Submission 25

Major Comments on Alpha and Delta Models

R. Hinrichsen and C. Paulsen

{These more substantive arguments were drawn from the general comments submitted, many of which were more editorial in nature.}

Comments from R. Hinrichsen

Using spawner-recruit and SAR data to test Alpha vs. Delta Models (Tables 4-2 and 4-3)

AIC/BIC tests (Table 4-2). The alpha model was not specified for the lower river stocks, only the Snake River stocks. The fit statistics in Table 4-2 give the fit of the alpha model (as developed for the Snake only) to *both* the Snake and the lower river stocks. Since our hypothesis is that there is a differential climate effect on upriver and lower river stocks, an alternative alpha model needs to be formulated for the lower river stocks. The delta model was developed and adjusted to fit both the Snake and lower river stocks well. Therefore, the comparison based on AIC and BIC is not a fair one. Until a version of the alpha model is developed for the downstream stocks, it will be impossible to compare the alpha and delta models on the basis of AIC and BIC.

Another reason why the AIC and BIC criterion are not really appropriate here is that the alpha model demands explanatory variables that have some scientific physical or biological meaning (e.g., flow). The delta model is composed mainly of factor variables; no physical or biological reason for changes in these factor variables (such as mu or delta) is enforced. Because of the stringent requirement of the Alpha model that year effects for the Snake stocks be explained by some quantifiable physical variable, the retrospective fit of the Alpha model will be predictably poorer, but the potential for scientific explanation is greater. This is the trade-off, scientific explanation versus model fit. The alpha model demands more scientific explanation and does not trust the use of downstream stocks as an adequate control. The delta model, on the other hand, demands a better retrospective fit, relies more on the strong assumption that the downstream stocks are a control for comparing productivities of upstream stocks. But it also demands less scientific explanation of changes in productivity.

To illustrate why the AIC and BIC are not entirely appropriate here, take this example:
Illustration:
We could have fit an alternative alpha model that carried a separate year effect for the upstream and downstream stocks that achieved a similar fit (SS, AIC, and BIC) of the delta model. We have already demonstrated the close correspondence of these two models. Then we could have used the model prospectively by selecting year effects based on flow and PAPA drift. I don't see how this would change the substantive prospective inferences of the Alpha model. Yet the AIC and BIC for the alternative alpha model would have superior fit to the retrospective data!

How could such a thing occur -- better AIC and BIC but no different prospective inferences? It occurs because the year effects of the alternative Alpha model--though they explain a lot of variance in the retrospective data -- are only important as they relate to flow and PAPA drift *prospectively*. Therefore, much of the variance they explain retrospectively ends up essentially relegated to the noise prospectively.

The delta model, although it uses the factor variables retrospectively to achieve a good model fit, must also use some selection of the estimated effects prospectively (The Cyclical or Markovian year effect or the selection of mu based on WTT). If this same prospective relationship were enforced retrospectively, as is required of the Alpha model, how good would the fit of the model be? Much of the explained variance might just as well have been relegated to the noise term when using the model prospectively. This illustrates why the AIC and BIC comparisons are not really appropriate. The Delta and Alpha models must be placed on a similar footing to make their AIC and BIC comparisons relevant.

SAR data (Table 4-3). A statistical test for a "significantly better fit" to the life cycle model to SARs has yet to be specified. Therefore we cannot say that the delta model fits the SAR data "significantly better." We need a formal test of the null hypothesis that the observed SAR = predicted SAR. We need p-values that consider the measurement error of the SAR data. Using this test, can we reject either the alpha or delta models as predictors of SARs? If the delta model fits the SAR better, it may be that the delta model hypothesis was framed and the spawner-recruit data constructed with the SAR data in mind, making the "better" fit a weak (possibly irrelevant) measure of model performance.

Use of Astoria Flow in Alpha Model Does Not Mix Anthropogenic and Environmental Effects

Granted, the under present conditions, Astoria flow (at the Columbia's mouth) is correlated with water transit time. However, I see no blurring of anthropogenic effects and environmental effects here. If drawdown, is implemented, that flow at Astoria will change (average from April-June). The current correlation between water transit time and Astoria flow exists based on the current reservoir volumes of the run-of-the-river dams. Thus we can conclude that *if the current volumes of the reservoirs are maintained*, an increase in WTT will produce a corresponding decrease in flow. There is no evidence that when the reservoirs are lowered for drawdown, producing smaller volumes, that we will see an increase in flow, only velocity. In fact, an analysis of the flow archives for the various alternatives show no important change in flows for any of the alternatives we consider. (See analysis below). This occurs the flow regime of the river will continue to be regulated by upriver dam operations (i.e. Dworshak, Hells Canyon)-- operations that do not change over any of the alternatives we considered (Submission #13 of the Appendix).

