Identifying the Spatial Structure in Error Terms with Spatial Covariance Models: A Case Study on Urbanization Influence in Chaparral Bird Species

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Abstract

This study uses various spatial statistical methods to examine and model large- and small-scale spatial structure in bird abundance and urbanization. A set of chaparral-vegetated points across an urbanizing landscape in the Santa Monica Mountains of southern California was surveyed for birds in 1997 and mapped in a GIS. For each sample location, GIS landuse data were used to calculate surrounding urbanization proportion.

We first used semivariograms and correlograms to detect large-scale trends, and Moran's I statistic to test for small-scale spatial autocorrelation in bird abundance. Relationships between bird abundance and surrounding urbanization levels were then analyzed using ordinary least-squares (OLS) regression. Upon detection of spatial autocorrelation in model residuals, spatial covariance models were constructed to incorporate this small-scale spatial dependence statistically and obtain non-biased estimates of urbanization influence. As a conservative comparison, we also removed the large-scale spatial trends from bird abundance and regressed the detrended model residuals on surrounding urbanization proportion to examine the effects of local variations in urbanization on bird abundance.

Results of spatial covariance models, as well as detrended non-spatial models, indicate that chaparral bird populations are affected by changes in surrounding landscape composition, regardless of spatial location. Semivariogram and correlogram analysis provided further insight into the spatial structures of the bird populations examined.