APPENDIX B

Impacts of Reduced Summer Spill on Steelhead in the Lower Columbia River – Considerations Regarding Downstream Passage

Introduction

The proposed changes in spill volume for summer operations at dams on the lower Columbia River will probably have some level of impact on adult listed steelhead passing downstream. The overall impact, however, is unknown and regional biologists have not ascribed to a common technique for determining the potential number of fish affected. Regional entities attempting to describe the overall impacts of adult downstream passage on steelhead have estimated that between 0 and 8,263 steelhead could be negatively impacted by the summer spill reduction due to fallback.

In estimating the numbers of fish impacted by a change in operations, a great deal of caution must be used. The data from which estimates could be made regarding non-spill operations and fallback during the summer is limited. Despite multiple years of tagging, sample sizes often range from single digits to tens of fish.

Availability of Data

Annually since 1996, roughly 1000 each of steelhead, spring/summer Chinook and fall Chinook have been tagged at Bonneville Dam and released downstream to monitor migration patterns. The purpose of the research was to determine adult passage at hydropower facilities, adult migratory success, if changes in construction and operations at specific projects changed fish behavior, the extent of wandering and straying, as well as unaccounted loss. In 2004, steelhead will continue to be tagged and any behavioral changes associated with operational changes will be monitored.

No studies have ever been requested or undertaken to specifically evaluate differences in mortality or escapement of steelhead that fell back during spill vs. non-spill conditions. To obtain statistically meaningful data for such an evaluation would require a significantly larger sample size for July and August than we currently have (with randomized blocks of spill and non-spill periods and monitoring all potential fallback routes). Escapement, measured as surviving upstream passage to a spawning stream, hatchery or above Lower Granite or Priest Rapids dams, has been the metric used to evaluate adult performance. Thus, escapement entails the entire passage history and fish that are unaccounted for can seldom be directly linked to a single event.

System-wide effects

Historically, fallback somewhere during migration has been associated with a system-wide population level escapement effect (escapement reduction * system percent fallback) of up to -3 percent for a run. Looking at the whole passage season, no differences in escapement were detected in comparisons of 2001 spill vs. no spill periods ($P > 0.05$). In addition, system-wide escapement adjusted for harvest for the years 2000, 2001 and 2002 were nearly identical (87.6,

87.7 and 88.8 percent) despite 2001 being a drought year with reduced spill volumes. These numbers were based on all steelhead tagged during those years (811, 775, and 909, respectively).

Fallback escapement reduction is the difference in system-wide escapement between all fish that never fallback and fish that do fallback. Escapement reduction for steelhead that fell back at some time during their migration for the years in 2000, 2001, and 2002 was 10.8, 15.8, and 18.6 percent, respectively. During those same years 20.6, 18.7, and 15.7 percent of the steelhead fell back at least once during their migration. By multiplying escapement reduction for fish that fall back by the percent of fish that actually fallback you obtain a system-wide effect of fallback on overall system escapement. The values of these numbers for 2000, 2001, and 2002 are -2.22, -2.95, and -2.92 percent, respectively.

Spill versus non-spill comparisons

The only data available for a retrospective evaluation of escapement is from periods of unusually low water when spill was stopped in 2001. Very few radio tagged (RT) fish fell back during July and August 2001 on which to base comparisons. At Bonneville, 7 steelhead fell back (1.6 percent of passage), during spill (4 via the navigation lock, 3 via spillway). At The Dalles, 2 fish fell back (0.7 percent), of which one occurred during spill and one during non-spill (unknown routes). No spill occurred at John Day where 7 fish fell back (5.2 percent) during the non-spill period (unknown routes). The route information is unusual in that during most spill seasons nearly all fish fall back via the spillway. For example, all steelhead did so in 2000 with an n of around 50. In 2002, 8 of 9 did with the 9th falling back via the navigation lock. The first two weeks of September were incorporated into some analyses for 2000-2002 to increase sample sizes for non-spill periods in all years.

