Dent, Diane (ECY)

From: Piccininni,John P - KEWR-4 [jppiccininni@bpa.gov]
Sent: Tuesday, March 04, 2008 4:56 PM
To: Kolosseus, Andrew (ECY); LUT Agnes
Cc: Turner, Rudd A NWD; dan.h.feil@usace.army.mil; Gleason,John M - LC-7; Schiewe,Roger P - PGPL-5; Fodrea,Kimberly A - PGPL-5
Subject: Review comments on 2 Presentations from February 12, 2008 TDG - AMT Meeting
Attachments: UW Anderson_ReviewMcCann_3_03_2008.pdf; Letter Review of McCann Spill Presentation.pdf

Andrew, Agnes,
As requested this e-mail constitutes Bonneville Power Administration's review comments on the Fish Passage Center's (FPC) February 6, 2008, analysis of spill volumes that might occur if the 115% Total Dissolved Gas (TDG) forebay monitoring sites were no longer used for management purposes. I also include reviews of another presentation to the February 12 Adaptive Management Team (AMT) meeting for which you did not request comments but which drew conclusions about fish survival related to increased spill levels.

(1) BPA Internal Review of the FPC analysis of spill volumes -- please contact Roger Schiewe (503-230-5335) with any additional questions on this review.

The analysis understates the amount of spill that occurs in the Base Case since FPC eliminated involuntary spill from the data (see page 2). Therefore, the expected increase in spill in the alternative scenarios is overstated.

FPC states (page 2) that they removed involuntary spill from their analysis "Since it is difficult to model…"
It may be more complicated but it is not an insurmountable task and would give a more valid result.
-FPC correctly states that it can be assumed in the Base Case that involuntary spill is all that in excess of the planned spill operation.

-All the components of total spill can be identified through the following steps:
1. Involuntary Spill (IS) = Total Spill - Planned Spill (PS)
2. Total Spill = PS + Involuntary Spill (IS)
3. Involuntary Spill (IS) = Spill for Lack of Turbine Capacity (SLTC) + Spill for Lack of Market (SLM)
4. Total Spill = PS + SLTC + SLM
5. SLTC = total outflow - turbine capacity (TC) of the project
(note: project turbine capacity must be reduced for units not available for operation)
6.SLM = IS - SLTC

-Using this process, all components of Total Spill (PS, IS, SLTC, SLM) are identified for the Base Case

This is important to the analysis of the scenarios since in some conditions increasing PS as a result of removing the FB TDG requirement will not increase total spill, it will only change what was SLM to PS. This can be done in a spreadsheet model but is easier with a model that is programmed to handle system requirements like meeting power loads. BPA's HYDSIM model accounts for all the components of Total Spill and therefore could provide a truer representation of the expected change in total spill affecting fish passage/survival at each project.

The procedure for estimating the proportion of fish passing through spillways (page 6 and Table 4) isn't explained.

The FPC concludes from their analysis that "the present operation of limiting spill on the basis of forebay monitoring criteria has resulted in reducing the numbers of fish that could pass a project via the spillway." From Appendix C, one can also conclude that it reduced the numbers of fish exhibiting gas bubble trauma, I believe.

(2) At the last AMT meeting the Fish Passage Center's Jerry McCann gave us a detailed PowerPoint presentation

entitled "Importance of spill in Juvenile Hydro-system Survivals and SARs -- Preliminary Analysis." We all understood that the effects of transport were not intended to be part of the discussion but I wondered if the conclusions could be drawn without integrating the effects of other water quality parameters. I asked our University of Washington - Columbia Basin Research contractors to determine if the conclusions were supported by the analyses. Both Dr. Jim Anderson and Dr. John Skalski were able to respond, from slightly different perspectives, but they did not have time to integrate their comments. If you have any questions please contact me at 503-230-7641.

<<UW Anderson_ReviewMcCann_3_03_2008.doc>> <<Letter Review of McCann Spill Presentation.doc>>

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

By James Anderson, School of Aquatic and fishery Sciences University of Washington. March 3, 2008

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.

