Profiting From Environmental Data (Newsletter)*

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Across the western US drought, wildland fires, cheatgrass, Western juniper, Lahontan cutthroat trout, bull trout, salmon, bald eagles, desert tortoise, and sage grouse all affect where and how natural resource companies operate. Project planning and approvals can be greatly facilitated by application of advanced statistical and spatial models to environmental data.

Causal relationships between explanatory variables such as habitat, food, and predators to response variables (species numbers and distributions) are explained by linear regression models. These analyses use mean environmental variable values which might yield mis-leading relationships and result in poor decisions. Mining exploration data provide an example.

A set of drill cores has a mean concentration of 2.1 oz/ton of the desired metal. The mean value can be influence by a single very high value, and the distribution of concentrations can be highly variable. Therefore, geologists look at concentration quantiles, perhaps from 10% to 90%, of all samples. This might reveal that the majority of the metal is at the lower end of the concentration range and not economic to mine. Or, sufficient metal concentrations are in the higher quantiles (e.g., the 80th percentile) and worth developing a producing mine. The statistical model used is quantile regression. Quantile regression of environmental data can provide equivalent benefits to operators and environmental managers.

Statistical distributions of environmental data often have unequal variation because of complex interactions between the explanatory factors and the biota. Not all of these variables can be measured or included in statistical models. Unequal variation means more than one slope (rate of change) describes the relationship between a response variable and explanatory variables measured on a subset of these factors. Quantile regression estimates multiple rates of change (slopes) from the minimum to maximum response. This produces a more complete picture of the relationships between explanatory and response variables than do other regression models. The ecological concept of limiting factors constraining species' populations and distribution often focuses on rates of change in quantiles near the maximum response when only a subset of limiting factors are measured.

Ecological applications of quantile regression include animal-habitat relationships, vegetation changes with conservation practices, and predator-prey relationships. Among others, this statistical model has analyzed Lahontan cutthroat trout density as a function of stream width:depth ratio in northeast Nevada, wild trout and hydrological indices in Pennsylvania, redband trout abundance by habitat characteristics in southwestern Idaho, sage-grouse nest survival as a factor of grass height in the Powder River basin of southeast Montana, and sage-grouse nest predation in the Virginia Mountains of Nevada.

The application of quantile regression and other advanced statistical methods such as compositional data analyses, logistic regression for biotic count data, and Bayesian models that use prior knowledge to predict future conditions produce results that are technically sound and legally defensible. This information can be beneficial to natural resource companies that take advantage of it, especially when commodity prices are low, project funding is difficult to obtain, and vast areas of land are burned, dry, and inhabited by species of concern.

When conditions have changed from those to which we have become accustomed and comfortable, it is necessary to accept the challenge to change. After all, we cannot do the same thing over and over while expecting different results. Extracting all the value contained in environmental data is often a key to increased profitability.

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