Comments on "Importance of spill in Juvenile Hydro-system Survivals and SARs Preliminary Analysis" Jerry McCann, Fish Passage Center February 2008.

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The overall strategy of McCann's analysis was to assume that spill is a major factor in both passage survival and the smolt to adult return rate, a measure of ocean survival. The predicted benefit of spill is exceedingly optimistic, e.g. for steelhead a 28% increase in spill results in a 1000% increase SAR (see Figure 1 below). It is noteworthy that to the best of my recollection the proposed benefits of spill in this analysis exceed all claims ever made by any agency over the past 25 years. The dashed line is computed from McCann's functions of spill vs. passage survival and passage survival vs. SAR under good ocean conditions.

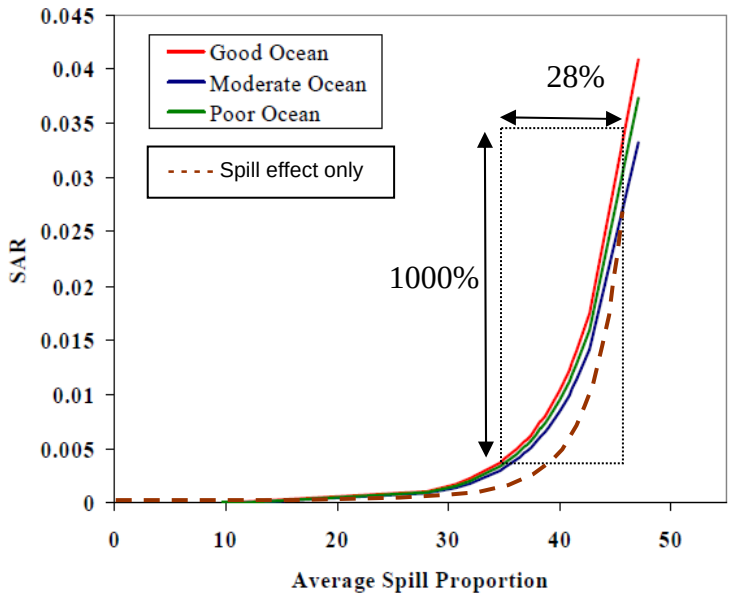

Figure 1. Regression of Chinook SAR vs reach survival from McCann and using bimodal random data (♦) and random bimodal data (●▲) predict similar regressions of survival vs. SAR. The dashed line is the SAR spill relationship generated by combining McCann's spill vs. passage model and passage survival vs. SAR model. It represents the isolated impact of spill from his model.

He obtained this striking benefit in Figure 1 by including spill in all multiple linear regressions reported in the analysis while disregarding factors that contribute to fish mortality and which are at times correlated with spill. In particular, these causative factors were strong in 2001 when spill was the lowest on record. Consequently, in the analysis the effects of ignored factors are attributed to spill, irrespective of the real effect of spill on passage survival and ocean survival. The most important ignored variables were water temperature and clarity and fish condition. These factors have been identified as the major contributors to the low passage survival in 2001. Furthermore, because spill

in 2001 was below 10%, which was less than 3 to 5 times the normal spill, the ignored factors in 2001 were largely attributed to spill. The FPC conducted a similar analysis previously, to claim a strong flow/survival relationship. Again, in that previous analysis temperature was excluded, and in particular the 2001 temperature. Including temperature in the analysis the correlation of water travel time and passage survival was significantly reduce to the point that water travel time was no longer the dominant factor determining passage survival (Anderson 2003). *Prior to any claims for the impacts of spill on fish McCann needs to include causative factors which are currently ignored in the analysis*.

McCann regressed passage survival directly to SAR stating that the analysis demonstrated a significant relationship between passage survival and SAR. In these single variable analyses he assumed that correlation implies causation. This is a logical fallacy. I suggest that the regression he obtained between survival and SAR were the result of plotting bimodal data sets with a sigmodial function. The combination will readily give high a R^2 even though the data have not causal relationship.

To demonstrate this feature I created a bimodal data set: one model represents the 2001 data. It has low passage survivals which I attribute to high water temperature and long fish travel times during passage. A hypothesis supported by COMPASS model analyses. The corresponding SAR for 2001is also set low to account for the poor condition when fish entered the ocean as a result of the poor passage conditions. This hypothesis has been suggested by NOAA (Williams et al. 2005). The second mode has a randomly distributed distribution of passage survivals and SARs representing normal years. With a random distribution within each mode the regression readily generates high R^2 comparable to the data presented in McCann's analysis (Figure 2). The salient point that McCann's correlation does not demonstrate a causative relationship exists between reach survival and adult returns. An alternative explanation is that 2001 was an anomalous year because of temperature and poor fish condition and other years were normal.

Bimodal data does not imply there is a continuous relationship between fish passage survival and SAR. Biologically it can be interpreted that when fish experience threshold conditions their vitality is reduced below a critical level and the ocean mortality is higher. Above the threshold the passage survival may have minimum or no impact on SAR. McCann's hypothesis is just the opposite. He claims that SAR is independent of fish conditions at very low passage survivals and SAR is highly sensitive to passage conditions at high passage survivals. *Analyses relating passage conditions to ocean survival are complex and it is inappropriate to make statements on the coupling from simplistic correlations*.

