Testing the relationship between carrying capacity of a fragmented landscape and home-range size

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Spatially explicit models of population dynamics have not considered the problem of home range settlement when the grain of the landscape is smaller than the home-range size of the species being studied. In this talk we present an individual based model (IBM) that combines age-structured population dynamics [1], dispersal [4], optimal foraging [3] and habitat selection [2] to study the effect of home-range size in the carrying capacity of a fragmented landscape. The IBM keeps track of two types of entities: the landscape and the female population. The landscape is a two-dimensional grid with each cell belonging to one of two habitats: forest or non-forest. Landscapes are generated automatically using a fractal algorithm [5] controlling for degree of forest cover and for fragmentation. Each individual in the population has two state variables, age and home range. The home range is a vector containing the set of landscape cells that an individual occupies. Home ranges of different individuals do not overlap. Each simulation year consists of the following sequential steps: reproduction of individuals in breeding age, adult mortality, juvenile territory establishment, juvenile density-dependent mortality. The fertility and survival probability of each female depend on the habitat available within her territory. The higher the proportion of non-forest habitat, the lower the fecundity and the survival probability. Therefore, during territory settlement each juvenile tries to find the territory that maximizes her fitness, given the constraints of the space already occupied and the different quality of the two habitats in the landscape.

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We show that there is a simple equivalent analytical model to the IBM for the case where the home range-size is one cell. There is also an equivalent analytical model for the case of a random landscape and large home-range size. The relationship between population size and habitat destruction is non-linear: only below a certain critical habitat threshold does the population decline. For home-range sizes larger than one, the carrying capacity of the landscape depends on the degree of fragmentation. Therefore species with small home-ranges persist in instances where species with large home-ranges go deterministically extinct. Finally, we show how the population dynamics differ between global and local dispersal and we study the effect of dispersal mortality.

References

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