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Scale-Sensitive Ecological Properties: Historical Context, Current Meaning

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1.1 Introduction

In landscape ecology, attention to scale is most important (Wiens 1989). Indeed, Levin (1992) has argued that the “problem of pattern and scale is the central problem in ecology”. A Special Features section in the journal Ecology with the title “Space: the final frontier for ecological theory” (Kareiva 1994) echoed the same theme. Clearly, the choice of appropriate time and space scales is important if understanding in ecology is to advance (Bissonette 1996). This issue is central to current dialog in landscape ecology (Golley 1989, Kareiva 1994) because different patterns and properties tend to emerge at different scales (May 1994).

Until recently, the importance of scale has not been widely recognized by wildlife biologists or explicitly by population, community, or ecosystem ecologists, and studies have been conducted as if they were scale free. For example, in 1988, Kareiva and Anderson surveyed the community ecology literature and showed that about half of the surveyed studies were conducted by using plots no larger than 1 m, despite considerable differences in size and distribution of the organisms studied. And yet, the effects of sample unit size (quadrat size) have been known for some time. Kershaw (1964) showed clearly the effects of quadrat size, the relationship between quadrat size and size of the organism being sampled, and the effect of pattern on sampling results, given a standard quadrat size (Figure 1.1). For
example, quadrat sampling units of different size can give widely different results, depending upon the relationship between quadrat size and size of the organisms being measured. Similarly, a specified quadrat size will give very different results if the organisms being measured are of very different size. Organism size varies by more than 20 orders of magnitude, from $10^{-13}$ to $10^8$ g (Brown 1995) and there is similar variation in life span and use of space. Finally, the distribution pattern of organisms being sampled will influence results obtained by using a specified quadrat size (Figure 1.1). This latter idea is most important because it has larger scale, landscape implications. Clearly, spatial and temporal scale (King et al. 1990) must be a consideration when designing methods to study this range of life forms and their spatial arrangement across the landscape (Bissonette 1996, in press). May (1994, p. 2) provides a nice summary of the history and reasons for the seeming avoidance by biologists of research efforts at large spatial scales.

Furthermore, we have not fully appreciated the implications of the new philosophy of science (Pickett et al. 1994) for ecology in general and landscape ecology in particular; and yet, how we conduct science—the domain and observation set we employ—always constrains the outcome (O’Neill et al. 1986). In this paper, I provide definitions for important landscape terms and discuss some of the underpinnings for landscape ecology. I first briefly