Salmon Insider

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Columbia Basin Research Newsletter

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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.

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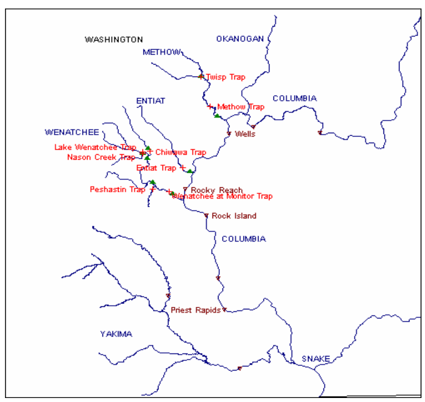
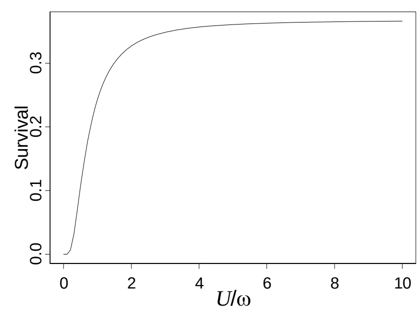
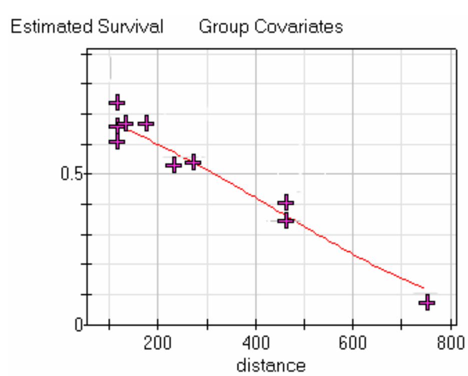
Mid-Columbia Monitoring of Juvenile and Adult Salmon Runs

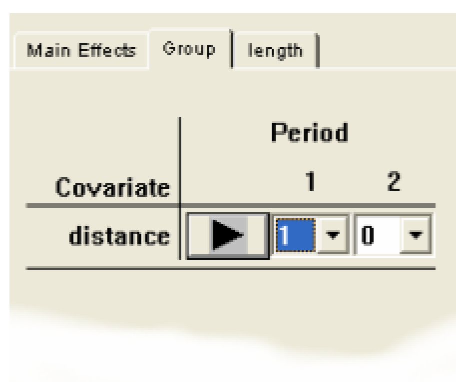


Flow-survival Relationship



Program SURPH: Studying Group Covariates





Mid-Columbia Monitoring of Juvenile and Adult Salmon Runs

To bring together juvenile and adult salmon information with river conditions for improved fish management, multiple agencies are collaborating on the Mid Columbia Status for Juvenile and Adult Salmon website, which provides access to inseason monitoring data from the Mid-Columbia River Basin.

The daily monitoring information includes juvenile trap collection counts of salmonids from the Methow, Entiat, and Wenatchee river basins and juvenile passage indices, adult passage visual counts, and river conditions from mainstem hydroelectric projects. The data are archived in the Columbia River Data Access in Real Time (DART) database. The information is provided courtesy of Chelan County PUD, Douglas County PUD, Fish Passage Center, Grant County PUD, U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, U.S. Geological Survey, Washington State Department of Ecology, Washington State Department of Fish and Wildlife, and Yakama Nation.

From the website, users can examine juvenile and adult passage counts and run-timing summaries with historical passage bar graphs, cumulative passage distributions, along with river flow plots.

For access to the data and more information, see http://www.cbr.washington.edu/mcpud/.

