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Articles

Spatial variability in ecosystem services: simple rules for predator-mediated pest suppression

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Agricultural pest control often relies on the ecosystem services provided by the predators of pests. Appropriate landscape and habitat management for pest control services requires an understanding of insect dispersal abilities and the spatial arrangement of source habitats for pests and their predators. Here we explore how dispersal and habitat configuration determine the locations where management actions are likely to have the biggest impact on natural pest control. The study focuses on the early colonization phase before predator reproduction takes place and when pest populations in crops are still relatively low. We developed a spatially explicit simulation model in which pest populations grow exponentially in pest patches and predators disperse across the landscape from predator patches. We generated 1000 computer-simulated landscapes in which the performance of four typical but different predator groups as biological control agents was evaluated. Predator groups represented trait combinations of poor and good dispersal ability and density-independent and density-dependent aggregation responses toward pests. Case studies from the literature were used to inform the parameterization of predator groups. Landscapes with a small nearest-neighbor distance between pest and predator patches had the lowest mean pest density at the landscape scale for all predator groups, but there can be high variation in pest density between the patches within these landscapes. Mobile and strongly aggregating predators provide the best pest suppression in the majority of landscape types. Ironically, this result is true except in landscapes with small nearest-neighbor distances between pest and predator patches. The pest control potential of mobile predators can best be explained by the mean distance between a pest patch and all predator patches in the landscape, whereas for poorly dispersing predators the distance between a pest patch and the nearest predator patch is the best explanatory variable. In conclusion, the spatial arrangement of source habitats for natural enemies of agricultural pest species can have profound effects on their potential to colonize crops and suppress pest populations.

Keywords: biological control, habitat configuration, landscape ecology, predator–prey interaction, source–sink dynamics, spatial ecology

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