**Carlin, M., and A.D. Chalfoun. Congruence among multiple indices of habitat preference for species facing human-induced rapid environmental change: a case study using the Brewer’s sparrow. *Ecological Solutions and Evidence*.**

**Data and R scripts used to model three indices of songbird habitat preference relative to surface disturbance associated with energy development on the Pinedale Anticline Production Area natural gas field in Sublette county, WY, USA. Data collection and analysis methods described in detail in manuscript.**

**Author(s)**

Max Carlin

Wyoming Cooperative Fish and Wildlife Research Unit

1000 E. University Ave., Laramie, WY 82072

maxfield.carlin@gmail.com

Anna D. Chalfoun, PhD

Wyoming Cooperative Fish and Wildlife Research Unit

1000 E. University Ave., Laramie, WY 82072

adchalfou@uwyo.edu

**File list (files found within DataESE.zip)**

**Data**

**Habitat preference**

 carlinchalfoun\_ESE\_territorypairing.csv

 carlinchalfoun\_ESE\_nestinitiation.csv

 **Shrub structure**

carlinchafloun\_ESE\_atcov.csv

carlinchafloun\_ESE\_height.csv

carlinchafloun\_ESE\_dens\_nest.csv

**R script**

 carlinchalfoun\_ESE\_analysis.R

**File descriptions**

**Habitat preference**

**carlinchalfoun\_ESE\_territorypairing.csv**

Data on two indices of songbird habitat preference (chronology of territorial settlement and pair formation) from spot mapping surveys conducted at the Pinedale Anticline Production Area (PAPA) in 2019. Model summaries are provided in Table 1. Graphical results for analysis of territorial settlement are provided in Figure 3, and results for pair formation are provided in Figure 4.

**Variable descriptions**

**Plot**

Two-part code for nest searching and monitoring plot. First value (P) refers to the natural gas field where the plot is located (Pinedale Anticline Production Area or PAPA). The number value corresponds to the density of natural gas wells around the plot when it was originally established.

**Visit**

Survey visit number. All plots were visited/surveyed seven times during the study period

 **Jdate**

Julian date of the survey. Values range from 126 (May 6, 2019) to 168 (June 17, 2019)

**Observer**

Initials for the observer(s) who conducted the survey. Five unique observers conducted surveys during the study period. Observer was tested as a random effect in models of songbird habitat preference.

**Plot.Size.ha**

Area of the study plot in hectares. Plot size varied among plots (21.51-26.88ha) was used to calculate density of male songbirds and determine territorial settlement.

**BRSP**

Number of territorial male Brewer’s sparrows detected during the survey. All individuals singing territorial vocalizations were included in this count.

 **BRSP.ha**

Density of territorial male Brewer’s sparrows. Calculated by dividing BRSP/Plot.Size.ha

**BRSP.Paired**

Total number of male Brewer’s sparrows singing longer, more elaborate songs known to be associated with pair formation.

**Period**

Surveys were grouped into four periods based on visit date for analysis of territorial settlement data. Although we initially aimed to keep spot mapping visits continuous across all plots over time, an extended bout of late winter weather conditions (snow, freezing rain, below freezing temperatures) disrupted our sampling continuity. We therefore specified time as a categorical variable for our territorial settlement data through careful inspection of our data to ensure each time category had an approximately even sample size across disturbance classes (i.e. Period 1 = Julian dates 124—131, Period 2=132—135; Period 3=136—155; Period 4=156—168).

**PropPaired**

Proportion of all territorial male Brewer’s sparrows detected during a survey that were paired (paired/total).

**SurfDist**

Proportion of a 1km2 buffer centered on the plot where infrastructure associated with energy development (roads, well pads, pipeline right-of-ways) had replaced the original sagebrush habitat

**carlinchalfoun\_ESE\_nestinitiation.csv**

Data on one of three indices of songbird habitat preference (timing of Brewer’s sparrow nest initiation) from nest searching and monitoring conducted at the Pinedale Anticline Production Area (PAPA) in 2019. Model summaries are provided in Table 1. Graphical results for analysis of nest initiation are provided in Figure 4.

