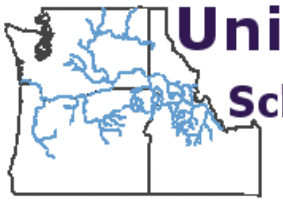
Salmon Insider

Summer 2008

Columbia Basin Research Newsletter

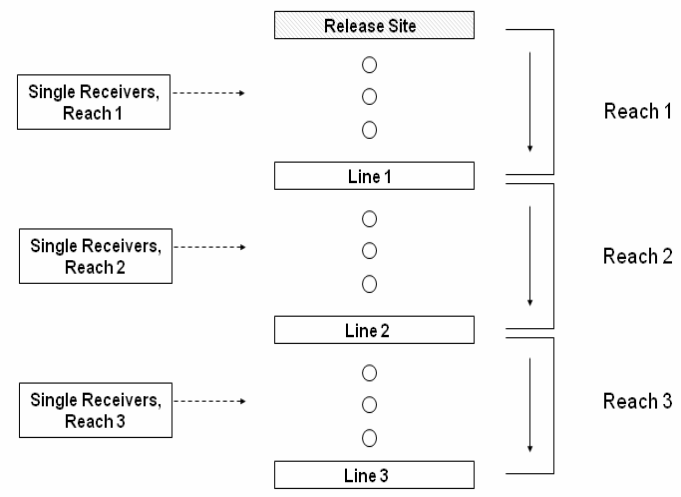


University of Washington
School of Aquatic & Fishery Sciences
Columbia Basin Research

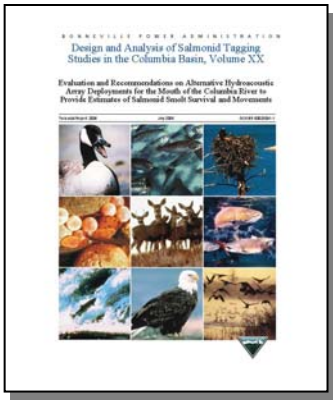
Columbia Basin Research (CBR) is a scientific research group at the University of Washington, School of Aquatic & Fishery Sciences. We investigate salmon biology and survival in the Columbia and Snake River Basins. We provide user-friendly data analysis and modeling tools, and maintain DART, an interactive secondary database, for the fisheries community and the general public.

Inside . . .

Separating Mortality from Residualization in Survival Estimates of Subyearling Fall Chinook Salmon



Statistical Support for Tagging and Other Fisheries Abundance Studies



University of Washington
School of Aquatic & Fishery Sciences
Columbia Basin Research
1325 Fourth Avenue, Suite 1820
Seattle, Washington 98101-2509

newsletter@cbr.washington.edu
www.cbr.washington.edu

Separating Mortality from Residualization in Survival Estimates of Subyearling Fall Chinook Salmon

Many populations of salmonids in the Snake and Columbia River Basins are protected under the Endangered Species Act. This requires hydrosystem managers to know how fish passing through the hydrosystem are faring – what percentage are surviving through the hydrosystem, and what percentage are dying within the hydrosystem. For species that complete their juvenile migration to the ocean in one migration season, such as spring and summer Chinook salmon, the Cormack-Jolly-Seber (CJS) statistical model is used with PIT-tag detection data to estimate survival, and mortality is simply the complement of survival (i.e., mortality = 1 – survival).

Estimating survival and mortality for fall Chinook salmon is complicated by their alternate life history forms. "Ocean-type" fall Chinook salmon migrate through the hydrosystem as subyearlings, while "reservoir-type" fall Chinook spend their first winter in freshwater and enter the ocean as yearlings. Furthermore, reservoir-type juveniles may migrate partway to the ocean as subyearlings, and holdover or "residualize" within the hydrosystem throughout either part or all of their first winter. In addition, some fish pass the dams when bypass operations (and the PIT-tag detection system) are shut down. The residualization life history means that instead of estimating only survival, the CJS model actually estimates the joint probability of both migrating and surviving for subyearling fall Chinook salmon.

