University of Idaho
College of Natural Resources

Department of Fish and Wildlife Resources
PO Box 441136
Moscow, Idaho 83844-1136

Phone: 208-885-6434
Fax: 208-885-9080
fish_wildlife@uidaho.edu
www.cnrhome.uidaho.edu/fishwild

To: Derek Fryer, USACE Walla Walla District

From: Mike Jepson, Matt Keefer, and Chris Caudill

RE: Evaluation of Passage and Fallback Events by Radio-tagged Chinook Salmon at Ice Harbor and Lower Monumental Dams as they Relate to Fish Count Discrepancies - 2009

Date: 11 February 2010

Introduction

This summary was developed in response to USACE concerns regarding counts of adult spring–summer Chinook salmon at Lower Monumental Dam that were higher than those recorded at the closest downstream dam (Ice Harbor Dam) in 2009. Specifically, 90,284 adult spring–summer Chinook salmon were counted at Lower Monumental Dam in 2009 whereas only 79,291 were counted at Ice Harbor Dam. This suggests an enumeration error of approximately 11,000 adult salmon (~12–14%). Possible explanations include under-counting at Ice Harbor Dam, passage via non-ladder routes at Ice Harbor Dam (i.e., via the navigation lock), over-counting at Lower Monumental Dam, misidentification of jack versus adult salmon, multiple-ascensions by individual salmon at Lower Monumental Dam (i.e., after fallback events), differences in the proportion that passed each dam at night, or some combination of these or other mechanisms.

Methods

We compared the number and distributions of jack Chinook salmon, steelhead, and sockeye salmon counted at Ice Harbor and Lower Monumental dams from 4 April to 11 or 13 August 2009, respectively (the spring–summer Chinook run dates for each dam) to see if discrepancies observed in adult Chinook salmon counts were similarly reflected in counts of jack Chinook, steelhead, and sockeye salmon.

We reviewed the radiotelemetry data collected from adult Chinook salmon at Ice Harbor Dam in 2009 to evaluate the frequency of: a) undetected and b) nighttime passage events. We also reviewed the radiotelemetry data collected from adult Chinook salmon at Lower Monumental Dam in 2009 and evaluated the merits of a high fallback rate being a viable explanation for the count discrepancy between Lower Monumental and Ice Harbor dams.

From 26 April-30 June 2009, we collected and intra-gastrically radio-tagged 599 Chinook salmon at the Adult Fish Facility of Bonneville Dam and released them approximately nine kilometers downstream from the dam. We monitored the movements of radio-tagged Chinook salmon through the Columbia and Snake River hydrosystems. At Ice Harbor Dam, a single SRX receiver with two yagi antennas connected to it was deployed approximately 0.5 kilometers downstream from the dam on the north-shore (Figure 1). Underwater antennas connected to SRX/DSP receivers were deployed at the ladder tops for both the south- and north-shore fishways, outside main fishway openings, in transition pools, and in the north powerhouse collection channel. Receivers located at sites other than the tailrace and ladder tops were deployed on 13 May 2009. Tailrace and top-of-ladder receivers were deployed throughout the adult spring–summer Chinook migration season.

