MigrationR: An R Package for Analyzing Bird Migration Data Based on Satellite Tracking

Authors : Xinhai Li, Huidong Tian, Yumin Guo

Abstract : Bird migration is fantastic natural phenomenon. In recent years, the use of GPS transmitters has generated a vast amount of data, and the Movebank platform has made these data publicly accessible. For researchers, what they need are data analysis tools. Although there are approximately 90 R packages dedicated to animal movement analysis, the capacity for comprehensive processing of bird migration data remains limited. Hence, we introduce a novel package called migrationR. This package enables the calculation of movement speed, direction, changes in direction, flight duration, daily and annual movement distances. Furthermore, it can pinpoint the starting and ending dates of migration, estimate nest site locations and stopovers, and visualize movement trajectories at various time scales. migrationR distinguishes individuals through NMDS (non-metric multidimensional scaling) coordinates based on movement variables such as speed, flight duration, path tortuosity, and migration timing. A distinctive aspect of the package is the development of a hetero-occurrences species distribution model that takes into account the daily rhythm of individual birds across different landcover types. Habitat use for foraging and roosting differs significantly for many waterbirds. For example, White-naped Cranes at Poyang Lake in China typically forage in croplands and roost in shallow water areas. Both of these occurrence types are of equal importance. Optimal habitats consist of a combination of crop lands and shallow waters, whereas suboptimal habitats lack both, which necessitates birds to fly extensively. With migrationR, we conduct species distribution modeling for foraging and roosting separately and utilize the moving distance between crop lands and shallow water areas as an index of overall habitat suitability. This approach offers a more nuanced understanding of the habitat requirements for migratory birds and enhances our ability to analyze and interpret their movement patterns effectively. The functions of migrationR are demonstrated using our own tracking data of 78 White-naped Crane individuals from 2014 to 2023, comprising over one million valid locations in total. migrationR can be installed from a GitHub repository by executing the following command: remotes::install_github("Xinhai-Li/migrationR").

Keywords : bird migration, hetero-occurrences species distribution model, migrationR, R package, satellite telemetry