The complement of this probability is not merely mortality, as it is for yearling Chinook, but is instead the probability of mortality or residualization (Figure 1). This result is that unless the probability of residualization is estimated along with the probability of migration, estimates of mortality will be biased high. Additional effort is required to estimate mortality for fall Chinook salmon populations, compared to spring and summer Chinook populations.

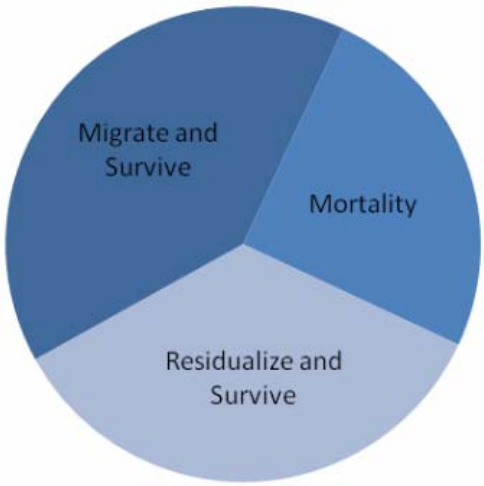


Figure 1. For any river reach or study area, the probabilities of migrating and surviving, residualizing (i.e., holding over) and surviving, and mortality sum to 1. The CJS model estimates the joint probability of migrating and surviving. Additional data are necessary to separately estimate residualization and mortality.

One study design that provides the data necessary for estimating residualization probabilities uses acoustic tags with both "lines" of acoustic receivers that are perpendicular to the shoreline, and single receivers spaced throughout the study area (Figure 2). The lines of receivers define the reaches, which are the main spatial unit in the study design. The lines of receivers should be designed to ensure 100% detection of all live tags present. The single receivers in each reach should be spaced so that adjacent receivers have non-overlapping detection areas. These two features allow identification of both the location where each tagged fish ended each detection period, and to estimate the numbers of fish that are alive in each reach at the end of the detection period. This, in turn, allows estimation of residualization probabilities. An alternative study design includes the lines of receivers, and uses mobile tracking in place of the single receivers; this design may be used with radio tags.

We have developed statistical methods for analyzing tagging data from the study designs described above to estimate each of the three probability parameters for each reach: migration and survival, residualization and survival, and mortality (Figure 1). This method has been applied in several studies of subyearling fall Chinook salmon on the Snake River. For more information, please contact Dr. Rebecca Buchanan, rabuchan@u.washington.edu.

