Distribution, abundance, and habitat associations of Chuck-will's-widow (*Antrostomus carolinensis*) and Eastern Whip-poor-will (*Antrostomus vociferus*) in eastern Nebraska

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Nongame Bird Program

Nebraska Game and Parks Commission

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Prepared by

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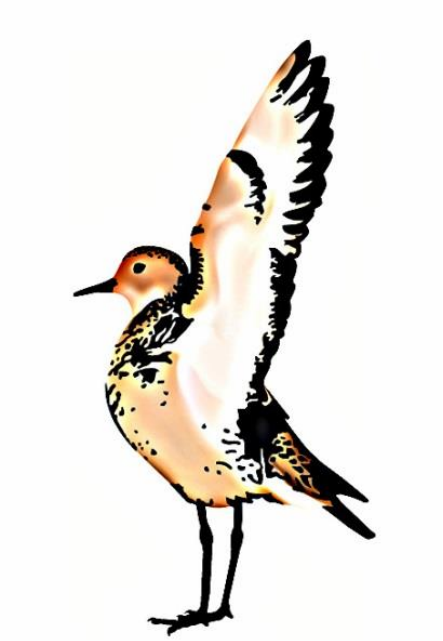

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Cover photo: Chuck-will's-widow at Tillinghast Pond Management Area, Rhode Island - June 2016. Photo by Stephen J. Brenner

Nightjars are crepuscular or nocturnal insectivorous birds that are infrequently and inconsistently detected by traditional avian survey methods such as the Breeding Bird Survey (BBS). As a result, less is known about nightjars' abundance, distribution, and demographics throughout their range compared to more visible species, particularly in less populated areas with fewer observers such as Nebraska. Four species of nightjar occur in Nebraska: Eastern Whip-poor-will (*Antrostomus vociferus*; EWPW), Common Poorwill (*Phalaenoptilus nuttallii*; COPO), Common Nighthawk (*Chordeiles minor*; CONI), and Chuck-will's-widow (*Antrostomus carolinensis*; CWWI). COPO is a species that occupies rocky outcrops in western North America (Woods et al. 2005). CONI breeds over much of North America, occupying open country and cities and is the most visible species of the group (Brigham et al. 2011). CWWI and EWPW breed in deciduous or mixed forests in eastern North America and are the focus of this project.

EWPW populations have declined significantly over the past 50 years across their range. BBS data show a range-wide annual decline of -2.76% (95% C.I.; -3.78, -2.13, Sauer et al. 2017). Habitat loss is the most likely cause of this decline, but it has also been speculated that reduction in food resources (insects) due to pesticides may also be a factor (Cink et al. 2017). CWWI occurs in similar habitat but is primarily restricted to southeastern Nebraska. However, this species has been detected irregularly in isolated locales as far north as Cedar and Knox Counties (Silcock and Jorgensen 2018a). CWWI numbers have likely decreased in core portions of their range of the southeastern United States, but CWWI appear to also be expanding their range northward (Straight and Cooper 2012). This includes in Nebraska, as the species was unrecorded until 1963 when a calling bird was discovered in Douglas County (Silcock and Jorgensen 2018a). It is believed CWWI increased during the latter part of the 20th Century in the state and that this increase has continued up to the present time (Silcock and Jorgensen 2018a). However, it is difficult to discern how the range expansion progressed in Nebraska because colonized locations may have gone undetected for years or even decades due to poor coverage by observers.

Given that Nebraska lies on the northwest fringe of the CWWI range and the western edge of EWPW range, the distribution of these species within the state are of particular interest. In general, populations at the periphery or edge of their range are presumed to be at lower densities than core areas (Brown et al. 1995). This pattern becomes less clear depending on region and scale (Blackburn et al. 1999) and might shift based on particular group behaviors, heterospecific dynamics, and traits of colonizing individuals (Duckworth and Badyaev 2007). However, information on all nightjar species in Nebraska is limited and their ranges are poorly defined. Both CWWI and EWPW are listed a Tier II at-risk species (= species of greatest conservation need) in Nebraska by the state's wildlife action plan (Schneider et al. 2011), further underscoring the need for study of these two species.

Relationships between habitat and nightjar occupancy in the state are also of interest because habitat loss is cited as the most likely cause of population decline in EWPW (Cink et al. 2017). Both EWPW and CWWI can occur in upland pine and/or mixed forests with minimal understory. In Nebraska, this habitat is represented primarily by oak woodlands, a forest type that is limited in eastern and northern portions of the state. There are growing concerns about the health and management of oak woodlands in the Midwest as fire suppression has led to increasing growth of dense understory and invasive species in what was historically disturbance-meditated habitats (Ryan et al. 2013,). Current management efforts to reduce the understory in oak woodlands owned by Nebraska Game and Parks Commission should improve the quality of habitat for EWPW and CWWI (Jorgensen et al. 2014, Akresh and King 2016). However, there is limited information on the impacts of woodland management on these species.

The purpose of this project is to 1) determine the distribution and occurrence of EWPW and CWWI in Nebraska, 2) summarize habitat characteristics of occupied and unoccupied sites and 3) evaluate landscape composition that may impact interactions (or lack thereof) between these closely related species, or how the differences between habitat-related factors contribute to the occupancy of EWPW and CWWI in Nebraska. This report summarizes the preliminary results from the first year (2019) of surveys in eastern Nebraska.

