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Why are species distribution models so poor at prediction?

Abstract

Spatial ecology aims to understand where organisms are, why they are there, and where else they might be. This latter objective requires us to extrapolate species distributions to regions we have never observed, or forecast change in the future. Such predictive capabilities can only be attained given rich field data, constant environments, a deep understanding of the study species and suitable theoretical models. It is certainly frustrating (if not entirely unexpected) that despite the frequent violation of most of these requirements, the scientific literature is teeming with publications that attempt such predictions for important issues in conservation and wildlife resource management. I will present a brief review of existing theoretical approaches to the analysis of species distribution data and of the reasons why their predictions regularly fail. I will present recent work that successfully extends the predictive reach of these models and illustrate their application with both synthetic and real data, using telemetry from grey wolves (Canis lupus). Beyond these developments, I will examine the underlying reason why spatial ecology has yet to fulfil its original promise: Its inadvertent de-coupling from the other two cornerstones of ecology population dynamics and evolution. I therefore propose a synthetic approach to these three fundamental areas and outline ways in which it can be achieved mathematically and estimated statistically. An interesting by-product of this approach is that it offers the potential to quantify from field data such chimeric concepts as the critical habitat and the carrying capacity.