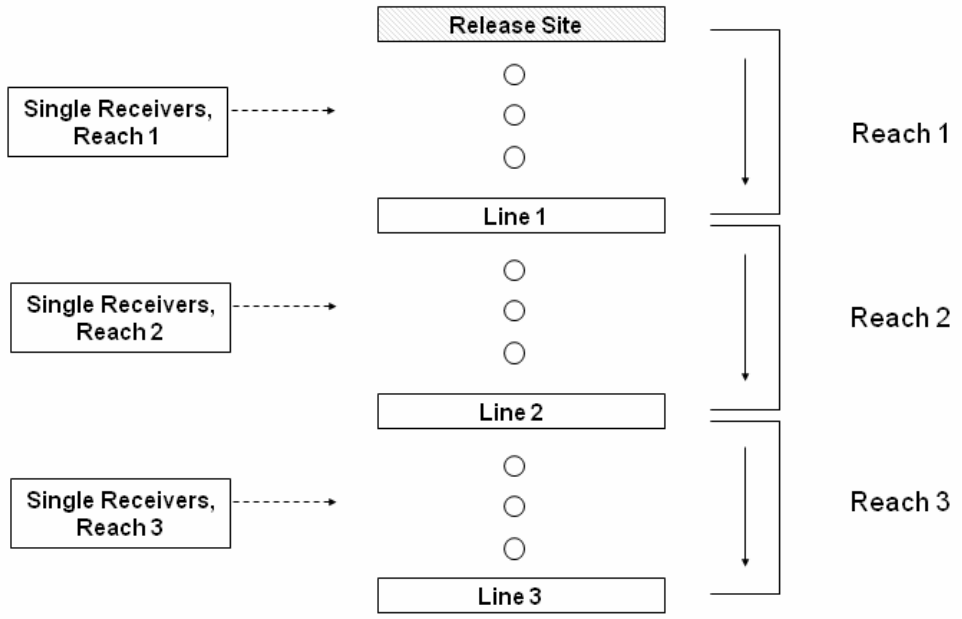


Figure 2. Basic study design to estimate migration, residualization, and mortality in 3 reaches, for subyearling fall Chinook salmon. Detection probabilities at the lines are 100%.

How We Can Help You: Statistical Support for the Design of Tagging and Other Population Estimation Studies

Staff at Columbia Basin Research, with a combined history of over 65 years of experience in designing and analyzing tagging studies, are available to assist Columbia Basin investigators with the design of complex tagging studies.

Support from the Northwest Power and Conservation Council, through Bonneville Power Administration (BPA) Project 1989-107-00, Statistical Support for Salmonid Survival Studies, provides investigators with our help in the design and analyses of mark-recapture studies and determination of appropriate sample sizes (Figure 3).

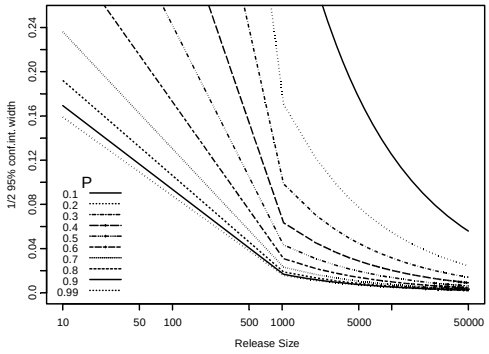


Figure 3. Precision (ε) expressed as the anticipated half-width of a 95% confidence interval for a given release size (R) and per-site detection rate of *p* (Peven et al. 2005).

We have also assisted with the design of other types of population estimation studies, i.e., the design of a creel survey study. And we have published a series of technical reports on the *Design and Analysis of Tagging Studies in the Columbia Basin*, that are available through Pisces and the BPA Report Center for Fish & Wildlife Publications, including most recently:

- Evaluations and recommendations on alternative hydroacoustic array deployments for the mouth of the Columbia River to provide estimates of salmonid smolt survival and movements (Vol. 20)
- A summary of method for conducting salmonid fry mark-recapture studies for estimating survival in tributaries (Vol. 21)
- Evaluating wetland restoration projects in the Columbia River estuary using hydroacoustic telemetry arrays to estimate movement, survival, and residence times of juvenile salmonids (Vol. 22 [Draft])
- Effects of array configuration on statistical independence of replicated telemetry array used in smolt survival studies (Vol. 23 [Draft])

We are available to help investigators with the statistical software programs available through our website for the design and analysis of tagging studies: USER, SURPH, SAMPLESIZE, and PitPro. (See the Parameter Estimation section on the CBR Tools & Models web page.) We are also available to conduct onsite workshops on the analysis programs.

Interested parties may call (206) 685-1995 to be directed to appropriate staff.

Literature Cited: Peven, C., A. Giorgi, J. Skalski, M. Langeslay, A. Grassell, S. G. Smith, T. Counihan, R. Perry, and S. Bickford. 2005. Guidelines and recommended protocols for conducting, analyzing, and reporting juvenile salmonid survival studies in the Columbia River Basin. U.S. Army Corps of Engineers, NOAA Fisheries, U.S. Geological Survey, and Mid-Columbia Public Utility Districts.