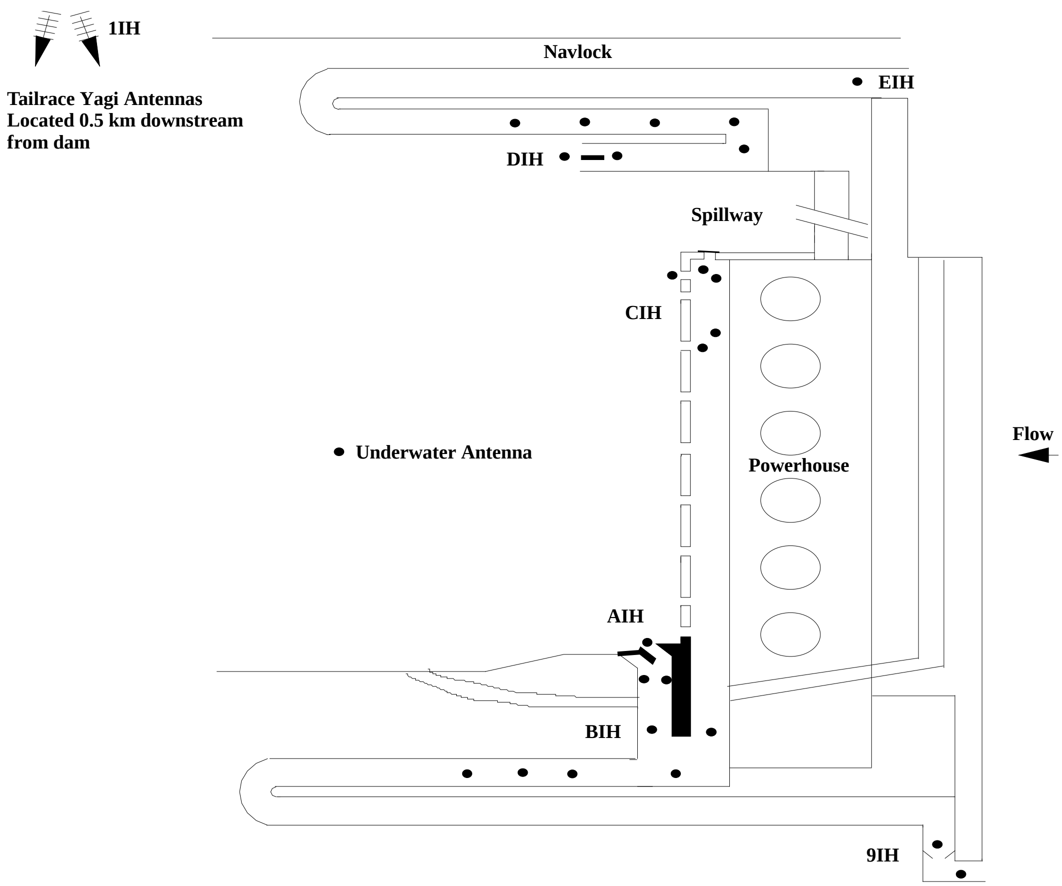

Figure 1. Aerial view of radio antenna deployments at Ice Harbor Dam in 2009.

We reviewed the Ice Harbor radiotelemetry data and tallied the number of undetected passage events (inferred from the absence of top-of-ladder records at Ice Harbor Dam and detections of the same radio-tagged salmon at upstream sites). We also examined the diel distribution of known passage events to determine if there was a high proportion of passage events by tagged salmon that occurred after normal counting hours (i.e., between 2100 hrs and 0500 hrs).

At Lower Monumental Dam, yagi antennas connected to SRX receivers were deployed approximately one kilometer downstream from the dam on both sides of the river (Figure 2). Similarly, underwater antennas connected to SRX/DSP receivers were deployed at the ladder tops for both the south- and north-shore fishways. No other radio antennas were deployed at Lower Monumental Dam in 2009.

Making inferences about the direction a fish is swimming based on detections at a single antenna in a fishway can be problematic without corroborating data from antennas deployed either upstream or downstream. For this reason, we estimated minimum and maximum numbers of fallback events by adult Chinook salmon at Lower Monumental Dam using different detection criteria. Specifically, fallback events included in the minimum estimate were characterized by the following detection histories:

A - Tailrace, Ladder Top, (fallback), Tailrace (no evidence of re-ascension)
B - Tailrace, Ladder Top, (fallback) Tailrace, Ladder Top

Events included in the maximum estimate were characterized by the following detection history:
C - Tailrace, Ladder Top, (min. 6 hr time gap/fallback), Ladder Top.

