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Articles

Habitat conversion, extinction thresholds, and pollination services in agroecosystems

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Parallel declines of wild pollinators and pollinator-dependent plants have raised alarms over the loss of pollination services in agroecosystems. A spatially explicit approach is needed to develop specific recommendations regarding the design of agricultural landscapes to sustain wild pollinator communities and the services they provide. I modeled pollination services in agroecosystems using a pair of models: a stochastic individual-based simulation model of wild pollinators, pollinator-dependent plants, and crop pollination; and a set of coupled difference equations designed to capture the nonspatial component of the simulation model. Five spatially explicit models of habitat conversion to crops were simulated, and results for pollination services were compared. Mean-field behavior of the simulation model was in good agreement with analysis of the difference equations. A major feature of the models was the presence of a cusp leading to loss of stability and extinction of pollinators and pollinator-dependent plants beyond a critical amount of habitat loss. The addition of pollen obtained from crop visitation caused a breakdown of the cusp preventing extinction of pollinators, but not of wild pollinator-dependent plants. Spatially restricted foraging and dispersal also altered model outcomes relative to mean-field predictions, in some cases causing extinction under parameter settings that would otherwise lead to persistence. Different patterns of habitat conversion to crops resulted in different levels of pollination services. Most interesting was the finding that optimal pollination services occurred when the size of remnant habitat patches was equal to half the mean foraging and dispersal distance of pollinators and the spacing between remnant patches was equal to the mean foraging and dispersal distance. Conservation of wild pollinators and pollinator-dependent plants in agroecosystems requires careful attention to thresholds in habitat conversion and spatial pattern and scale of remnant habitats. Maximization of pollination services was generally incompatible with conservation of wild pollinator-dependent plants. My prediction is that pollination services will be maximized by providing islands of nesting habitat where interisland distance matches mean foraging distances of wild pollinators.

Keywords: [agroecosystems](#), [Allee effect](#), [conservation](#), [difference equations](#), [ecosystem services](#), [habitat conversion](#), [habitat fragmentation](#), [landscape model](#), [mutualism](#), [pollination services](#)

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