Steelhead fallback proportions in July and August 2001 did not differ ($P > 0.05$) between spill and no-spill periods at Bonneville or The Dalles dams. For July and August, with all years pooled (1996,1997, and 2000-2002), steelhead fallback percent was significantly higher during spill versus non-spill at Bonneville Dam (6.1 versus 0.0 percent, $P = 0.015$). At John Day, no steelhead fell back during spill events but during non-spill events, 7 fish fell back with an escapement of 92 percent.

Limited data on the effect on escapement related to route-specific fallback at Bonneville for 2000-2002 (during both spill and non-spill events) indicates a 15-25 percent lower escapement for fish falling back via non-spillway routes (e.g. navigation locks, and turbines) compared to spillway routes. Only 15 percent of the non-spillway fallbacks occurred through turbines. One reason this reduced escapement related to non-spill routes does not appear to affect overall system-wide escapement may be because so few fish fell back at Bonneville during summer non-spill periods as compared to spill periods. There is no indication that any of the other dams have reduced escapement for non-spillway routes.

Discussion of fish impact estimate

The assessment that was made regarding 8,263 fish impacted by fallback due to the reduction in summer spill was based on a number of assumptions. The 3 main assumptions are discussed

below.

Assumption 1) 50 percent of fish falling back during a non-spill scenario pass downstream via turbines and incur 50 percent mortality.

Response 1a) Limited data on the effect of escapement related to route-specific fallback at Bonneville during 2000-2002, indicates a 15-25 percent lower escapement for fish falling back via non-spillway routes compared to spillway routes with only 15 percent of the non-spillway fallbacks occurring through turbines. There is no indication that any of the other dams have reduced escapement for non-spillway routes.

Response 1b) Little information exists regarding the survival of adults passing through turbines. In the Foster Dam studies (Wagner and Ingram, 1973) a minimum survival of 22 - 41 percent was estimated. However, at Foster Dam, turbines are spinning at 163 rpm versus 69-90 rpm as at the lower Columbia projects. Some research has reported that turbine velocity does not impact survival levels (Bell 1981); however, a Ploskey and Carlson (2004) reported that rpm was a primary factor attributed to blade strike of fish. This conflicting information leads to uncertain conclusions about the mortality levels. Another study by Liscom and Stuehrenberg (1985) estimated that 46 percent of the steelhead suffered mortality at Lower Monumental Dam when falling back through turbines.

Estimates of adult fish injury were gathered in a pilot test in 2002; however, a survival assessment was not part of the study design and was not calculable due to the small number of fish used for the study (n = 23 steelhead). Four (17 percent) were injured. However, as mentioned in response 1a, overall escapement reduction for non-spillway routed fish is roughly 15-25 percent less than spillway-routed fish; not approaching the 50 percent estimate used in the analysis.

Response 1c) Of the fish that fell back at Bonneville during July and August 2001, no fish fell back during non-spill periods. It is feasible to assume that overall fallback rates would be far less than what was estimated.

Assumption 2) The steelhead run would mimic what occurred in August 2002 at John Day (158,933), The Dalles (109,283), and Bonneville (226,307).

Response 2a) During the past 6 years, steelhead runs at Bonneville ranged from 57,022-249,250 in August. Thus, using the 2002 number of 175,664 may not be appropriate given that water temperature and flow are uncertain for 2004.

Response 2b) The wild steelhead numbers used in the analysis for Bonneville and The Dalles were double counted so the estimates are inflated. We could not verify the number for John Day Dam.

Assumption 3) Fallback rates used for John Day, The Dalles, and Bonneville dams were 6.94, 6.2, 4.3 percent, respectively.

Response 3) Actual fallback rates measured during July to September 15 for 2000-2002 were 5.2 percent at John Day, 0.7 percent at The Dalles, and 0.7 percent at Bonneville. The 4.3 percent fallback rate assumed for Bonneville was a yearly estimate for 2001 with no seasonality taken into consideration. We assume the other values are the same.