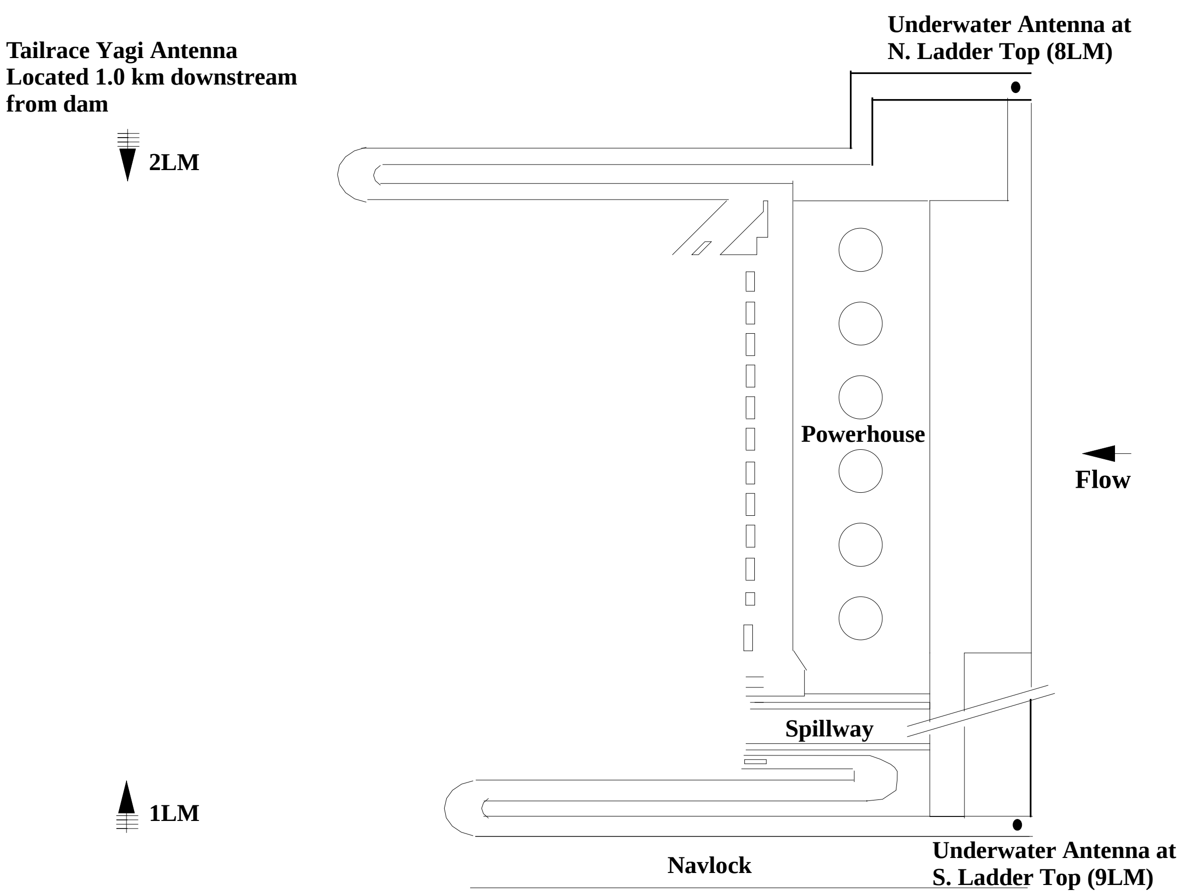

Figure 2. Aerial view of radio antenna deployments at Lower Monumental Dam in 2009.

Results and Discussion

Counts of jack Chinook salmon at Lower Monumental Dam were approximately 5,500 fish (15-17%) *lower* than those at Ice Harbor Dam in 2009 (Figure 3). In contrast, counts of adult spring–summer Chinook salmon at Lower Monumental Dam were approximately 11,000 fish (12-14%) higher than those recorded at Ice Harbor Dam. One potential explanation for the apparent over-counting of adult Chinook at Lower Monumental Dam may be that counters estimate the size of salmon differently at the two dams and thereby assign jack versus adult status differently. Interestingly, there were also higher counts of steelhead (~1,300, 6%) and sockeye salmon (~300, 34%) at Lower Monumental Dam than at Ice Harbor Dam during the study interval. The parallel over-counting of adult Chinook salmon, steelhead, and sockeye salmon suggests a systematic counting error or a substantive difference in passage behavior at the two dams.