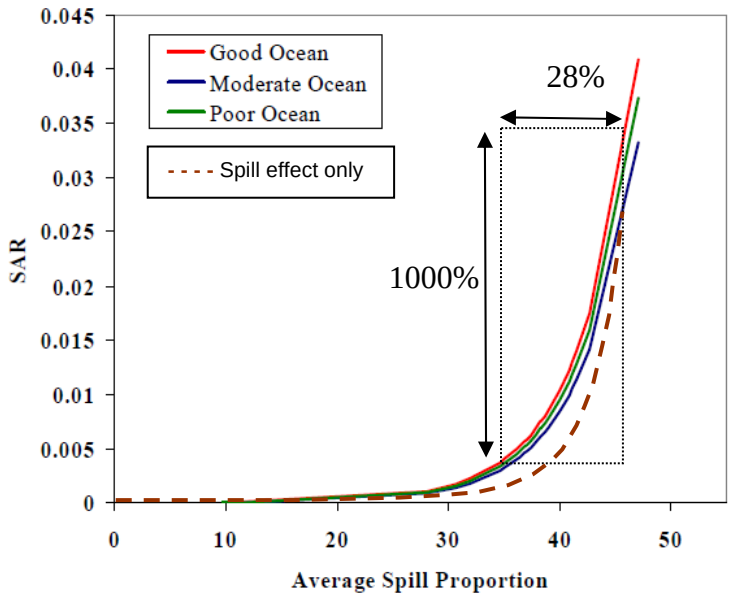

Figure 1. Regression of Chinook SAR vs reach survival from McCann and using bimodal random data (♦) and random bimodal data (●▲) predict similar regressions of survival vs. SAR. The dashed line is the SAR spill relationship generated by combining McCann’s spill vs. passage model and passage survival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

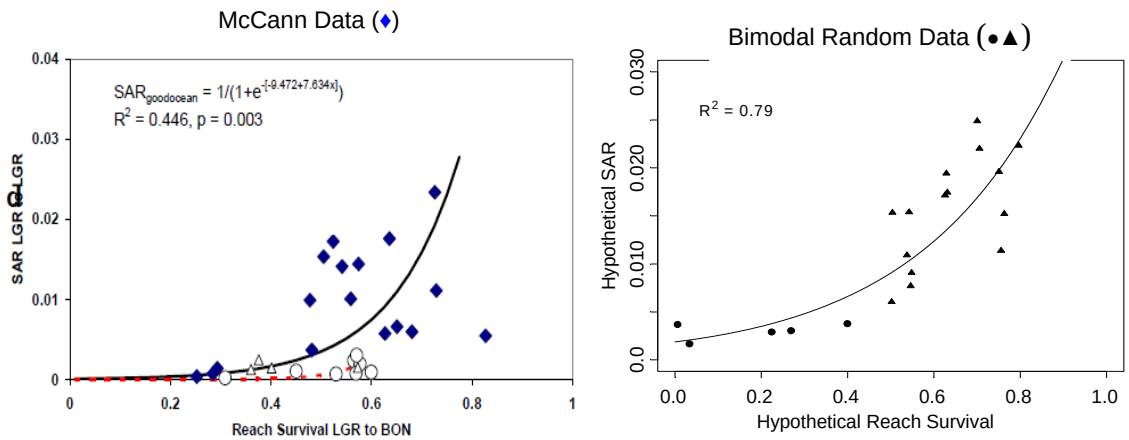

Figure 2. Regression of Chinook SAR vs. reach survival from McCann (♦) and with bimodal random data (●▲) predict similar regressions of survival vs. SAR.

