

## Spatial scales of population fluctuations of two species ecosystems: effects of harvesting, competition or predator prey coupling.

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Synchronous fluctuations in the size of populations separated in space strongly affect their persistence to variations of the environment. We show that proportional harvesting and competition modify the spatial structure of population fluctuations of two competing species living in a variable environment. Proportional harvesting always increases the spatial scale of population synchrony. The effects of interspecific competition on the geographical scaling are dependent on the pattern of spatial covariation of environmental variables. If the environmental noise is uncorrelated between the competing species, competition will always increase the spatial scale of synchrony in the population fluctuations of both species. In contrast, if the environmental stochasticity is strongly correlated between the species, competition may increase the spatial synchrony of one or both species. The magnitude of these spatial scaling effects is strongly modified by the migration capacity of the two competing species. The strength of competition between the species may strongly modify the effects of harvesting on the spatial scale of the synchrony in the population fluctuations. For example, harvesting of one species may affect the spatial distribution of competing species that are not harvested. These analytical results indicate that harvesting may synchronize population dynamics over large geographical areas, affecting the vulnerability of harvested species to environmental changes. This shows that potential effects on distribution of individuals in space should be included in the design of multi-species harvest strategies. We will also advance our more recent results for spatial scale of population synchrony in predator prey ecosystems.

[1] J. Jarillo, B.-E. Saether, S. Engen, F. J. Cao , Submitted (2017).

[2] J. Jarillo, B.-E. Saether, S. Engen, F. J. Cao , In preparation (2017).