An analysis of the flow archives used for the passage models shows that the flow at Bonneville under A1, A2, and A3 shows an absolute difference of flows has a mean of 1.9 Kcfs and a standard deviation of 3.4 Kcfs. Using the close relationship between flows at Bonneville and Astoria (correlation = 0.990), we find that the absolute difference of Astoria flows has a mean of

2.26 Kcfs and a standard deviation of 4.05 Kcfs. This is a minute difference given that the range of flows at Astoria (water years 1928-1987) is 434 kcfs. The estimated error this generates for the predicted log(R) in the alpha model is of the order 0.01, which is well within the noise level of the model stddev(log(R)) ~1.08 (CRiSP) and stddev(log(R))~1.02 (FLUSH) The range of error in assuming the same regulated flow at Astoria among the three alternatives is negligible.

The "common year effects" of the delta model are correlated (weakly) with flow (correlation coefficient = 0.22). In a linear regression between flow and the "common year effects" the C.V of the flow coefficient was 0.73. This weak relationship with flow is ignored in projecting forward the delta model in time. Instead the "common year effect" is treated as a Markovian stochastic process where the effect next year depends on the year effect this year. In reality, lower flows generally lead to poorer year effects and poorer passage survival. Since the relationship between the year effect and flow is ignored, there is a mismatch between the projected flows used for the passage models and the year effects. It is not certain that this mismatch changes the substantive inferences, however. The Alpha model contains a term to directly connect flow with changes in productivity, making the Alpha model better able to consistently model the effect of flow on both "year effects" and passage effects.

This difficulty also has the potential to blur anthropogenic and environmental sources of variability, making this framework poorly able to accommodate hydrosystem management actions that involve changes in flow. However, since flow does not change significantly between the alternatives we have explored, this problem can be safely ignored, just as it could be ignored with the Alpha model.

Commn Year Effects in Alpha and Delta Models

The delta model (when mu + nX is interpreted as passage mortality) actually implies something stronger than a common year effect between the Snake and Lower River stocks. It says that in the absence of "passage effects" due to the Snake River dams, that the mean fluctuation in upriver stock productivity would *equal* the mean fluctuation in downstream stock productivity. No evidence has been presented that can shed light on whether or not this strong assumption is true. Thus evidence presented in (d5) "A variety of evidence supports the idea that climatic changes have common effects on many stock over a wide geographic range" does not address this very strong assumption actually employed. Furthermore, there has been no evidence that the "common year effects" as estimated in the Delta model are related to any climatic phenomenon. Do any of the studies show that stocks as widely separated as the Snake and lower Columbia stocks show *the very same changes* in mean productivity from year-to-year? This is what is needed in support of the Delta model.

The Alpha model does not assume that regional differences in extra mortality exist or that they don't exist. It does not rely on the strong assumption required for the delta model when mu + NX is interpreted solely as a passage effect: *the year effects, barring dams and hydro-development, would be the same for the upriver and downstream stocks from 1970-1990*. In this sense, the Alpha model is more robust to assumptions about common year effects. The Alpha model also explicitly identifies climatic variables that are important for the life-cycle model's year effects, while the delta model does not. Delta does not really measure a common year effect (delta). In reality, during 1970-1990, it is the year effect of the downstream stocks only. It is only a "common year effect" *by untested assumption*. One wonders whether the "common year effects," which are really just the year effect for the downstream stocks from 1970-1990, are an artifact of the spawner-recruit reconstruction assumptions (assumptions about age structure or conversion rates, for example) rather than a real phenomenon. One also wonders whether relegating the "common year effect" of the delta model to the noise term of the model would change any of the substantive inferences about the expected ability of meeting jeopardy standards.

