival exceeds other passage routes and overall dam survival increases with increases in spill. Consequently, to address the high levels of mortality from project passage at McNary Dam, spill should be the preferred route of passage to maximize the benefit of this route of passage volumes should occur instantaneously to the gas cap level.

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DATA REQUEST FORM

Request Taken By: Michele **Date:** 2-9-2010

Data Requested By:
Name: FPAC meeting **Phone:**
Address: discussion **Fax:**
Email:

Data Requested: Comments on COE proposal discussed @ FPAC prior to Feb 18. review past studies

Data Format: Hardcopy ☐ Text ☐ Excel ☐

Delivery: Mail ☐ Email ☐ Fax ☐ Phone ☐

Comments:

Data Compiled By: Jerry, Margaret Brandon, Jack, Tom **Date:** 2-17-2010

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