Detecting and Enumerating Outmigrating Salmon Smolts

with a DIDSON Imaging Sonar System

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Executive Summary

We assessed the performance of the DIDSON imaging sonar system for detecting and enumerating outmigrating sockeye salmon (*Oncorhynchus nerka*) smolts on Sweltzer Creek. Sweltzer Creek has a seasonal smolt enumeration fence which provided an independent estimate of smolt migration that we used to verify the accuracy of the DIDSON-based estimates of outmigration. The DIDSON system was deployed 40 m downstream of the enumeration fence on the left-bank and operated continuously from 06 April through 01 May 2009. The smolt count through the enumeration fence was 177,487 during this period, but only 54,409 downstream smolt-sized targets were counted in DIDSON files (i.e., 31% of the enumeration fence estimate) by four independent observers. An errors-in-variables analysis revealed systematic bias in the DIDSON and enumeration fence data and precision among repeated counts of files as measured by APE (a lower value indicates higher precision between observers) was 44.4%, which is the worst value estimated for a DIDSON-related project to date. Although there is a strong positive cross-correlation between the daily enumeration fence and DIDSON counts on the same day, auto-correlation patterns in these series are inconsistent with each other. Analysis of hourly DIDSON counts revealed high frequency variation and we suspect that similar high frequency variation at periods of less than a day in the enumeration fence data may be responsible for the strong cross-correlation in daily counts; we are not able to test this hypothesis as hourly data from the enumeration fence are not available. Spectral analysis reveal cyclical behaviour in the hourly DIDSON counts with peaks at frequencies of 3-, 5-, 8-, and 12-h. The peak occurring at 12-h roughly corresponds to the twice daily cleaning and removal of debris from the enumeration fence at 0700 and 1900 hours and is consistent with the hypothesis that the DIDSON count data were biased by our inability to separate fish and downstream moving debris. Based on these findings, we conclude that estimates of downstream counts from DIDSON images and the daily downstream passage data from the enumeration fence are not equivalent measures of the same phenomenon.

The primary challenge of using the DIDSON system to estimate the outmigration of smolts in a riverine environment is to quickly detect, identify, and separate from debris, a small target moving passively with the water current that does not provide strong visual cues consistent with a fish (i.e., swimming movements). DIDSON systems have been successfully used to assess smolt behaviour at protection devices on dams, irrigation intakes, and around fishing gear, but in these studies separating smolts from debris was less of an issue operationally and the aggregation behaviour observed in these smolts provided strong identification cues in the DIDSON images. In contrast, we were unable to achieve reliable detection of smolts moving downstream in the relatively controlled conditions of Sweltzer Creek, where the enumeration fence provided confirmation of the presence of smolts. Field applications of the DIDSON system for smolt outmigration assessment would face significant challenges with respect to finding smolts in the water column and ensuring detection as most tributuaries in the Fraser River watershed do not have a seasonal enumeration fence. Based on our findings and analyses we conclude that a standard DIDSON imaging system is not capable of providing consistent detection and identification of passively moving outmigrating sockeye salmon smolts in a riverine environment and we do not recommend the DIDSON technology for this application at present.