**Variable descriptions**

**Plot**

Two-part code for nest searching and monitoring plot. “P” refers to the natural gas field where the plot is located (Pinedale Anticline Production Area or PAPA) and the number corresponds to the density of natural gas wells around the plot when it was originally established for breeding bird monitoring in 2008.

 **NestID**

Unique three-part identifier assigned to each nest. The first two values correspond to the year (2019), followed by the initials of the observer who originally found the nest, and the number nest discovered by that individual.

 **Species**

Four-letter American Birding Association code of the species the nest belongs to. Only Brewer’s sparrows (BRSP) were included in this study.

**Season**

Study season in which nest was discovered. Only nests from 2019 were used in this study.

**UTM E/UTM N**

Coordinates of the nest in the Universal Transverse Mercator coordinate system

 **Init\_Cert**

Certainty of nest initiation date. Values are what do S and P stand for?. We recorded nest initiation as certain when the exact date that the first egg was laid was known (i.e., nests found during building or laying). For nests first located during the incubation or nestling stages, we estimated nest initiation dates by back-calculating based on average period lengths (10 days for incubation, and 8 days for nestling) using conventions detailed in (Martin & Geupel, 1993).

 **Jdate**

Julian date of nest initiation. Values range from 152 (June 1, 2019) to 164 (June 13, 2019).

 **SurfDist**

Proportion of a 1km2 buffer centered on the plot where infrastructure associated with energy development (roads, well pads, pipeline right-of-ways) had replaced the original sagebrush habitat

**Shrub structure**

Variation in shrub structure metrics among six study plots at the Pinedale Anticline Production Area (PAPA), Sublette County, Wyoming. Summary statistics (mean, standard deviation, and covariance) of shrub height, shrub cover, and shrub density from previous research at our study sites (Hethcoat and Chalfoun 2015) were used to ensure that microhabitat did not vary systematically with surface disturbance. Results for analysis of shrub structure relative to surface disturbance are provided in Appendix 1 of Supplementary Material. See Chalfoun and Martin 2007 for detailed description of shrub structure field methods.

**Variable descriptions**

Variables listed below appear in all shrub structure files unless otherwise indicated.

**NestID**

Unique three-part identifier assigned to each nest. The first two values correspond to the year (2011 or 2012), followed by the initials of the observer who originally found the nest, and the number nest discovered by that individual.

**shrcov**

Width of shrubs (cm) intersecting with vegetation plot measuring tape.

**dens**

Density of shrubs (# shrubs ≥20cm/m2) within vegetation sampling plot

**shrheight**

Height of shrubs (cm) intersecting with vegetation plot measuring tape.

**Species**

Four-letter code for the species each nest belonged to. We used the code system defined by the American Birding Association.

**Plot**

Two-part code for nest searching and monitoring plot. “P” refers to the natural gas field where the plot is located (Pinedale Anticline Production Area or PAPA) and the number corresponds to the density of natural gas wells around the plot when it was originally established for breeding bird monitoring in 2008.

**Season**

Year in which data were collected. Only data from 2011 and 2012 were used in this analysis.

**SurfDist**

Proportion of a 1km2 buffer centered on the plot where infrastructure associated with energy development (roads, well pads, pipeline right-of-ways) had replaced the original sagebrush habitat.

**Literature cited**

Chalfoun, A.D., & Martin, T.E. (2007). Assessments of habitat preference and quality depend on spatial scale and metrics of fitness. *Journal of Applied Ecology, 44(5),* 983-992 . https://doi.org/10.1111/j.1365-2664.2007.01352.x

Hethcoat, M.G., & Chalfoun, A.D. (2015). Towards a mechanistic understanding of human-induced rapid environmental change: a case study linking energy development, nest predation, and predators. *Journal of Applied Ecology, 52(6),* 1492-1499. https://doi.org/10.1111/1365-2664.12513

Martin, T.E. & Geupel, G.E. (1993). Nest-monitoring plots: methods for locating nests and monitoring success. *Journal of Field Ornithology, 64(4),* 507-519.