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.*

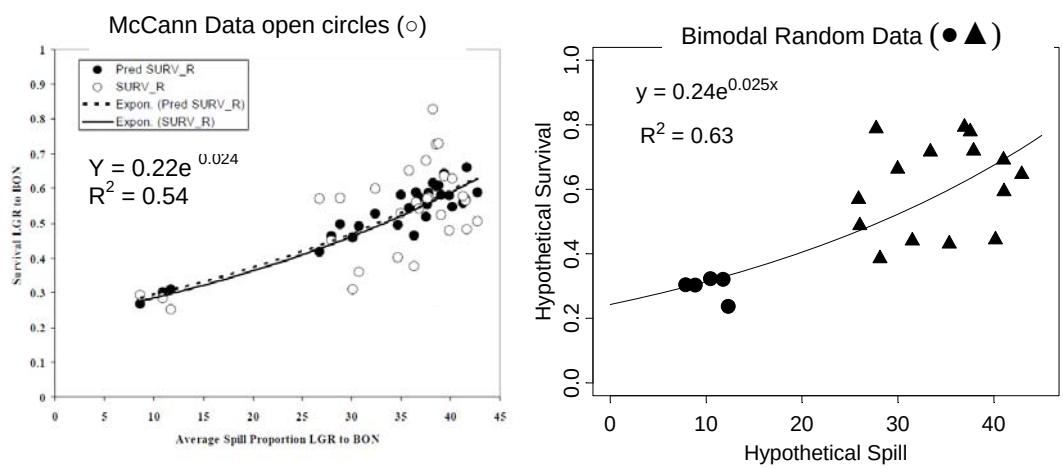

Figure 3. Survival data (○) and random bimodal data (●▲) predict similar regressions of survival vs. spill.

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).

SCHOOL OF AQUATIC & FISHERY SCIENCES
COLUMBIA BASIN RESEARCH

UNIVERSITY OF WASHINGTON

3 March 2008

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Dear John,

RE: Statistical Review of McCann (February 2008) Presentation, "Importance of spill juvenile hydro-system survival and SARs"

Overview

The analysis of spill survival relationships was based largely on the use of an information-theoretic approach (Burnham and Anderson 2002) which has become popular in recent years. This approach to analysis is relatively new and still evolving. Not everyone agrees on exactly how to use it or interpret it, or on its utility (Guthery et al. 2005). Nevertheless, common sense should prevail when analyzing any data. There are a few fundamental concerns with the spill analyses which I wish to summarize.

1. In the analysis of inriver juvenile survival, only three covariates were considered:
    a. Average spill proportion
    b. Water particle travel time
    c. Inseason group release order

    Other variables such as water temperature, turbidity, etc., also known to affect survival were not considered. A thorough analysis should have used a wider range of potential covariates.

2. The so-called "relative weight of evidence" for the individual variables is a term formulated by the presenter. Burnham and Anderson (2002), developers of the concept, call it "relative variable importance" (RVI). It expresses the relative strength of the covariates to each other and has no absolute meaning. The value of RVI depends on the models considered and is very sensitive to the set of models analyzed.

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3. In the first section on inriver survivals, the calculation of the RVI appears to be correct. A balanced set of models with each variable represented an equal number of times was used. In the last section on SARs, however, the calculation of RVI values seems to be incorrect. It appears from the presentation that all or most of the models compared included average spill proportion as a variable. If this is the case, the RVI for that variable will have a value at or near 1 regardless of its importance, simply because of the nature of the models compared. In this situation, the RVI values are not reasonable.

Consequently, the relative weight of evidence as applied in the presentation is an unfortunate misinterpretation of information-theoretic analyses (Burnham and Anderson 2002). Furthermore, it appears the model comparisons performed in the latter half of the presentation were misformulated, resulting in the spill proportion appearing more important than it really is.

Specific Comments on the Presentation

Review comments are provided according to the three main sections of the presentation.

