## Data Collection and Preprocessing

We collected woodcock locations with altitude readings from 2020 to 2024 using GPS transmitters as a part of a larger collaborative effort by the Eastern Woodcock Migration Research Cooperative (Blomberg et al. 2023, Clements et al. 2024, Fish et al. 2024). We captured woodcock at 100 sites across the eastern portion of their range, including Alabama, Florida, Georgia, Louisiana, Maine, Maryland, New Jersey, New York, North Carolina, Nova Scotia, Ontario, Pennsylvania, Québec, Rhode Island, South Carolina, Vermont, Virginia, West Virginia, and Wisconsin. We caught woodcock using a combination of spotlighting and mist netting (McAuley et al. 1993). We aged and sexed birds upon capture, where we classified birds undertaking their first fall and spring migrations as juveniles, and all other birds as adults. We then attached 4–7 g PinPoint transmitters (Lotek Wireless Inc., Newmarket, Ontario, CA) using a rump-mounted leg loop harness (Fish et al. 2024).

We programmed transmitters to collect locations every 1–3 days during migration, with locations alternating between diurnal (1300–1500 hours Eastern Time) and nocturnal (0000–0100 hours) times. Transmitters recorded time, latitude, longitude, and GPS-derived altitude above the WGS84 ellipsoid, and transmitted data back to the ARGOS satellite constellation after every third location. We subset these locations to include only those within the migratory classification dataset produced by Berigan (2024). This dataset classified individual locations as migratory or non-migratory based on the assumption that migration starts after the first ≥16.1 km movement and ends after the final ≥16.1 km movement of the season. We used ArcGIS Pro 3.2.1 (ESRI 2024a) to calculate the difference between the altitude and orthometric elevation recorded for each location (ESRI composite elevation layer; ESRI 2024b), providing a measurement of altitude above ground level for each point.

We classified data for our models based on prior descriptions of woodcock activity patterns. Woodcock are ground-feeding birds that rarely fly outside of crepuscular hours (Rabe et al. 1983). When rare diurnal flights do occur, these are generally brief, comprising 1–3% of diurnal time budgets, and close to the ground (McAuley et al. 2020). We therefore made a modeling assumption that all diurnal locations could be treated as though they were known to be recorded on the ground (hereinafter “known ground locations”). As woodcock are nocturnal migrants, we define potential flight locations as all points that were nocturnal, occurred during migration based on the classification in Berigan (2024), and were preceded and followed by >6.68 km steps (defined as lines connecting consecutive locations). The 6.68 km threshold was based on the 99th percentile of step lengths recorded within a stopover site (Berigan 2024). Ensuring that the preceding and following steps were >6.68 km increased the likelihood that the bird had moved away from a stopover site before the point was recorded.

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