Environmental Data: Organisms and Their Habitats (Newsletter)*

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Understanding relationships between organisms and their habitats is important to operators and regulators, as well as being critical to managing species with low population levels. Pacific salmon in the Columbia River system and sage grouse and Lahontan cutthroat trout in the Great Basin are among many examples where understanding the factors limiting the presence or number of individuals in a defined area need to be quantified in a technically sound and legally defensible way.

Spatial distribution of plants and animals are not random or regular, but clumped. Populations almost always exhibit strong spatial autocorrelation; i.e., spatially close organisms or populations are more similar to each other than they are to more remote individuals or populations. This spatial autocorrelation greatly affects most organism-habit models. These models are either specific to a single location and do not apply to other locations, or they are so general they provide no useful insights to any specific location.

The statistical family of regression models quantify relationships of organism numbers, densities, or biomass to explanatory habitat variables and are the tools of choice to evaluate factors limiting populations. Such knowledge is valuable for making ESA-listing decisions, recovery plans, and delisting criteria. This knowledge is also valuable for operators and regulators to determine whether the regulated activity has measurable adverse impacts on organisms of concern.

The cause-and-effect relationship between a response variable and an explanatory variable is shown as a straight line through the cloud of data points. This line represents the mean value of the response variable (on the 'Y' axis) to changes in the explanatory variable (on the 'X' axis). Because of the clumped distribution of organisms and spatial autocorrelation it is not unusual to find that this regression line shows no significant relationship between the variables. However, if the response variable values are grouped into quantiles (e.g., the 10th and 90th percentiles of values) regression of those values on the explanatory variable are likely to show significant relationships not seen at the mean (50th) percentile. The 90th, or 95th, percentile can be ecologically interpreted as the factor limiting population numbers, density, or biomass at that location. The statistical model for these analyses is quantile regression.

Statistical distributions of environmental data often have unequal variation because of complex interactions between factors affecting organisms, and not all these factors can be measured and accounted for in statistical models.

Unequal variation implies that there is more than a single slope (rate of change) describing the relationship between a response variable and predictor variables measured on a subset of these factors.

Quantile regression estimates multiple rates of change (slopes) from the minimum to the maximum response, providing a more complete picture of the relationships between variables that are missed by other regression methods. The ecological concept of limiting factors constraining organisms focuses on rates of change in quantiles near the maximum response even when only a limiting subset of factors are measured.

Given the importance of making decisions about sage grouse, Lahontan cutthroat trout, Pacific salmon, or any other wildlife species, the robustness, technical soundness, and legal defensibility of statistical models such as quantile regression should make them a required component of environmental data analysis and prediction.

Of equal value is the application of quantile regression and similar statistical models to baseline data collected for an EA or EIS. When wildlife and their habitats are important elements of an environmental assessment objective statistical models remove subjectivity and ambiguity and facilitate a Record of Decision in less time, at lower cost, and with lessened likelihood of administrative appeal or legal challenge.

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