SMOLT RESPONSES TO HYDRODYNAMIC CONDITIONS IN FOREBAY FLOW NETS OF SURFACE FLOW OUTLETS, 2007

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ABSTRACT

We integrated data on smolt movements and hydrodynamic conditions at surface flow outlets (SFOs) at McNary and The Dalles dams during 2007 to determine: 1) Which hydraulic variables were most strongly associated with fish behavioral responses? 2) Of these, were there threshold levels that could be used to support SFO design guidelines?

Fish movement data were collected with an acoustic camera (DIDSON). Water velocity and associated hydrodynamic data were obtained from an acoustic Doppler current profiler (ADCP, sampling simultaneously with the DIDSON) and a computational fluid dynamics model (CFD, instituted after the field work). The fundamental biological response variable -- *fish swimming effort* -- was computed by subtracting the water velocity vector from the observed fish movement vector.

Comparison of the ADCP and CFD results revealed an apparent problem with our application of the ADCP. The instrument was functioning properly, but the assumption that water currents were sufficiently homogenous for a given range in the ADCP beams was not met, producing anomalous water velocity vectors. Therefore, all water-related and fish effort variables were calculated using CFD data. Future studies to collect water velocity simultaneously with fish movements should use a new modified ADCP method that resolves the homogeneity assumption.

The ADCP issue notwithstanding, the 2007 study provided new information having important management implications: 1) Schooling behavior was dynamic and prevalent; the implication is that SFO entrance area must be large enough to accommodate fish schools. 2) Fish behavior was dependent on distance from the SFO entrance; this supports the notion that SFO flow nets need to be expansive enough spatially for smolts to discover despite competing flow fields. 3) Passive fish behavior was observed less than 5% of the time in the SFO flow nets we studied, implying that SFO designs cannot rely only on fish following bulk flow. 4) Active swimming against the flow was the most common behavioral response; thus, SFO performance evaluations should include a metric for fish swimming effort in SFO flow fields. 5) Fish effort variables were correlated with water velocity, acceleration, and strain. The non-linear regressions indicate potential for this approach of merging fish/flow data to lead to SFO design guidelines in the future as the fish/flow dataset is further populated.

In conclusion, analyzing merged fish/flow data from a diversity of sites over multiple years will strengthen the relationships between smolt responses and hydrodynamic conditions such that universal trends may emerge to support bioengineering efforts to improve juvenile salmonid survival rates.