A. Juvenile salmon reach survival analyses

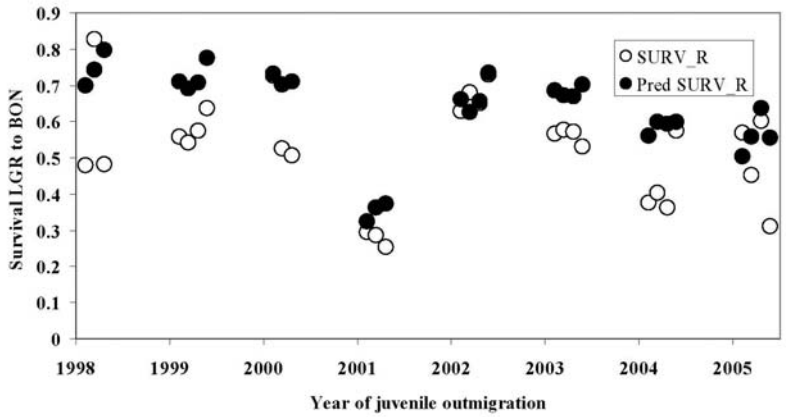
1. Overall, the analyses found average spill proportions to be a useful predictor of spring/summer Chinook salmon smolt inriver survival. However, for steelhead, average spill proportions were no more useful than the other two covariates (water particle travel time and date of group release).

2. The model selection procedure was appropriate with a balanced design of alternative models for the three covariates considered. Of greater concern, however, is that only three covariates were considered in the analyses. Other variables such as water temperature and turbidity, known to affect inriver survival, were not considered. If the goal is to investigate spill–survival relationships, the best way to find it is to exclude alternative explanations.

3. The model averaging approach of Burnham and Anderson (2002) should be based on only "reasonable" models. This means *biologically* and *quantitatively reasonable* models. Unfortunately, "reasonable" is in the eye of the beholder. The author appears to have averaged all models tested. The other approach would consider only models with delta AIC_c of 10 or less from the best model. The consummate model would then change.

4. The fitted model for inriver survival of yearling Chinook salmon seems to possess systematic bias. For the majority of years, predictions exceed observed values.

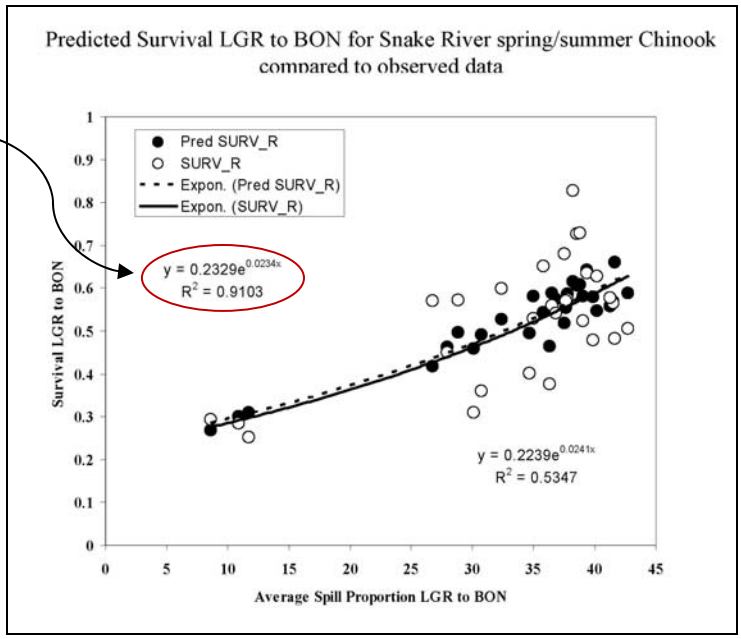
SURV_R compared to Predicted SURV_R (survival from Lower Granite Dam to Bonneville Dam), for Snake River yearling spring/summer Chinook (R^2 = 0.5198).



5. There is a contradiction in the regression results. The multivariate final models have smaller R^2 values than the univariate models with only average spill proportions (Chinook salmon: Model average, R^2 = 0.5198, univariate = 0.5347; steelhead: Model average, R^2 = 0.534, univariate = 0.5467). The R^2 expresses the proportion of variability explained by the regression model. In classical multiple regression, R^2 values increase monotonically as the number of variables increases.