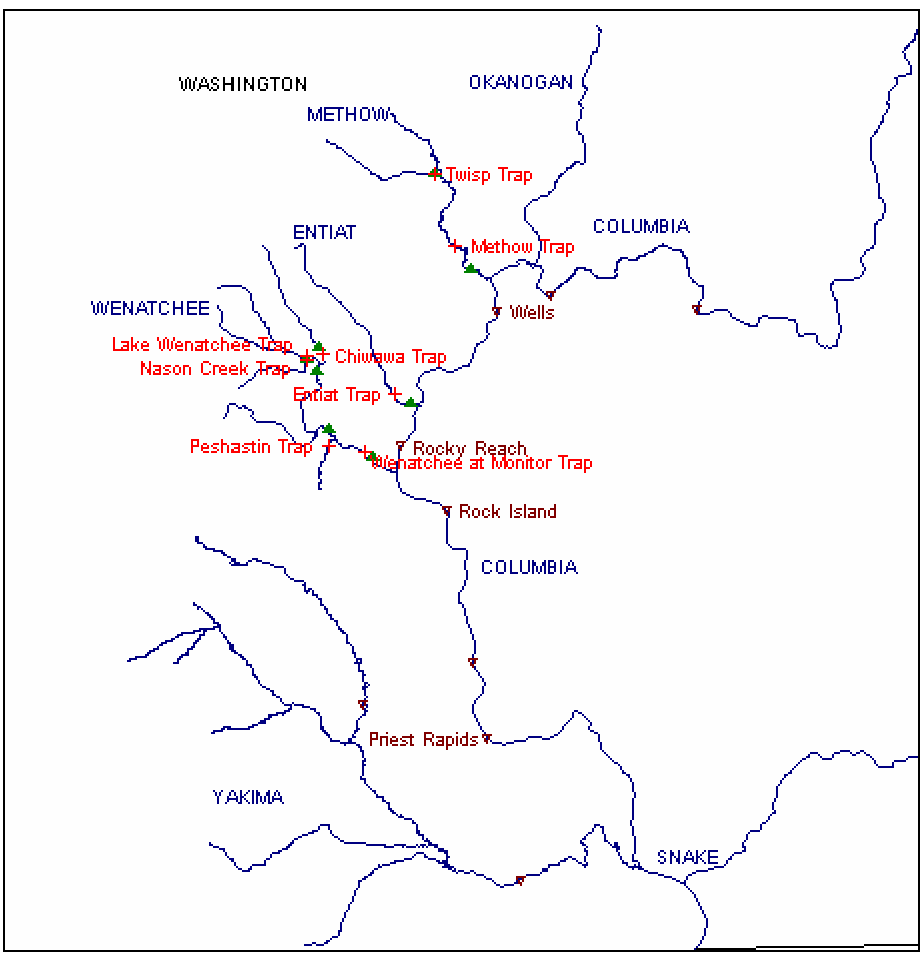


Figure 1. Trap locations (in red) are approximate. Green triangles indicate flow monitoring stations.

Explaining the Flow-survival Relationship

A decade of survival studies conducted by NOAA scientists suggests that smolt survival has a broken-stick relationship with flow, in which survival is independent of flow above some threshold flow but declines with flow below that threshold. However, the theoretical basis of this relationship has been elusive. A model (Anderson et al. 2005), adapted from the theory to predict collision rates of molecules, provides a mechanism for this relationship in terms of directed and random movements of smolts and their predators. The model infers that, when predators are territorial, smolts migrate through a gauntlet of predators making smolt survival dependent on the distance of migration rather than the migration time. The temporal and spatial dimensions of predator-prey encounters are determined by movement rules and the predator's field of vision. These biologically meaningful parameters can accommodate a broad range of behaviors within a mathematically tractable framework. The theory generates a broken-stick relationship between smolt survival and migration velocity, which is related to flow (Figure 2). Survival depends on velocity only when the ratio of the average migration velocity, U, to the random encounter velocity, ω, is less than two. However, a further analysis suggests that temperature plays a critical role in producing the observed broken-stick relationship.

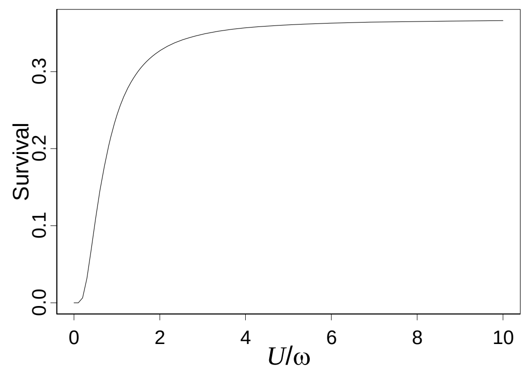


Figure 2. Smolt survival vs. average migration velocity, U, divided by the random component of the velocity, ω.

