Ornithological Monographs
Volume (2006), No. 61, 1–13
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Printed in USA.

INTRODUCTION

THE PAST AND PRESENT OF MIGRATORY CONNECTIVITY

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"Migratory connectivity" refers to the degree to which two or more periods of the annual cycle are geographically linked. The term was first proposed by a group of scientists during a workshop on "Connectivity of Migratory Birds" in October 2000 sponsored by the National Science Foundation (Webster et al. 2002, Rubenstein and Hobson 2004). The renewed interest in tracking birds over long distances arose, in part, from the application of two intrinsic markers: stable isotopes and genetic markers, such as microsatellites and mitochondrial DNA (mtDNA). Because each individual carries information about its origin in its tissues, the advantage of using intrinsic markers is that an individual needs to be captured only once to estimate its geographic origin in a previous season (Wenink and Baker 1996, Chamberlain et al. 1997, Haig et al. 1997, Hobson and Wassenaar 1997). Measuring migratory connectivity was also driven by the long-standing interest in identifying factors that limit populations in different periods of the annual cycle and understanding how events interact between periods to influence populations (Fretwell 1972, Holmes and Sherry 1992, Sherry and Holmes 1995, Marra et al. 1998). Without knowledge of how populations are spatially distributed between these periods, it is virtually impossible to understand how events in different periods of the year influence abundance (Webster and Marra 2005, Marra et al. 2006). Below, we review the definition of migratory connectivity, briefly outline the history of this field of study, and provide an update on recent studies that have used multiple intrinsic markers to describe migration patterns.

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A Definition

Migratory connectivity describes the degree to which individuals or populations are geographically arranged among two or more periods of the annual cycle (Webster et al. 2002, Marra et al. 2006). In the simplest sense, the periods of the annual cycle include the breeding season, fall migration, the (stationary) wintering season, and spring migration. "Very strong" or "strong" connectivity refers to the state when all or most individuals from a given area migrate to a single area in the following period of the annual cycle, respectively (Marra et al. 2006; Fig. 1). By contrast, "no connectivity" occurs when individuals from a given area migrate equally to multiple areas the following season (Marra et al. 2006; Fig. 1). In reality, the relative degree of migratory connectivity will likely vary between these two extremes. The concept was initially defined for migratory birds but can readily be applied to any migratory taxa, such as invertebrates, fish, turtles, ungulates, or marine mammals. Migratory connectivity is important for understanding population dynamics, interactions of events between seasons, life-history strategies, and evolution of migration patterns. It is also critical for designing effective conservation plans (see Webster et al. 2002, Webster and Marra 2005; for a detailed review, see Marra et al. 2006).

The Phenotypic and Banding Period (Pre-1996)

Although migratory connectivity is relatively new, the concept of linking breeding and nonbreeding regions has a much longer history. Below, we review some of these early contributions.