6. In the univariate regression of ln survival against average spill proportion, the author also included a regression of the predicted values (black dots) against spill and obtained high R^2 values. For example, for yearling Chinook salmon, R^2 = 0.9103; steelhead, R^2 = 0.8301). In short, the author used spill to predict survival and then used the predictions to refit the spill model. The resulting conclusion that spill is a good predictor is circular in logic, and thus cannot be supported.

These values are nonsensical and should be ignored.



7. The "weight of evidence" for the various covariates is a term of the author's creation. Burnham and Anderson (2002:168-169) call the quantity the "relative variable importance" (RVI) and state the larger the quantity, the more important the variable is *relative* to the other variables considered. High values do not imply high *absolute* importance. Their values depend on what models were examined. For steelhead, for example, the RVI for average spill proportion is 0.98 while 0.96 for WTT; thus, the average spill proportion is

$$\frac{0.98}{0.96} = 1.0208$$

or 2% more important than WTT. Any other interpretation of RVI is not acceptable.

Weight of evidence for each variable in explaining ln SURV_R for Snake River spring/summer Chinook and steelhead.

	Relative Weight of Evidence for each variable by Species	
Variable	Spr/Smr Chinook	Steelhead
AvgSpillProp	0.97	0.98
WTT	0.85	0.96
Date_Grp	0.28	1.00

B. Juvenile salmon reach survival and relationship to adult returns

1. The presentation uses a creative way of ranking years by oceanographic conditions. However, transforming the four continuous oceanographic variables into a single categorical variable is fraught with problems. Bishop et al. (1975:301) suggests such approaches may be useful as a preliminary step for detecting interactions but the consummate analysis should use the continuous values to avoid loss of information. There are other concerns as well.

    a. The choice to subdivide the ocean data into thirds is arbitrary.

    b. The ranking weights the four oceanographic variables equally, which may or may not be correct if they are correlated—in which case, methods such as principal component analysis would be more appropriate.

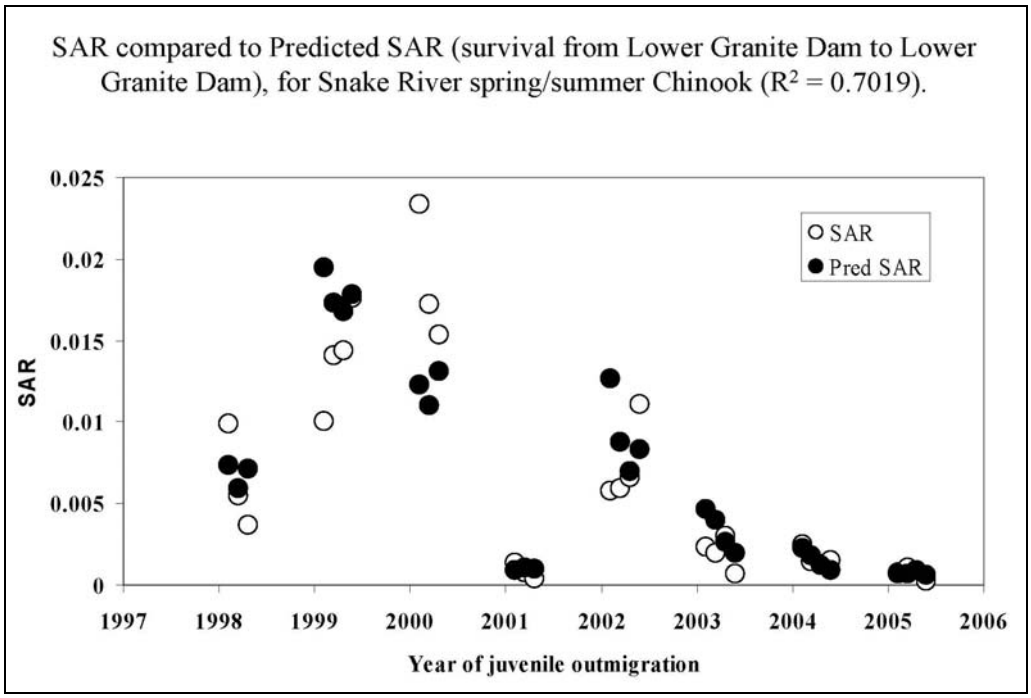
    c. The classification of years into good, moderate, and poor is again arbitrary but also inconsistent. Using the values good (3), moderate (2), and poor (1), as specified in the presentation, the various classifications can be given an overall score. The overall scores indicate contradictions in classification. For example, there are two oceanographic conditions with a score of 9, one classified as a good year, the other as moderate. There are two oceanographic conditions with a score of 7, one classified as moderate, the other as poor.

