

MEMORANDUM

June 18, 2004

FOR: FCRPS Remand File

FROM: Chris Ross and Rich Domingue

SUBJECT: FCRPS Effects on Adult Survival

In the FCRPS, salmon must pass up to eight mainstem dams. The cumulative loss for adults migrating up the Columbia and Snake rivers can be calculated as the difference in adult counts between dams (after adjustments for legal harvest and tributary turnoff). Adult loss, calculated this way, represents both mortality and apparent loss. Mortality can be related to passage through the dams and to other factors as well, such as illegal harvest, predation, gill-net interactions, and disease. Apparent adult loss between dams may be due to factors other than mortality, such as counting errors, double-counting adults that fall back and re-ascend ladders, and straying and tributary turnoff. A more reliable way to estimate adult passage loss is through the use of data from adult radio-tracking studies. This rules out the double-counting error associated with the dam count method, because it monitors the passage behavior of specific individual adults. Even with this method, however, many adult losses are not counted. For instance, there may not be any indication of a tagged adult's final fate except that it did not arrive at the next upstream dam. This unaccounted-for loss may be the result of mortality or straying and tributary turnoff, but it will not result from the counting errors inherent in the use of dam adult counts. The use of individually coded adult radio-telemetry tags greatly increases the precision associated with studies of adult migration behavior at dams and survival through the mainstem corridor (NMFS 2000e).

While the final fate of many radio-tagged adults is uncertain, NOAA Fisheries considers the unaccounted-for adult loss estimate calculated from these studies to be more representative of the mortality rate associated with passage through the FCRPS dams than an adult loss estimate based on the comparison of adult counts between dams (NMFS 1995a). Therefore, data from radio-tagging studies, when available, were used to estimate the unaccounted-for adult loss rate and, as a corollary, the minimum survival rates of adults passing through the hydrosystem. These estimates are considered minimums, because some radio-tagged adults that were considered dam-passage-caused mortalities in our analysis may have survived or suffered non-dam-caused fates. Minimum survival rates were derived by dividing the number of radio-tagged adults detected at an upstream dam by the number of adults tagged minus the number of fish accounted for in the study. Where multi-year study data are available for a particular species, the multiple-year results were averaged.

Because it is not possible to differentiate fish destination at the time of collection and release, Keefer *et al.* (2004) focused on the fate of fish that reached the upstream end of the Bonneville Dam fishways in their study of adult conversions through the FCRPS, reasoning that fish that successfully ascended the Bonneville ladders did not suffer sampling mortality and were destined to spawn upstream from the dam. Thus, the effects of passing Bonneville Dam are not included in their report. To better estimate system survival including the effects of passing Bonneville Dam, we obtained additional data from that study, including the survival of known destination fish detected in Bonneville Dam's tailrace. In several instances, insufficient data are available from this study to identify the survival effects of Bonneville Dam. In those instances, other available data were used to estimate the Bonneville Dam passage survival rate (Keefer *et al.* 2002; Bjornn *et al.* 2002). The mean unaccountable loss rate in the multi-year reach studies, the mean minimal survival rates (1-loss), and the per-project survival rates for specific ESUs are shown in Table 1. The per-project survival rate was determined by assuming that each project imposes a similar influence on adult survival and taking the observed system survival value to the $1/n$ power, where n is the number of dams passed. The assumption that each dam imposes similar survival stresses is not likely to be wholly correct, as it is known that pinniped predation in and near Bonneville Dam fishways amplifies the effect of delay there and that other dams, notably John Day Dam, have higher than average passage delays, suggesting a stronger passage survival effect. However, the generally high level of adult survival through the FCRPS suggests that this simplifying assumption does not greatly bias the results.

High per-project and system survivals indicate adult salmonid biological requirements are generally being met under current conditions. It is anticipated that biological requirements for migrating adult salmon and steelhead are met under the reference operation. NOAA Fisheries does not anticipate a substantial difference in adult salmon and steelhead survival rates between the proposed action and the reference operation.

Table 1. Estimated minimum adult survival and unaccounted loss (top of Bonneville Dam to top of John Day, Lower Granite, or Priest Rapids dams) based on radio-tracking studies of known-source fish through FCRPS projects. Source: Staff product (see footnotes).

	Adult Counts	Adult Loss				Current Condition				
		1997 ¹	2000 ²	2001 ²	2002 ²	Mean Loss	Minimum Mean Survival	Number of Dams	Per Project Survival ⁴	Per Project Survival with Bonneville
<i>Chinook Salmon</i>										
SR spring/summer chinook ¹²			0.250	0.064	0.102	0.138	0.861	8	0.982	0.982
SR fall chinook ¹²					0.200	0.200	0.800	8	0.973	0.973
UCR spring chinook ⁵			0.081	0.105	0.110	0.099	0.901	4 (5 ⁵)	0.974	0.972
LCR spring chinook ⁶							0.982	1	0.982	0.982
LCR fall chinook ⁷							0.973	1	0.973	0.973
LCR coho ⁷							0.973	1	0.973	0.973
<i>Steelhead</i>										
SR steelhead ¹²				0.114	0.101	0.108	0.893	8	0.986	0.986
UCR steelhead ¹²				0.097	0.048	0.073	0.928	5	0.985	0.985
MCR steelhead ⁹							0.959	3	0.986	
LCR steelhead ⁹							0.986	1	0.986	
<i>SR sockeye salmon</i>	0.154 ¹⁰	0.132 ¹¹				0.143	0.857	8	0.981	

¹ T. Bjornn, personal communication, November 2000 (data from 1996, 1997, and 1998 radio-tracking [RT] studies).

² Escapement summary 96-02, Keefer, M., U. of ID., 5 feb. 04

³ 1 minus mean loss.

⁴ Calculated by taking the nth root of the minimum mean survival estimate based on the number of dams (n) passed.

⁵ Bonneville passage survival rate based on Bjornn et al. 2002; fish origin unknown (Bonneville passage survival = 96.5%)

⁶ Calculated from SR spring/summer chinook salmon per-project survival rates

⁷ Calculated from SR fall chinook salmon per-project survival rates.

⁸ Bonneville passage rate based on Keefer et al. 2002; origin of fish unknown

⁹ Calculated from SR steelhead per-project survival rates.

¹⁰ Based on count analyses (1985 to 1994; 1995 Biological Opinion)

¹¹ Sockeye passage to Wells Dam.

¹² Data from Matt Keefer, Chris Peery, University of Idaho, Memo of Aug 11, 2004. Includes data from released fish that reached Bonneville Dam.

Literature Cited

Keefer and Peery. 2004a. Adult salmonid fallback and escapement during summer (July-August) spill/no spill periods at Bonneville, The Dalles, John Day, and Ice Harbor dams. Letter Report, U. of Idaho. 7 p.

Keefer *et al.* 2004b. Escapement, harvest and unaccounted-for loss of radio-tagged adult chinook and steelhead in the Columbia-Snake river hydrosystem. U.S. Army Corps of Engineers and BPA. Draft Report. 40 p.

U.S. Army Corps of Engineers (Corps). 1960. Fisheries Engineering Research Program, North Pacific Division, U.S. Army Corps of Engineers, Portland, OR. 152 p.

Bell, M.C. 1991. Fisheries handbook of engineering requirements and biological criteria. Report to U.S. Army corps of Engineers, Portland, OR