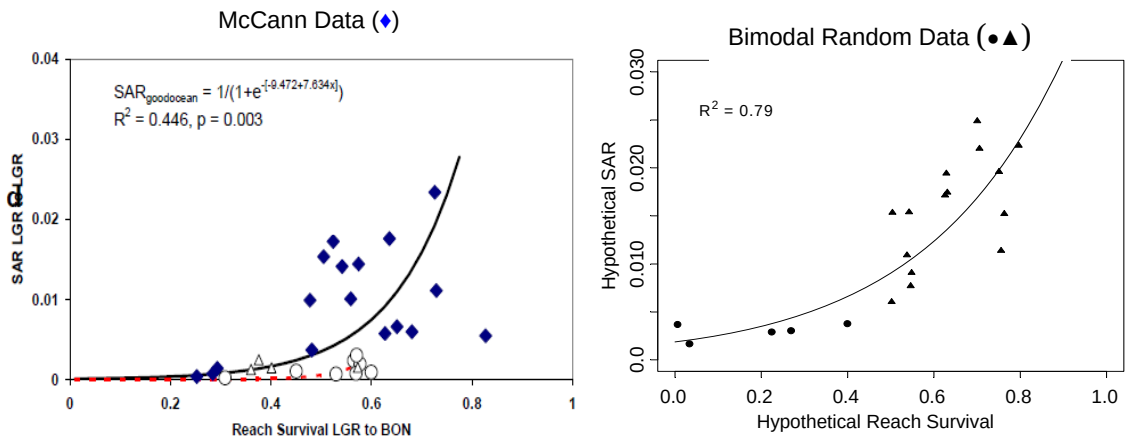

Figure 2. Regression of Chinook SAR vs. reach survival from McCann (♦) and with bimodal random data (●▲) predict similar regressions of survival vs. SAR.

A logic flaw also exists with his claim that spill is strongly related to passage survival. He attributes all survival to spill in graphs of spill vs. passage survival while disregarding water and fish quality factors. His observed correlation can be readily generated in an exponential regression on data distributed in two modes. To demonstrate this I represented one mode of hypothetical data in which low spill and low survival co-occur but where the temperature and long fish travel times are the major cause of the low survival. Low spill is a minor factor. This mode represents the conditions observed in 2001. The second mode has normal spill and survival conditions but the relationship between the two factors is low and for this the demonstration the two factors are uncorrelated. The regression of bimodal data is very similar to the results obtained by McCann (Figure 3). The hypothetical data has no relationship between spill and survival. Thus, while McCann's regression shows correlation it is not possible to claim causation. *The claim that that spill is wholly responsible for the relationship is unfounded.*

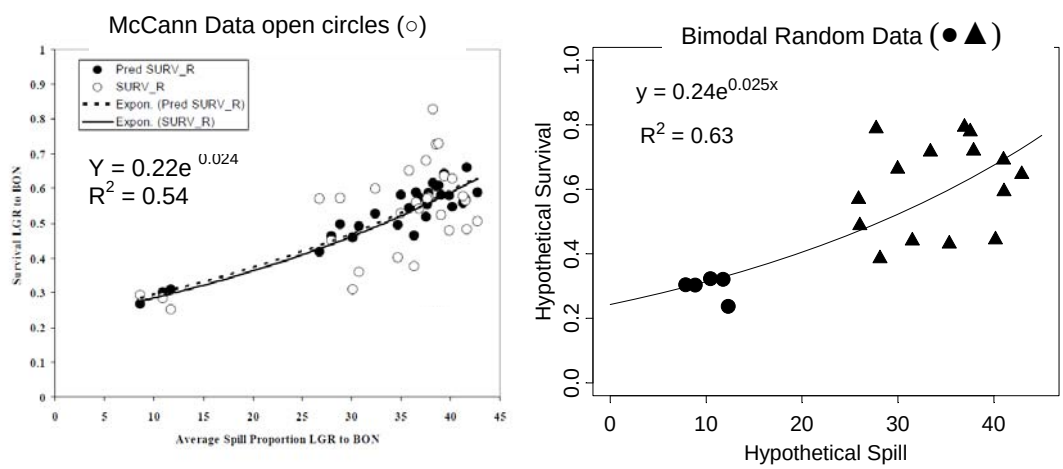

Figure 3. Survival data (○) and random bimodal data (●▲) predict similar regressions of survival vs. spill.

Impacts of ocean

The analysis by McCann implies that within each ocean category (poor, moderate or good) ocean conditions have no impact of ocean survival, only passage conditions and in particular spill (see dashed line in Figure 1) determine ocean survival. The argument is essentially a repackaging of claim made by state and tribal fish agencies more than 15 years ago when it was proposed that small variations in passage survival and travel time were wholly responsible for the ocean survival of the stocks. This notion was subsequently discredited by numerous studies (Williams et al. 2006).

References

Anderson J. J. 2003. An analysis of smolt survival with implications to flow management www.cbr.washington.edu/papers/jim/FlowSurvivalAnalysisNRC.pdf)

Williams, JG, SG Smith, RW Zabel, WD Muir, MD Scheuerell, BD Sandford, DM Marsh, RA McNatt, and S. Achord. 2005. Effects of Federal Columbia River Power System on salmonids populations. NOAA Technical Memo. NMFS-NWFSC-63. (http://www.nwfsc.noaa.gov).