

Spatial Modelling of Fish Counts in a Stream Network

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Abstract

Spatial autocorrelation in species abundance can be induced by ecological processes operating at multiple spatial scales. In stream and river networks, autocorrelation in fish counts can arise from (1) directional aquatic processes constrained by waterflow, such as upstream and downstream fish movements and downstream transport of waterborne nutrients and pollutants; (2) terrestrial processes that influence watershed soil structure, local topography, and water chemistry at various spatial scales. We used a moving-average (convolution) construction to model fish counts in a stream network by means of a Poisson log-normal mixture incorporating random effects for time and space. The spatial component incorporated both hydrological (“as the fish swims”) distance, to capture directional effects, and Euclidean (“as the crow flies”) distance, to capture latent terrestrial effects, such as geological processes. Additionally, covariates were used to account for local environmental effects. We used a Bayesian approach to fit a set of models representing different combinations of temporal and spatial effects, including complete independence. We compared models by means of information criteria, examined the variance accounted for by each of the covariance components, and used prior-posterior differences to clarify the relative contribution of different processes to variation in fish counts.

Keywords: Bayesian inference; count data; ecological processes; hydrological distance; mixed model; moving average.