Summarizing the logic used to classify each year

Good (3)	Moderate (2)	Poor (1)	Overall Category	Overall Score
3	1	0	good	**11**
3	0	1	good	**10**
2	2	0	good	**10**
2	1	1	good	**9**
1	**2**	1	moderate	**8**
1	**3**	0	moderate	**9**
0	**3**	1	moderate	**7**
2	0	2	moderate	**8**
1	0	**3**	poor	**6**
0	1	**3**	poor	**5**
0	2	**2**	poor	**6**
1	1	**2**	poor	**7**

All of these factors suggest a more rigorous and objective handling of oceanographic conditions is required.

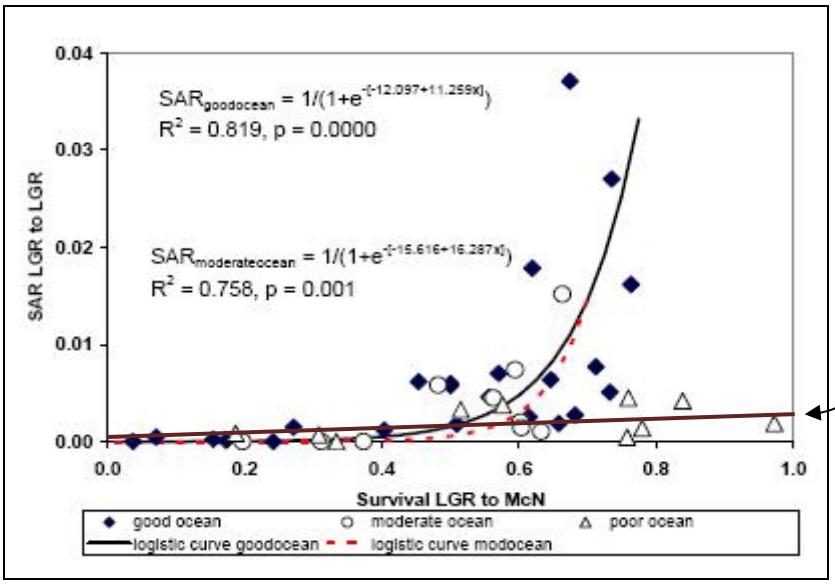
2. The analyses use an inappropriate scale for the observations. Because oceanographic conditions are measured at an annual scale, use of the biweekly release groups is pseudo-replication. Accordingly, the author has four years of poor oceanographic conditions, two years moderate and five years of good on which to base these analyses. All releases within the same year share the same oceanographic conditions, so they are not independent observations but repeated measures.



Thus, analyses should have been based on the 11 yearly observations or adjusted for subsampling. Note in the above figure, SARs within a year are clustered, illustrating their lack of independence within a year, particularly for yearling Chinook salmon.

3. Note that while SAR curves were generated for "good ocean" and "moderate ocean" data, they were not produced for poor ocean conditions. For both yearling Chinook salmon and steelhead, their data indicate SARs are unaffected by inriver survival during poor ocean years. Under any inriver conditions, SARs are at or near zero under poor ocean conditions.

