Avian sampling

NN technicians visited sites once per year, between April and July, from 2000-2016. Each NN visit consisted of a banding demonstration for the homeowner/participant lasting 3-5 hours in which birds were targeted with audio playback and captured in mist-nets. NN technicians affixed uniquely numbered U.S. Fish and Wildlife aluminum bands and a unique combination of colored plastic bands to the legs of captured birds. Technicians measured body mass using an electronic scale and unflattened wing chord using a wing rule. When possible, birds were aged to hatch year (HY), after hatch year (AHY), second year (SY), or after second year (ASY) age classes using a combination of plumage and molt characteristics and skull ossification (Pyle 1997). Participants were given the band numbers and color combinations of all birds banded at the site and instructed to report any banded birds they saw over the course of the year. After each annual visit to a study site, NN technicians spent roughly one hour searching for previously banded birds within a 200m radius of the site. Birds were targeted for re-sighting with audio playback.

Analysis

I estimated the survival of seven common bird species that breed in the study area: American Robin (*Turdus migratorius*), Carolina Chickadee (*Poecile carolinensis*), Carolina Wren (*Thryothorus ludovicianus*), Gray Catbird (*Dumetella carolinensis*), House Wren (*Troglodytes aedon*), Northern Cardinal (*Cardinalis cardinalis*), and Song Sparrow (*Melospiza melodia*). Analysis was carried out using package *marked* (Laake et al. 2013) in program R (Team 2014). I fit Cormack-Jolly-Seber (CJS) maximum-likelihood mark-recapture models (Pledger et al. 2003) to data to examine the influence of individual and site covariates on parameters:

ϕ Apparent survival

*p* Probability an individual in the survey area is detected

Apparent annual survival refers to the probability that an individual survives to the next year andremains within the survey area. I selected the best model from a set of candidate models using AICc values. Models with a ΔAICc value of less than 2 was considered to have substantial support (Burnham and Anderson 2003). I calculated AICc weights to determine the relative weight of each model in the set.

For each species, I created a set of a priori candidate models including covariates known to influence bird survival and detection as well as a set of models including cat abundance covariates (Table 4). Individual behavior can differ greatly by sex, resulting in differential capture rates and detection (Amrhein et al. 2012) as well as survival (Evans et al. 2015) and dispersal (Clarke et al. 1997), so I included a binary sex covariate to estimate detection and apparent survival.

Body condition may be an important factor influencing survival (Johnson et al. 2006). I calculated a scaled body condition measure (BCI) using wing chord and body mass by the method proposed by Peig and Green (2009). Differences in body condition may differentially influence survival of males and females, so in the models that included BCI, I also included a sex × BCI interaction term.

I used percent impervious surface cover to represent the urbanization gradient of the study area. Depending on the species, impervious surface may have a linear, quadratic, or no relationship with survival (Evans et al. 2015), so models were constructed without the impervious surface term and with both impervious surface and squared-impervious surface terms. Evans et al. (2015) uncovered a potential urbanization-sex interaction influencing bird survival, so some models also included a sex × impervious interaction term.

Although in a survival analysis across years it may be appropriate to include a detection and survival variable for year effect, including a parameter for each year of the study would greatly reduce the predictive power of the model to uncover effects of other covariates. Consequently, no year effect variable was included in this analysis.

Models including cat covariates were divided into two sets: a set including a cat metric derived from transects and a set including a cat metric derived from camera traps. The transect metric was the total number of distinct individual cats seen per transect at a site. The camera metric was the total number of distinct individuals seen per camera deployment at a site. Because cameras were only deployed at a subset (n=48) of the total sites (n=53), I compared a priori models and cat-transect models separately from a priori models and cat-camera models. Averaged counts were used rather than modeled abundance estimates because the cat abundance models included an impervious surface covariate, which would bias survival model estimates. The full set of models I compared is shown in Table 5.

Table 4. Variables used in a priori and cat models for ϕ, apparent survival, and *p*, probability that an individual in the survey area is detected. Cat metric was either average individuals counted by transect or average individuals counted in camera images by deployment.

|  |  |  |  |
| --- | --- | --- | --- |
| Model set | Variable | Description | Parameter |
| a priori | sex | Sex (male/female) | ϕ, *p* |
| a priori | BCI | Scaled body condition measure | ϕ |
| a priori | imp | Percent impervious surface in 100m-radius to site | ϕ |
| a priori | imp2 | Percent impervious surface, quadratic form | ϕ |
| a priori | sex × BCI | Interaction between sex and body condition | ϕ |
| a priori | sex × imp | Interaction between sex and impervious surface | ϕ |
| Cat | cat | Cat metric | ϕ |
| Cat | cat × sex | Interaction between cat metric and sex | ϕ |
| Cat | cat × BCI | Interaction between cat metric and BCI | ϕ |
| Cat | cat × imp | Interaction between cat metric and impervious surface | ϕ |

Table 5. A priori and cat candidate models constructed to examine the influence of cat abundance on bird survival

|  |  |  |
| --- | --- | --- |
| Model ID | ϕ formula | *p* formula |
| 1 | ~1 | ~sex |
| 2 | ~sex | ~sex |
| 3 | ~sex + BCI + sex × BCI | ~sex |
| 4 | ~sex + BCI + imp + sex × BCI | ~sex |
| 5 | ~sex + BCI + imp + sex × BCI + imp2 | ~sex |
| 6 | ~sex + BCI + imp + sex × BCI + sex × imp | ~sex |
| 7 | ~sex + BCI + imp + sex × BCI + sex × imp + imp2 | ~sex |
| 8 | ~sex + cat + sex × cat | ~sex |
| 9 | ~sex + BCI + cat + sex × BCI + sex × cat | ~sex |
| 10 | ~sex + BCI + cat + sex × BCI + sex × cat + BCI × cat | ~sex |
| 11 | ~sex + BCI + cat + imp + sex × BCI + sex × cat + BCI × cat + imp × cat | ~sex |
| 12 | ~sex + BCI + cat + imp + sex × BCI + sex × cat + BCI × cat + imp × cat + imp2 | ~sex |
| 13 | ~sex + BCI + cat + imp + sex × imp + sex × BCI + sex × cat + BCI × cat + imp × cat | ~sex |
| 14 | ~sex + BCI + cat + imp + sex × imp + sex × BCI + sex × cat + BCI × cat + imp × cat + imp2 | ~sex |

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