References

Anderson, J. J., E. Gurarie, and R. W. Zabel. 2005. Mean free-path length theory of predator-prey interactions: Application to juvenile salmon migration. *Ecological Modelling* (in press). Article available online at http://dx.doi.org/10.1016/j.ecolmodel.2005.01.014.

Zorich, N. 2004. Foraging behavior and swimming speed of the northern pikeminnow (*Ptychocheilus oregonensis*) in the Columbia River. Thesis, University of Washington, Seattle, Washington.

Using SURPH to Study Effects of Group Covariates on Survival

SURPH (Survival Under Proportional Hazards) is a tool for modeling survival-related parameters as a function of covariates from release-recapture data. The covariates can be either (1) "group"-based factors, e.g., environmental factors that an entire group experiences, or (2) "individual"-based factors that pertain to each individual. Figure 3 shows the covariate design dialog for a study of out-migrating pacific salmon smolts, with one group covariate labeled "distance," representing the river miles from release to the first detection site.

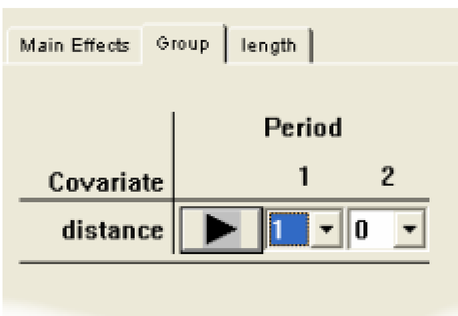


Figure 3. Incorporating distance covariates in SURPH model.

The "1" for the first period (or river reach in this case) tells SURPH to model the survival probability for the first period as a function of migration distance; the "0" for the second period excludes distance as a parameter for the second reach survival.

Program SURPH allows alternative models to be created. Examples include a model where survival in the first reach is a function of distance traveled, a second model where survival in the first reach is constant, and yet a third model where survival is release specific. For example, a model with survival common across reaches but unique for each release group is partially illustrated in Figure 4. SURPH can provide survival estimates for each model and perform model selection using analysis of deviance (ANOVA), likelihood ratio tests, or AIC values.

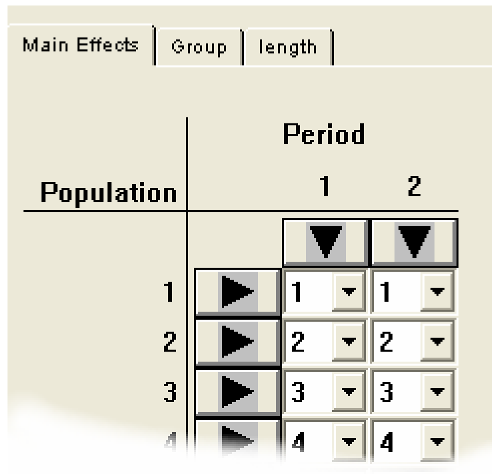


Figure 4. Iterative model selection in SURPH.

SURPH also provides diagnostic tools for testing the fit of a model to the data. Figure 5 shows a plot of the modeled survival (Y-axis) as a function of distance (X-axis). The "+" characters show the survival estimates for the 10 populations in this study, and the red line indicates the modeled survival as a function of distance.

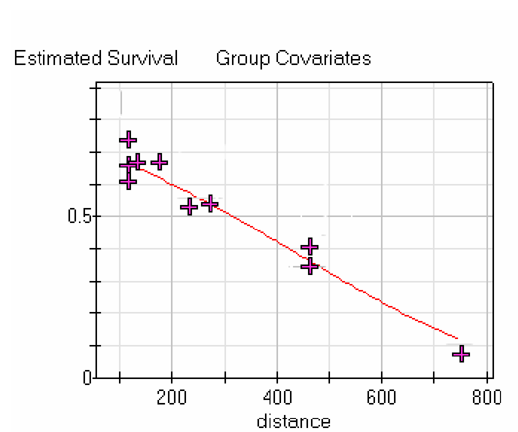


Figure 5. Diagnostic plot from SURPH.

For more information, see http://www.cbr.washington.edu/paramEst/SURPH.