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Analysing the large-scale spatial synchrony of a boreal rodent population subject to high seasonality

Northern ecosystems are subject to very strong seasonal differences with long winters and short summers. These striking differences in seasonality have large effects in the population dynamics of several species, contributing to density-dependent regulation and adding to the effect of environmental stochasticity. However, seasonality is too often disregarded in the study of large-scale population processes even though its importance is widely recognised. This is especially true in the case of spatial population synchrony – the correlation in population cycles of a species across space, for which stochasticity (the "Moran effect") has been postulated to be an important driver.

In this study, we single out the contribution of seasonal environmental stochasticity (i.e. seasonal Moran effect) to spatial population synchrony in a boreal rodent species, the Gray-sided-vole. Mark-recapture-based population time series were collected at 19 stations, across a transect of over 150 km in northern Norway, in both spring and fall, for 21 years. Specifically, we decompose the contribution of three important factors contributing to spatial population synchrony: (1) season- and (2) subregion-specific density dependence, and (3) season-specific weather stochasticity. We first de-trend the time series using autoregressive models, incorporating subregional and seasonal-varying density-dependence (direct and delayed). We then analyse the spatial correlation in the model residuals, separately for each season, to estimate the scale and shape of the spatial population synchrony. To investigate environmental drivers synchronising the populations, we then model the de-trended population synchrony as a function of the spatial correlation in relevant weather variables.

Our results reveal marked differences in the scale and shape of synchrony during spring and fall, as well as the influence of winter weather conditions on population synchrony. Interestingly, winter weather appears to display a lagged effect on synchrony during the summer season – highlighting the importance of the changing winter in boreal ecosystems and, more generally, the importance of explicitly addressing seasonality in studies population synchrony.