Snake River Spring-Summer Chinook Survival and Habitat Quality:
Current BSM Implementation and Additional Habitat Hypothesis

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Current BSM Implementation

Past work by myself and others (e.g., Chapter 4, PATH Draft Retrospective Report) failed to uncover any consistent relationship between time series of spawner-recruit survival and time series of land use practices (grazing, logging, and fire). Therefore, the PATH habitat work group, coordinated by Mike Jones, used expert judgement by individuals familiar with Snake and mid-Columbia subbasins to assess how Ricker "a" parameters would change over time, with and without habitat enhancement activities (PATH Draft Prospective Report, Appendix A). The group decided that for many stocks, Ricker "a" parameters would probably decline over time in the absence of habitat enhancements. However, it also decided that for most stocks this decline could be reversed if enhancement activities were carried out. Therefore, under the logic outlined by the habitat group, habitat enhancement should increase the likelihood of survival and eventual recovery for most stocks.

However, in currently available BSM results, habitat enhancement always decreases the probability of meeting survival and recovery goals for the "sixth best" stock (see Chapter 5). Clearly, if these results are correct, one would never undertake enhancement activities, since they always result in reduced stock performance. The explanation for this oxymoron is as follows. The BSM implementation of the changes in Ricker "a" parameters associated with enhancement activities differed from the analysis undertaken by the habitat group. Base-case Ricker "a" parameters were drawn from the posterior parameter distribution for the retrospective analysis. Then, posterior distribution for the "enhancement" case were drawn from the habitat group's analysis. Since the enhancement case "a" values are often lower than the retrospective Ricker "a" values (for reasons described above) the result is a net decline in survival and recovery when enhancement activities are undertaken. One straight-forward fix would be to use the proportional change in the group's Ricker "a" values, with and without habitat enhancement, to adjust the BSM retrospective Ricker "a" estimates. Others are obviously possible as well.

Additional Habitat Hypothesis

Note: the following is based on my recent analysis of PIT tag Cormack-Jolly-Seber survivals and habitat. A manuscript will be available for review next week.

Using data on releases and recoveries of naturally produced, marked juvenile chinook salmon (*Oncorhynchus tshawytscha*), and indices of land use/vegetation and road density, we show that there is a close association between land use patterns and juvenile survival. Parr tagged and released in wilderness areas have the highest survival during their last 6-9 months of freshwater residence. In contrast, those tagged in young, dry forest lands have

the lowest survival from release in the summer prior to downstream migration to subsequent detection at mainstem dams the following spring. Similarly, fish tagged in areas of low road density have substantially higher overwintering survival than those tagged in areas where road density is high.

Although the number of tagged fish exceeds 150,000, the size of individual release groups was often on the order of 100-200 parr, with recoveries at dams an order of magnitude lower. Therefore, we bootstrapped 1000 samples from the original data (with replacement), and used these to estimate distributions of model parameters, including habitat effects. In addition, we used three functional forms to relate land use indices to fish survival: linear, logistic, and Poisson. The three functional forms all gave similar results. Since the release sites vary widely in elevation and distance from the sites to the first dam (where fish are detected), we included elevation and distance as independent variables. Year of tagging, treated as a factor variable, was used as a proxy for changing climatic conditions. In addition, size at tagging was also included. These independent variables were interacted with the habitat indices to allow for different responses by fish in differing habitat. The models were developed and calibrated using fish released from 1988-1996, and tested with fish tagged in the fall of 1997.

At least two classes of management actions could increase survival, if the above relationships are truly cause-and-effect. First, making heavily managed areas (agricultural, young dry forest, etc.) more like wilderness areas would increase parr-to-smolt survival. Second, reducing road density via road closures would increase survival as well. These increases could be implemented in the BSM via changes in Ricker “a” values. Posterior distributions of the magnitudes and variances of the survival increases could be derived from the bootstrapped distributions of habitat class and road density parameter distributions.