Stock Productivities

The estimates of the Delta model Ricker-as for the Snake are highly sensitive to a few of the spawner recruit observations in the Middle Fork of the John Day River. Actually, when a few of these questionable observations (1959,1964, and 1968) are deleted from the data set, the average Snake Ricker-a (average intrinsic productivity) of the Snake stocks falls from 3.13 to 2.37. (See Hinrichsen 1998, "Influence of Exceptional Spawner-Recruit data of the John Day Middle Fork on the Delta Model Parameter Estimates.") Given this high sensitivity, I conclude that the Ricker-*a’* s of both the alpha and delta models (between 2.5 and 3.0 for the Alpha model) are in remarkable agreement.

Comments from C. Paulsen

Coded Wire Tag Data

Note that the spawner-recruit analysis of wild fish relies on the ocean CWT recoveries of hatchery fish to show that ocean harvest rates of wild fish are very low (treated as zero in the run reconstructions). This implicitly assumes that the hatchery and wild Columbia yearling chinook must have similar ocean distributions, at least insofar as their ocean distributions affect their vulnerability to ocean harvest. In addition, the reconstructions assume that hatchery and wild fish from different regions (Bonneville-McNary, mid-Columbia, and Snake) have identical rates of mainstem river harvest and identical rates of dam mortality when passing the same stretch of river. For example, all fish returning in year “t” are assumed to have the same harvest rate when migrating from the ocean to Bonneville Dam. As noted in the report, in the one case where one can test wild and hatchery fish ocean harvest distributions, one cannot reject the null hypothesis of identical ocean distributions for wild and hatchery fish (for John Day wild fish and Bonneville-McNary hatchery fish). While the results are obviously based on “unpublished” data, it was collected from a public source (PSMFC), whose contents are verified by the agencies responsible for the release and recovery information contained therein. Although *methods* for construction of the S/R data have been reviewed in PATH, neither the basic S/R data nor the SARs noted in this section have been “reviewed” in the sense noted in Starr et al (referenced above). Finally, there is substantial “extra” mortality under both the alpha and delta models that is not accounted for by Ricker parameters, passage model survival output, or (for the alpha model) mainstem flow or Poppa drift. The differential ocean distribution was put forward as one potential explanation for the decline of the Snake stocks relative to Bonneville-McNary wild spring chinook, not as its exclusive or even primary cause.

Upper Fraser River Chinook Data

Several items lead me to give this an applicability of 4+. First, the stocks are located hundreds of kilometers north of the Columbia. PATH participants have declined to perform run reconstructions for spring chinook on the Willamette and other Columbia tributaries due to lack of time and relevance. The mid-Columbia spring chinook have largely been ignored, due to the need to bring the passage models up to speed for them. Given this, the Fraser seems, if anything, even less relevant. Second, Bradford's analysis of similarity among the stocks was based on spawning abundance. I note from the PSC joint chinook technical committee 1994 annual report (# 96-1, table A-4) that the terminal harvest rates for the Fraser were large and varied during the period that Bradford analyzed (see table, below), and wonder whether or not this may cause some of the observed covariance. Bradford does not test whether the broad covariance in escapement translates into a covariance in life-cycle survival, as is posited in the delta model.

		Escapements (all #'s in thousands)					
Run Year	Upper Fraser	Middle Fraser	Thompson	Total	Fraser Sp./Sum Terminal Run	Harvest (Terminal run-Escapement)	%
1975	7	15.5	37	59.5	119	59.5	50%
1976	7.6	10.9	14.9	33.4	99	65.6	66%
1977	10.1	13.3	30.3	53.7	133	79.3	60%
1978	14	13.4	38.5	65.9	109	43.1	40%
1979	12.5	8.6	25.1	46.2	104	57.8	56%
1980	15.8	9.6	19.3	44.7	69	24.3	35%
1981	9	8.2	23.4	40.6	66	25.4	38%
1982	11.6	10.5	20.4	42.5	83	40.5	49%
1983	17.1	15.4	20.4	52.9	73	20.1	28%
1984	21.9	13.9	29.9	65.7	96	30.3	32%
1985	34.5	17.6	40	92.1	124	31.9	26%
1986	41.2	27.3	45.1	113.6	146	32.4	22%
1987	39.4	27.3	36.7	103.4	128	24.6	19%
1988	34.4	25.9	47.1	107.4	129	21.6	17%
1989	25.3	15.1	37.9	78.3	107	28.7	27%
1990	35.9	26	42	103.9	134	30.1	22%
1991	27.3	21.1	36.5	84.9	113	28.1	25%