Multiscale models of animal movement and space use

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Abstract

Most ecological processes occur at multiple spatiotemporal scales, and there is great incentive to develop mechanistic models that link small-scale events to the resulting large-scale patterns. In this talk, I will discuss this general problem in the context of animal space use, where short-term movement decisions of animals give rise to long-term distributions. Despite the multiscale nature of animal movement, statistical methods have often focused on a single scale: models of short-term movement fail to estimate long-term distributions, whereas large-scale distribution models fail to capture the mechanisms of animals' movement. This disconnect limits the utility of single-scale models to explain and predict animal space use. I will describe a multiscale model based on an analogy between the movement of animals and that of stationary stochastic processes (such as the ones used as the basis for Markov chain Monte Carlo algorithms). This new approach provides a coherent statistical framework to jointly estimate movement parameters (e.g., speed) and the emerging long-term spatial distribution, while accounting for temporal autocorrelation in the data. One implication is that this new approach can be used to combine data on the small scale (e.g., high-resolution GPS locations) and on the large scale (e.g., survey data from camera traps), therefore increasing the statistical power of space use analyses. More generally, this framework has great potential to further our mechanistic understanding of pattern formation in animal population distributions.