Discussion

Although the data for comparing spill versus non-spill operations is limited, the analysis showed no difference in system-wide steelhead escapement. The analysis comparing 2000, 2001, and 2002 relied on larger sample sizes (hundreds of fish) and no real difference in the system-wide escapements during low flow years was determined (see Table 1). Based on these data, we have no evidence to support the concern that cessation of August spill would affect system-wide steelhead escapement.

Table 1.

Year	Flow Year	2000 BiOp Escapement Requirements (%)	Measured System-wide Escapement (%)	Measured System-wide Escapement (%)	Measured System-wide Reduction of Escapement Due to fallback (%)
		Snake River Steelhead	Snake River Steelhead	All Steelhead	All Steelhead
2000	Near Normal	80.30	NA	87.6	-2.22
2001	Below Normal	80.30	89.3	87.7	-2.95
2002	Near Normal	80.30	91.4	88.8	-2.93

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Impacts of Reduced Summer Spill on Fall Chinook in the Lower Columbia River – Considerations Regarding Downstream Passage

Introduction

The proposed changes in spill volume for summer operations at dams on the lower Columbia River will probably have some level of impact on listed adult fall Chinook passing downstream. The overall impact, however, is unknown and regional biologists have not ascribed to a common technique to determine the potential number of fish affected. Regional entities have estimated that between 0 and 3,589 fall Chinook could be negatively impacted due to fallback by reducing summer spill.

To estimate the numbers of fish impacted by changing operations, a great deal of caution must be used. The data from which to estimate non-spill operations and fallback during the summer is limited. Despite multiple years of tagging, sample sizes often range from single digits to tens of fish.

Available Data

Fallback for fall Chinook at Bonneville between 2000 and 2002 was slightly higher during spill versus non-spill periods. Escapement for those fish that fell back was 44 percent during spill operations (n = 9) and 45 percent during non-spill operations (n = 80).

Overall escapement for fall Chinook passing John Day in 2000 and 2002 was 91.1 percent (n = 170) with 1 fallback and, in the low flow year of 2001, escapement was 87.7 percent (n = 57) with no fallback.

At Ice Harbor Dam from 2000-2002, no fish fell back during spill events and 20 fell back during non-spill events. Escapement for fish falling back during non-spill events was 90 percent.

Discussion of fish impact estimate

The assessment made regarding 3,589 fish impacted by fallback due to the reduction in summer spill was based on a number of assumptions. The two main assumptions are discussed below.

Assumption 1) About 50 percent of the fish falling back during a non-spill scenario pass downstream via turbines and incur 50 percent mortality.

Response 1a) Total escapement at Ice Harbor and John Day for fish falling back was close to 90 percent during non-spill operations. In addition, fish escapement for those falling back via non-spill routes at Bonneville was nearly identical to those falling back via spill. Therefore it is not possible to determine that falling back via non-spill routes is worse than through spill.

Assumption 2) The run would mimic what occurred in August 2002 at John Day (37,086), The Dalles (63,943), and Bonneville (149,283).

Response 2a) Actual numbers of fall Chinook passing in 2002 were 142,114 at Bonneville, 60,282 at The Dalles, and 33,312 at John Day. Since 1980, the average percent of Snake River fall Chinook monitored at Ice Harbor (as a percent of fish counted at Bonneville) is between 0.5 and 4.0 percent. Over the last 4 years it has averaged 3.4 percent. Using this value and the adjusted counts, we estimated the total Endangered Species Act-listed fish would be 4,832 at Bonneville, 2,050 at The Dalles, and 1,132 at John Day. This gives a total listed fish baseline of 8,014 compared to the 250,312 used in the calculation. In addition, the high estimate included summer Chinook as well as fall Chinook.

Discussion

Of the available data, with the exception of Bonneville, fish falling back at John Day and Ice Harbor dams had relatively high escapements after falling back during non-spill events. Based on the lack of difference between escapement for fallback fish during spill and non-spill events at Bonneville, it is not possible to determine a difference between these operations. Based on these data, we have no evidence to support the concern that cessation of August spill would affect system-wide fall Chinook escapement.