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Detection of environmental thresholds by assessing discontinuities in slopes and variances via a Bayesian regression model

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Abstract: An ecological threshold occurs at a point along an environmental stress gradient at which there is a discontinuous change in the conditional distribution of a biological response. Traditionally, ecological thresholds are estimated from the discontinuities in the central tendency (e.g., slope) using a piecewise linear regression model (PLRM). However, thresholds can also be manifested as changes in the range of natural variation (e.g., conditional variance) for a given level of the environmental stress. In this paper, we defined a Bayesian PLRM by incorporating experts' knowledge about the relationships between the biological response relative to environmental stress represented via prior distributions. The posterior distributions of the thresholds are obtained by combining the information in the data with experts' prior knowledge, and optimized via Gibbs sampling and the Metropolis algorithm. We applied our method to two datasets relating an index of the health of marsh-nesting bird communities to habitat alteration (areal extent of land development adjacent to wetlands) within the Detroit River Area of Concern. Our preliminary analysis identified two potential thresholds - one manifested via the change in slope and the other observed from increased variance across the environmental stress gradient.