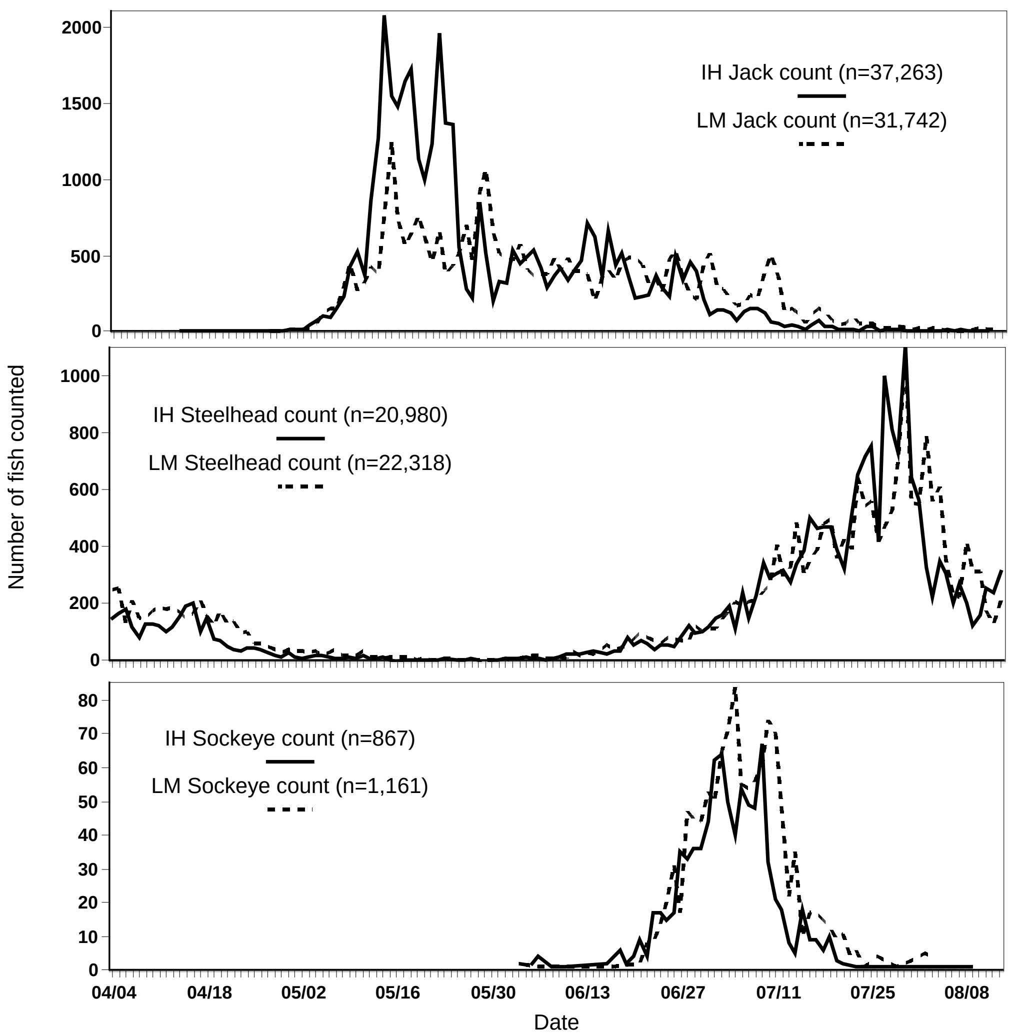

Figure 3. Distribution of jack spring–summer Chinook salmon (upper panel), steelhead (middle panel) and sockeye salmon (lower panel) counted at Ice Harbor (IH) and Lower Monumental (LM) dams 4 April – 13 August 2009.

