

## MOVEMENT RESPONSES TO PATCH STRUCTURE IN EXPERIMENTAL FRACTAL LANDSCAPES

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**Abstract.** Neutral landscape models predict that habitat loss will abruptly disrupt landscape connectivity. We performed a series of simulation experiments to explore whether thresholds in landscape connectivity affect movement attributes (path length, net displacement, and fractal dimension of pathway) within fractal neutral landscapes. We then tested these assumptions by generating fractal landscape patterns in the field across a range of habitat abundances (0%, 20%, 50%, and 80% grass) and patchiness (clumped vs. patchy) and quantified how patch structure affected movement behavior in a generic organism, the common cricket *Acheta domestica* (Orthoptera: Gryllidae).

In the simulation experiment, individuals constrained to move only through adjacent grass cells (neighborhood size = 4 cells) exhibited abrupt thresholds between 50% and 80% grass cover for all movement parameters in clumped fractal landscapes but exhibited a linear decline in movement with decreasing habitat in patchy landscapes. Individuals constrained to move in sand within these same landscapes did not exhibit thresholds in movement with decreasing sand habitat. The exception is for the fractal dimension of pathways (a measure of tortuosity) in which a threshold occurred between 50% and 80% grass (50% and 20% sand) in patchy landscapes. Increasing the scale of movement by allowing individuals to move through unsuitable habitat (neighborhood size = 12 cells) reduced or eliminated any effects of patch structure on movement.

Live crickets can traverse both grass and sand, and thus threshold effects in movement behavior were generally not evident in the field experiment. Only small crickets (15–25 mm) exhibited a threshold response in net displacement (straight-line distance traversed) between 50% and 80% grass cover (50% and 20% sand). Crickets did exhibit significant responses to patch structure, however. Crickets moved faster and with less tortuosity in the control (0% grass) and less-vegetated (20% grass) plots than in plots with greater habitat coverage. Crickets used grass cells significantly more (73%) than expected in the 20% patchy fractal microlandscape; crickets were reluctant to leave isolated cells of grass. Grass provided cover, but sand facilitated movement. While experimentation at the landscape scale is generally intractable or impossible, computer simulation and field experiments founded on neutral landscape models permit initial assessment of how disrupting landscape connectivity affects movement behavior.

**Key words:** animal movement; crickets; experimental model systems; fractal geometry; habitat fragmentation; landscape connectivity; landscape ecology; neutral landscape models; percolation theory; spatial patterns.

### INTRODUCTION

One of the more immediate consequences of habitat fragmentation is the disruption of dispersal among populations. “Dispersal is the glue that keeps populations together” (Hansson 1991), especially in terms of maintaining metapopulation dynamics. Increasing isolation among populations, which leads to reduced dispersal success and patch colonization rates, results in a decline in the persistence of individual populations and an enhanced probability of regional extinction for the entire metapopulation across the landscape (e.g., Lande 1987, With and King 1999a). Maintaining landscape

connectivity has thus been identified as the key to preserving dispersal among populations (Taylor et al. 1993, Pearson et al. 1996, With et al. 1997). “Connectivity” is often taken literally to mean the physical connectedness among habitat patches, as evidenced by the recommendation and establishment of habitat corridors for the conservation of some species (but see Mann and Plummer 1995). Nevertheless, landscape connectivity need not imply *structural connectivity*, the actual connection of habitat patches by corridors, but may instead result from *functional connectivity*, the connection of habitat patches (and populations therein) by dispersal. For example, species capable of crossing gaps of unsuitable habitat (e.g., a neotropical migrant bird) may perceive landscapes as connected across a greater range of habitat availability than species constrained to move only through suitable habitat (e.g., a

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