19
The Roles of Spatial Heterogeneity and Ecological Processes in Conservation Planning

Hugh P. Possingham, Janet Franklin, Kerrie Wilson, and Tracey J. Regan

Abstract

In this chapter we ask the question: To what extent does an understanding of landscape spatial heterogeneity inform conservation decisions? We answer this question in the context of two central decision-making fields within conservation biology: systematic conservation planning and population viability analysis. The conservation planning principles of comprehensiveness and representativeness are fundamentally reliant on data and concepts of compositional landscape heterogeneity. The principle of adequacy is not accommodated in conservation planning very well and it relies on an understanding of the configurational heterogeneity of the landscape. A major challenge for conservation planning scientists is to develop theory and decision support tools that incorporate ideas of population viability and spatially explicit ecological processes. Population viability analysis invariably includes spatial population processes, and as a field has largely focused on the importance of the configurational heterogeneity of landscapes. We argue that this focus might only be justified when the scale of planning coincides with either the scale of habitat heterogeneity or the scale at which small populations operate. Integrating population viability analysis into conservation planning, and showing a balanced interest in compositional and configurational heterogeneity, are important future challenges.

Introduction

Ecological heterogeneity comes in many forms ranging from the biophysical to the ecological. Substrates like soil type are highly variable but relatively static on an ecological time frame. Other aspects of heterogeneity, for example species distributions and ecological processes, can exhibit greater temporal variation. There are two components of heterogeneity: composition and configuration. Compositional heterogeneity refers to the number

of different elements in the landscape, and configurational heterogeneity refers to the spatial arrangement of these elements. The elements can be discrete (patches) or continuous (gradients). We discuss two areas of application: systematic reserve system design and population management using population viability models.

In the field of reserve system design, the overall objective is to create a system of protected areas that conserves as much of a region's biodiversity as possible in the long term (McNeely 1994). To do this we first need to sample as much of the biodiversity as possible. Hence, an understanding of compositional spatial heterogeneity is absolutely central to reserve system design. In contrast, the role of configurational spatial heterogeneity is discussed, but poorly dealt with, in the systematic conservation planning literature.

The only way we know how to determine the adequacy of a reserve system is to assess the viability of key species. Population viability analysis (PVA) is a tool for choosing between different management options for threatened species. Traditionally, PVA has dealt with compositional heterogeneity by assuming there are only two habitat types: suitable and unsuitable. This is clearly inadequate as habitat quality will, in general, vary continuously (Franklin this volume). Configurational heterogeneity is believed to be important to the viability of populations, but the evidence is equivocal (Fahrig this volume). Ultimately good conservation planning will involve a marriage of reserve system design principles and population viability principles.

For both reserve system design and population management, we postulate that spatial heterogeneity is relatively unimportant to conservation decision-making when the spatial scale of management (the spatial extent of typical planning actions or reserves) is significantly different to the spatial scale of the underlying heterogeneity or the population processes of the species of concern. We suggest that spatial heterogeneity is most important when its scale of variation is roughly the same as the scale of management *and* the scale of population and other ecosystem processes.

In this paper, we will (1) describe the general reserve system design problem, (2) look at how heterogeneity at different scales has or could influence reserve system design, (3) consider the role of spatial processes in reserve system design, (4) examine how spatial heterogeneity at different scales influences conservation plans derived from population models, and (5) present an initial general framework for how we might deal with heterogeneity considerations in conservation planning.

The General Reserve System Design Problem

In its broadest sense, conservation planning is about allocating parts of a landscape to a management regime. For example, in forestry we could allocate any 50-ha compartment to one of the following: no harvesting, no harvesting and predator control, selective harvesting, clear-fell at 30-year rotation for