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Using demographic attributes from long-term monitoring data to delineate natural population structure

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Summary

1. The concept of 'natural' populations is a foundation of modern ecology and conservation, with a large body of theoretical literature using these discrete demographic units to understand population dynamics and prioritize conservation strategies. To date, there are currently no objective methods for empirically delineating large-scale population boundaries using demographic data.

2. We present a novel approach for using large-scale, citizen-science monitoring data to quantify geographic structure in trend and abundance and identify distinct natural populations. We demonstrate this approach by delineating populations of eight passerine species using data collected as part of the North American Breeding Bird Survey.

3. Our approach was able to identify geographic structure in both trend and abundance and to delineate distinct populations for all eight species. An independent validation of three species indicated this demographic variation was reflected in underlying vital rates.

4. *Synthesis and applications*. Natural populations are biologically based alternatives to the traditional geographically defined units that can improve the ability of researchers and managers to quantify spatial variation in population dynamics. Our analysis of natural population structure in breeding songbirds demonstrates that species can show substantial geographic variation in population attributes and underlying demography. We recommend managers define spatial units using natural populations when setting regional population objectives for both single and multispecies conservation plans.

Key-words: Andrewartha & Birch, Breeding Bird Survey, conservation planning, demography, hierarchical clustering, local population, monitoring, natural population, population dynamics

Introduction

In one of the seminal contributions to modern ecological theory, Andrewartha & Birch (1954) formalized the concept of ecological populations by recognizing that the dynamics shaping the distribution and abundance of species operate at two spatial scales: 'local' populations and 'natural' populations. At the local scale, immigration and emigration are the primary drivers of population dynamics, making local populations vulnerable to extinction/recolonization over short time-scales (Camus & Lima 2002). The local population concept has subsequently played a central role in modern population ecology and conservation by providing the foundation for metapopulation theory (Camus & Lima 2002). At larger spatial scales, however, immigration and emigration simply reshuffle individuals among local populations and therefore do not contribute to changes in the overall number of individuals over time. Thus, natural population (Andrewartha & Birch 1954) dynamics are governed primarily by birth and death processes rather than redistribution processes (Berryman 2002). On contemporary time-scales, natural populations form a fundamental unit

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