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Editorial: Bird movements and migration under global environmental change: current and future implications

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Editorial on the Research Topic

Bird movements and migration under global environmental change: current and future implications

Birds are capable of amazing feats of movement and migration that span entire geographic regions and hemispheres (Newton, 2007). The patterns and processes of avian migration are invariably linked to environmental cues of seasonality, climate, and shifting resources. As these cues change so might the migratory tendencies of birds (Gordo, 2007). Of mounting concern is that birds are increasingly exposed to inhospitable and novel environments due to anthropogenic threats. The natural pathways, corridors, and stopovers that many bird species have encoded into their strategies of movement and migration are under threat due to global climate change, pollution, habitat degradation, and urbanization. These environmental changes have profound implications for bird species worldwide, affecting their distribution, behavior, and persistence.

The study of avian migration has always hinged on technological advances (Flack et al., 2022). The seminal studies of Emlen (1970) and Walcott (1974) used caged birds in planetariums and magnets to lay the groundwork for the roles of celestial navigation and the Earth's magnetic field in bird migration. Now, half a century later, technological advancements such as geolocators, weather surveillance radar, citizen science, and advanced statistical modeling have widened the circle of investigation.

The goal of this Research Topic on *Bird movements and migration under global environmental change: current and future implications* is to explore how bird movements and migration patterns are influenced by global environmental changes. Three studies explore how anthropogenic pressures are impacting avian migration now and into the future.

One of the most significant drivers of change in bird migration patterns is global climate change. Rising temperatures alter the timing of seasonal events such as flowering and insect emergence, which in turn affects food availability for birds. Many migratory species rely on precise timing to coincide their migration with peak food availability at breeding and wintering grounds. As climate change shifts the timing of these events, birds

may face mismatches in resource availability, leading to decreased reproductive success or survival (Visser and Gienapp, 2019). Modeling these potential impacts of climate change on bird migration often relies on species distribution, but many of these models are limited by a static view of the role of climate in constraining bird distributions. In their review, Stevens et al. argue that the current state of ecological forecasting may fail to capture the effects of seasonal interactions and variability and non-climatic threats on species distributional changes. To date, most studies model range shifts during one season for bird species that breed in North America and Europe and do not consider the combination of other threats that these species are likely to encounter across the annual cycle. Looking ahead, the authors argue for advancing full annual cycle distribution models that account for migratory connectivity and non-climatic threats.

Climate change is altering the weather patterns that birds use for navigation during migration. Changes in wind direction, speed, and timing can disrupt traditional migratory routes and increase the energy expenditure required for migration. Some species may adapt by altering their migration or changing their use of wintering and breeding grounds, potentially making them vulnerable to novel environmental changes across their range. El Hindi et al. compiled movement data from light-level geolocators on individuals of two South American flycatcher populations breeding at different latitudes. They used these data to estimate each population's current and projected future geographical distributions in South America under climate change. Their modeled projections identified significant losses in geographic distributions with the magnitude of these changes varying by population and season. Their findings provide novel insights into how migratory bird populations in an understudied portion of the globe could be affected by future climate change. Their results also underscore that different populations of birds face varying risks due to climate change. Further, the authors emphasize the need for tailored conservation strategies that consider both seasonal dynamics and regional variation.

In addition to climate change, human activities such as deforestation, urbanization, and agriculture continue to fragment and degrade natural habitats critical for bird migration. Loss of stopover sites along migration routes can lead to increased stress and mortality among migratory birds, as they are unable to rest and refuel adequately during long journeys. The degradation of breeding and nonbreeding habitats could affect survival and fitness, and in some cases these effects can carry over into subsequent seasons. Using banding and tracking data for a South American flycatcher species, Barbosa et al. found that birds are less likely to return to their nest sites if they breed in large cities the previous year. This outcome suggests breeding in urban environments is a factor whose effects can extend to subsequent breeding seasons. Ongoing land-use change and urbanization will continue to degrade seasonal habitats used by migratory birds. Associating with suboptimal habitats across the annual cycle is likely to generate compounding effects on survival and fitness, adversely affecting the long-term persistence of these species.

In conclusion, bird movements and migration are intricately linked to global environmental changes in a complex and dynamic fashion. Understanding these nuanced relationships is essential for implementing effective conservation strategies to safeguard migratory bird populations in the face of ongoing and future environmental challenges. As the findings from these studies emphasize, migratory birds represent a unique ecological scenario when it comes to the implications of global change. However, the emergence of new and refined empirical resources has created exciting opportunities to advance bird study across multiple taxonomic, spatial, and temporal scales. As global environmental change progresses, data driven science can now take on a more significant role advancing understanding and conservation efforts. Birds have long played a role as bioindicators due in large part to their ubiquity and charisma (Fiedler, 2009). Consequently, the insights generated from these efforts will play an important role informing the public on how natural systems are being affected by global change. With greater public awareness, the chances that effective global change mitigation measures will be developed and applied for birds and other taxa will inevitably grow.

Author contributions

BZ: Conceptualization, Writing – original draft, Writing – review & editing. FS: Conceptualization, Writing – original draft, Writing – review & editing.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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