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**Wild Turkeys Context-Dependence in their Use of Roads by Season, Time of Day, and Land Cover Type**

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**METHODS**

**Study Area**

**Field Methods**

Turkey Capture and Processing

We captured female turkeys at baited sites across three winters (2019-2021) using both rocket (Grubb, 1988) and drop nets (Glazener et al., 1964). Upon capture, we equipped a subset of hens with 90-g Lotek GPS transmitters (Lotek Wireless, Newmarket, Ontario, CA) attached via a backpack-style harness. The transmitters were carefully fitted to ensure they did not exceed 4% of the bird's body mass. The GPS units were programmed to record hourly locations during daylight hours from 1 November through 31 July, and a single roost location each night at either 12:00 AM or 1:00 AM (Cohen et al., 2018). Spatial data were downloaded weekly using a handheld telemetry yagi and a Lotek GPS downloading device (Lotek Wireless, Newmarket, Ontario, CA). All animal handling protocols were approved by the University of Maine’s Institutional Animal Care and Use Committee (IACUC Protocol # A2017\_11\_03). To account for potential capture-related mortality, we censored birds that died within two weeks of capture. To minimize pseudo replication arising from closely traveling individuals, we used GPS data from only one hen per flock in our analysis.

**Data Management**

Road Categorization

To test hypotheses about turkey selection of roads while accounting for vehicular speed and anthropogenic disturbance, we obtained road data from the Maine Department of Transportation public roads shapefile from the Maine GIS Office (Kane 2019). This shapefile portrayed public roads centerlines from the state of Maine and contained six different road types including “Interstate”, “Minor Arterial”, “Major Collector”, “Minor Collector”, “Other Freeway or Expressway”, “Other Principal Arterial”, and “Local”. For our analysis, we categorized roads into two groups: primary roads, which include state roads, arterials, collectors, and highways; and secondaryroads, which consisted of local (i.e., municipal or township) roads. Using the `sf ` (Pebesma & Bivand, 2023) and `terra` (Hijmans, 2024) R packages, we generated separate 30 × 30 m raster layers and calculated the Euclidean distance from each GPS location to the nearest primary and secondary road structures.

Defining Seasons and Time of Day

To gauge for differences in selection of roads based on seasonality, we estimated annual and seasonal home ranges by generating 95% utilization distributions using dynamic Brownian bridge movement models (dBBMMs) (Kranstauber et al., 2012). Movement periods were categorized into five seasons (winter, spring dispersal, pre-nesting, summer, and fall) based on a visual assessment of Brownian motion variance estimates (σ²ₘ) (Kranstauber et al., 2012), which quantify the irregularity of movement paths between successive locations within a dBBMM (Byrne et al., 2014). To assign seasonal periods, we first generated a dBBMM for the full movement track of each individual over the course of a year. We then plotted σ²ₘ over time for each individual and identified periods where trends in variance shifted significantly. These shifts were aligned with specific ecological seasons, and we matched GPS locations to each location. To test hypotheses about turkey road selection by time of day, we used the `suncalc` package (Thieurmel & Elmarhraoui, 2022) to calculate the time elapsed from each GPS timestamp to sunset. We included time of day as a distance to sunset covariate in each model.

Land Cover Categorization

We processed spatial land cover data from the National Land Cover Database (NLCD) (Homer et al. 2010) using the `tigris` (Walker et al., 2024) and `FedData` (Boscinsky 2024) packages to gauge the effect of landscape variables on road selection. The NLCD portrays land cover information as grid cells with a 30 m × 30 m spatial resolution. We grouped NLCD classifications into three categories that we believe represented differing levels of visibility of turkeys in proximity to roads by motorists. A "Forest" category was formed by combining deciduous, evergreen, mixed forest, and wooded wetland cover types. To represent human-developed areas, we merged the categories for developed open space, low-intensity developed, medium-intensity developed, and high-intensity developed into a single "Developed" category. Finally, an "Open" category was created by combining all other NLCD classifications to determine if turkey selection of roads changed based upon open landscape composition.

**Statistical Analysis**

We fit separate models for each season, including interactions between land cover type (forest and developed) and road type (primary and secondary), as well as interactions between time of day and road type. All models were fit using the glmmTMB package (Brooks et al. 2018) within program R (R Core, 2024). We evaluated uncertainty associated with each estimate using 95% confidence intervals and only included predictors within our models that contained a Pearson’s correlation value lower than 0.7. We standardized all continuous predictors within each model to a mean of zero and standard deviation of one. We set open land cover as the reference level to compare the effects of turkey selection of roads in more visually obscured habitats to motorists relative to open areas.

Step-Selection Functions

We analyzed hen movement using conditional logistic regression, commonly known as a step-selection function (Fortin et al. 2005, Thurjfell et al. 2014, Muff et al. 2019). This method is likelihood-equivalent to a Poisson distribution with fixed intercepts specific to each stratum, which can be modeled using a random effect with a large, fixed variance (Warton and Shepperd 2010, Muff et al. 2019). For each observed step, we generated ten "available" steps by sampling from the observed distribution of step lengths and turning angles across all individuals using the ‘amt’ package (Signer et al. 2019). Each combination of one used location and ten available locations constituted a stratum in the conditional logistic regression model. Each used or available observation *j*, at time *t*, for hen *n*, was assumed to arise from a Poisson distribution

(1)

in which was a stratum-specific intercept, and was a vector of coefficients that described the effects of the covariates (Muff et al. 2019).

**RESULTS**

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