Steelhead



Poor ocean

According to the author, poor ocean conditions occurred during 4 of the last 11 years (1995-1997, 2004), i.e., 36.4% of the time.

B. Relationship between SAR (and SOA) and both inriver and ocean variables

1. The relative variable importance (RVI) results in this section share the same interpretation problem mentioned in the previous section (see comment A7). Again, high values do not imply high absolute importance. The higher the value, the more important this variable is relative to the other variables considered.

Weight of evidence for each variable in explaining variability in adult return data for Snake River spring/summer Chinook and steelhead.

	Relative Weight of Evidence for each variable by Species and Reach			
Variable	Yearling Chinook lnSAR	Yearling Chinook lnSOA	Steelhead lnSAR	Steelhead lnSOA
AvgSpillProp	0.996	0.999	1.000	0.991
May_PDO	0.999	0.999	0.431	0.981
Date_Grp	0.588	0.593	0.985	0.423
Sep_PDO	0.946	0.736	0.178	0.062
WTT	0.258	0.430	0.483	0.375
Apr_Upwell	0.191	0.455	0.081	0.349
Oct_Upwell			0.016	0.130

This time, however, there is also a fundamental analysis flaw. Burnham and Anderson (2002:169) state when assessing the relative importance of variables, it is necessary to achieve a balance in the number of models that contain each variable. It appears that all or at least perhaps most of the models analyzed included the variable for average proportion spill.

Model selection results for **lnSARs** of Snake River steelhead versus environmental variables; Average Spill Proportion, Water Travel Time (days), Date at Lower Granite, April Upwelling, May and Sept. PDO. Smolt migration years were 1998-2005.

Variables in Models	AICc	delta AICc	weight
AvgSpillProp,Date_grp	59.921	0	0.254
AvgSpillProp,Date_grp,May_PDO	60.399	0.478	0.200
AvgSpillProp,WTT,Date_grp	60.873	0.952	0.158
AvgSpillProp,WTT,Date_grp,May_PDO	61.297	1.376	0.128
AvgSpillProp,WTT,Date_grp,May_PDO,Sep_PDO	62.778	2.857	0.061
AvgSpillProp,WTT,Date_grp,Apr_Upwell	63.146	3.225	0.051
AvgSpillProp,Date_grp,Sep_PDO	63.191	3.27	0.050
AvgSpillProp,WTT,Date_grp,Sep_PDO	63.451	3.53	0.044
AvgSpillProp,WTT,Date_grp,Apr_Upwell,May_PDO	65.12	5.199	0.019
AvgSpillProp,WTT,Date_grp,May_PDO,Sep_PDO,Oct_Upwell	65.931	6.01	0.013

By design, then, this action will always result in that variable having an RVI value at or near 1, as reported. As such, the results reported are of little value.

2. In plotting percent fish passing in spill vs. percent spill, the spill efficiency curves that are usually expressed in terms of the ratio

$$\frac{\text{proportion of fish passage}}{\text{proportion of spill}} = \frac{p_F}{p_S}$$

are instead being expressed as an odds ratio,

$$\frac{\left(\dfrac{p_F}{1-p_F}\right)}{\left(\dfrac{p_S}{1-p_S}\right)},$$

which may not be familiar to most people. Note, therefore, an odds ratio of 4:1 does not mean a spill efficiency of 4:1.

Literature Cited

Bishop, Y. M. M., S. E. Fienberg, and P. W. Holland. 1975. Discrete multivariate analysis: Theory and practice. The MIT Press, Cambridge, MA.

Burnham, K. P., and D. R. Anderson. 2002. Model selection and multimodel inference. Springer-Verlag, New York, New York, USA.

Guthery, F. S., L. A. Brennan, M. J. Peterson, and J. J. Lusk. 2005. Information theory in wildlife science: Critique and viewpoint. Journal of Wildlife Management 69:457-465.

I hope this review will be of some help. If we can be of any further assistance, please call.

Sincerely,

John R. Skalski
Professor of Biological Statistics