

Modeling survival at multi-population scales using mark–recapture data

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Abstract

The demography of vertebrate populations is governed in part by processes operating at large spatial scales that have synchronizing effects on demographic parameters over large geographic areas, and in part, by local processes that generate fluctuations that are independent across populations. We describe a statistical model for the analysis of individual monitoring data at the multi-population scale that allows us to (1) split up temporal variation in survival into two components that account for these two types of processes and (2) evaluate the role of environmental factors in generating these two components. We derive from this model an index of synchrony among populations in the pattern of temporal variation in survival, and we evaluate the extent to which environmental factors contribute to synchronize or desynchronize survival variation among populations.

When applied to individual monitoring data from four colonies of the Atlantic Puffin (*Fratercula arctica*), 67% of between-year variance in adult survival was accounted for by a global spatial-scale component, indicating substantial synchrony among colonies. Local sea surface temperature (SST) accounted for 40% of the global spatial-scale component but also for an equally large fraction of the local-scale component. SST thus acted at the same time as both a synchronizing and a desynchronizing agent. Between-year variation in adult survival not explained by the effect of local SST was as synchronized as total between-year variation, suggesting that other unknown environmental factors acted as synchronizing agents. Our approach, which focuses on demographic mechanisms at the multi-population scale, ideally should be combined with investigations of population size time series in order to characterize thoroughly the processes that underlie patterns of multi-population dynamics and, ultimately, range dynamics.

Key words: Atlantic Puffin; Bayesian modeling; demography; deviance information criterion; environmental forcing; *Fratercula arctica*; mixed model; multi-population scale; sea surface temperature; synchronization; WinBUGS.