Of the 599 salmon tagged and released at Bonneville Dam, 195 (32.6%) were recorded at Ice Harbor Dam between 7 May and 20 July 2009. A total of 199 passage events were recorded (or inferred from detections at upstream sites) by 189 unique salmon during this interval. Of the 199 passage events, seven passage events were classified as 'unknown'. Three of the seven unknown passage events occurred during a receiver outage at the north-shore ladder top in early May, an interval in which there were no other receivers deployed except those in the tailrace and at the south-shore ladder top. It is therefore probable that the three unknown passage events were via the north-shore ladder and not through the unmonitored navigation lock. If we assume this to be true, as many as four passage events by radio-tagged Chinook salmon were likely via the navigation lock among the 199 total passage events, or approximately 2% of total passage. Of the192 known (recorded) passage events by radio-tagged salmon at Ice Harbor Dam in 2009, 189 (98.4%) of them occurred when counting was occurring (0500 – 2100 hrs). We therefore conclude that it is unlikely that high number of navigation lock or nighttime passage events through fishways were responsible for the count discrepancies between Ice Harbor and Lower Monumental dams.

Of the 599 salmon tagged and released at Bonneville Dam, 188 (31.4%) were recorded at Lower Monumental Dam between 8 May and 21 July. In both fallback estimates, 15 dam passage events were inferred from detections of radio-tagged salmon at upstream dams. The absence of detections at top-of-ladder antennas likely resulted from receiver outages or passage events through the unmonitored navigation lock. Using the minimum fallback estimate, four fallback events were recorded among 186 passage events by 184 unique tagged salmon (fallback rate = 2.2%, reascension rate = 50%). Using the maximum fallback estimate, seven fallback events were recorded among 189 passage events by 184 unique tagged salmon (fallback rate = 3.8%, reascension rate = 71%).

If we examine the ratio of the total number of passage events to the total number of unique salmon, the minimum estimate produces a ratio of 186:184 = 1.011 and a maximum estimate produces a ratio of 189:184 = 1.027. These ratios are similar to the count adjustment factors used in Boggs et al. (2004) to account for fallback and reascension.

If one assumes:

1) the count at Ice Harbor Dam is accurate and represents the true number of unique salmon past it.
2) all salmon that passed Ice Harbor Dam were counted at least once at Lower Monumental Dam.
3) salmon that fell back at Lower Monumental Dam did so only once before re-ascending,

Then:

1) The fallback:reascension-corrected count at Lower Monumental Dam would be:

$$79{,}291 \times 1.011 = \mathbf{80{,}163} \text{ or } 79{,}291 \times 1.027 = \mathbf{81{,}432}.$$

2) FB rate at Lower Monumental = Lower Monumental count/ Ice Harbor count = 1.139
(90,284) / (79,291)

Clearly, the fallback:reascension-corrected estimates (80,163-81,432) are thousands of salmon fewer than the 90,284 adult Chinook salmon counted at Lower Monumental Dam. Moreover, these results suggest that fallback and re-ascension at Lower Monumental Dam would need to be 5-13 times higher (0.139/0.027 or 0.139/0.011) than what we estimated using the radiotelemetry data. We conclude that a high fallback rate at Lower Monumental Dam by adult Chinook salmon was not likely responsible for the difference in counts at the two dams. Potential problems with the assumptions used for this evaluation include: a) the count at Ice Harbor Dam likely included salmon that fell back and re-ascended the dam, b) the sample of radio-tagged salmon passing Lower Monumental Dam is relatively small, and c) some salmon may have fallen back multiple times at Lower Monumental Dam.

When we looked at the difference in daily salmon counts between Ice Harbor and Lower Monumental dams based on both a one-day and two-day lag (Figure 4), we noted that both higher and lower daily counts were recorded at Lower Monumental Dam (compared to Ice Harbor counts) across the entire range of daily counts at Lower Monumental Dam. However, the frequency and magnitude of the over-counts tended to be highest when absolute numbers of salmon counted were also relatively high. This may suggest that the accuracy of the counts tend to diminish when there are relatively high numbers of salmon present in the fishways. Other potential sources of counting errors between dams include species misidentification, counter variability, downstream movements of fish past counting windows, and potential paths for salmon to pass count windows unobserved (e.g., a hole in a picketed-lead weir). An experiment that could shed light on the nature of the count discrepancies may include having the counters typically stationed at Ice Harbor Dam rotate duty stations with the counters typically working at Lower Monumental Dam. If count differences between the two dams diminish over the course of several weeks, one might have reasonable support for suggesting that counter variability contributes to count discrepancies between dams.

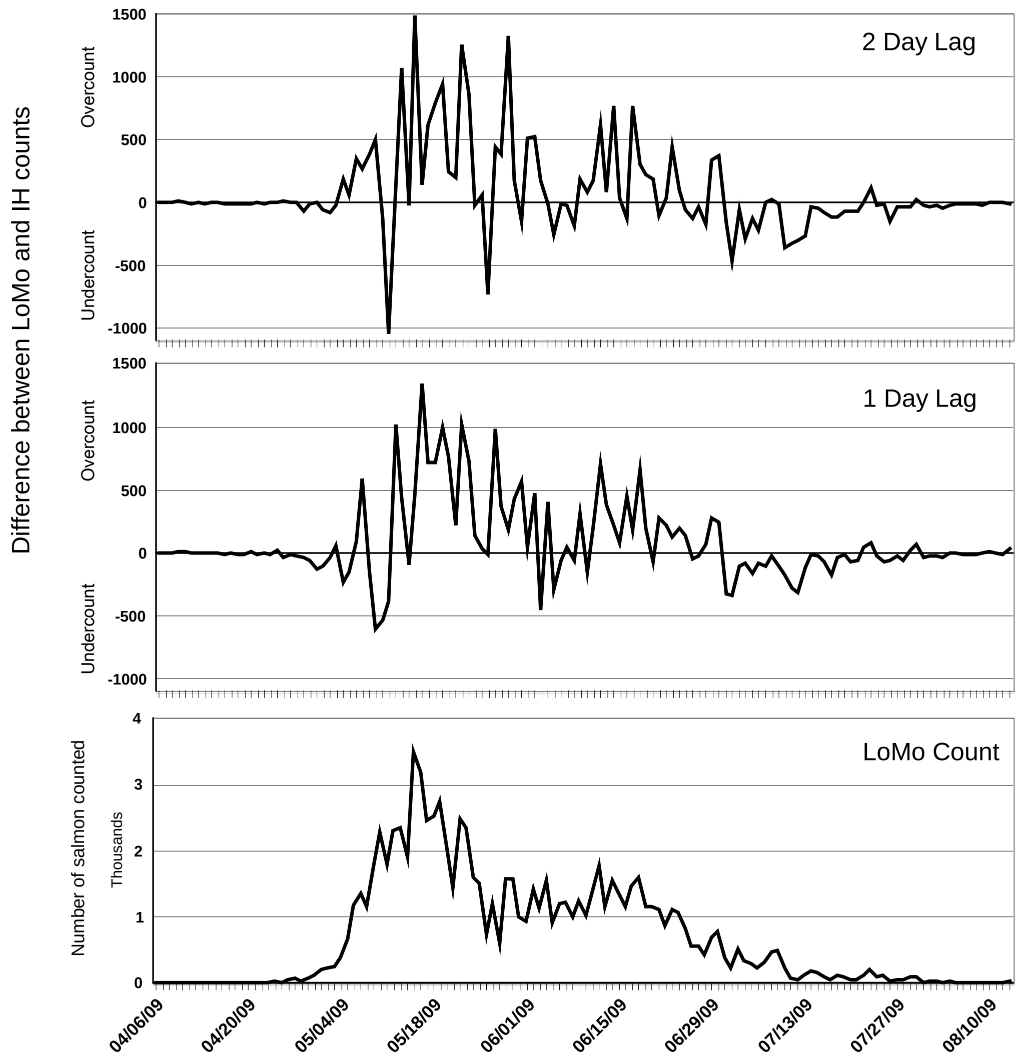

Figure 4. Number of adult spring–summer Chinook salmon counted passing Lower Monumental Dam in 2009 (lower panel), and differences in daily counts at Ice Harbor and Lower Monumental Dam based on a one-day lag (middle panel), and a two-day lag (upper panel).

Literature Cited

Boggs, C. T., M. L. Keefer, C. A. Peery, T. C. Bjornn, and L. C. Stuehrenberg. 2004. Fallback, reascension and adjusted fishway escapement estimates for adult Chinook salmon and steelhead at Columbia and Snake River dams. Transactions of the American Fisheries Society 133(4): 922-931.