METHODS

We followed the general methodology of the Nightjar Survey Network (http://www.nightjars.org). Point counts were conducted on moonlit nights during the time of the breeding season with the highest moon brightness (2019 study period: May 11 – May 26, June 9- June 20). All surveys began 30 minutes after sunset and ended at least 30 minutes before sunrise. We conducted 10 point counts along each survey route, with stops separated by 1.6 kilometers. We conducted a 5-minute point count and recorded all individual nightjars seen or heard to species. We recorded the detection history by minute of each individual nightjar seen or heard during the 5-minute survey period, as well as approximate distance and direction of each bird from the observer. Nightjars seen or heard outside of the five-minute observation period (n=6) were noted and included in analysis. We chose to include these individuals because we were interested in identifying habitat features occupied by individual birds. We did not use data to estimate occupancy or abundance using time-removal based methods of analysis. We also recorded other nocturnal and difficult-to-detect species of interest (i.e. owls). While owls and all four species of nightjar were recorded when encountered, EWPW and CWWI remain the focus of this study and are the only species used in statistical analysis. All surveys were conducted by the authors.

Route Selection

We surveyed nightjars in five Biologically Unique Landscapes (BULs) in eastern Nebraska: Sandstone Prairie, Southeast Prairie, Missouri River, Lower Platte River, and Middle Niobrara River (Fig 1). These BULs were chosen because they lie within the predicted/known ranges of EWPW and CWWI, and they include the largest tracts of woodland habitats in the state. We began the season with a set of points in the Lower Niobrara BUL, but had to abandon these routes due to the catastrophic flooding in the spring of 2019 along with additional logistical constraints and concerns.

We developed survey routes by creating 200 randomly placed points within the five BULs of interest. Using ArcGIS and statewide land cover data (Bishop et al. 2009), we created 6.5 km buffers around each point to assess the amount of likely habitat (i.e. oak woodland) near the points. Points with > 10% of woodland and points separated by at least 14 km from each other were selected as starting locations for survey routes. We placed two additional routes outside the BULs near Lincoln, Nebraska, which is where we were based. Given that this was a pilot study, we wanted to optimize our survey coverage by including these easily accessible areas that also fit our habitat selection criteria. The remaining point count locations along each route (n = 22) proceeded from starting points based on a) road configuration (i.e. avoid major highways, avoid going around in circles) and b) optimized proximity to woodland habitat. Occasionally, one or more of the original 10 points mapped out for each route were not surveyed due to logistical concerns or a lack of appropriate habitat nearby.

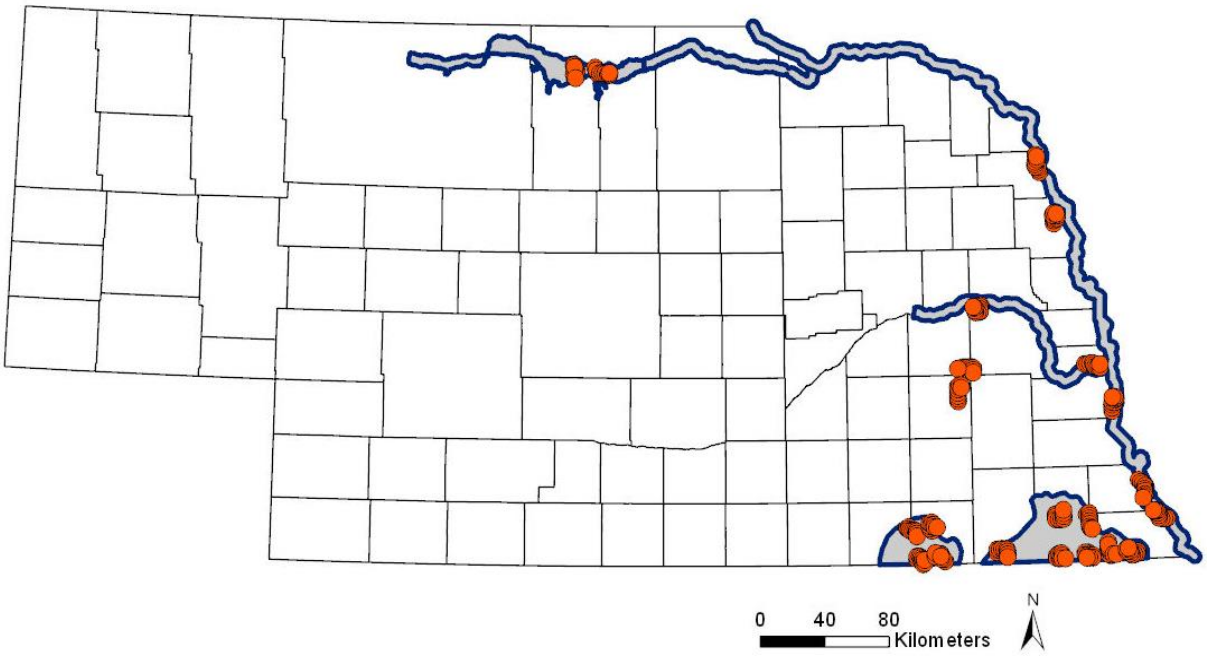

Figure 1. 2019 point counts (orange dots) completed during the 2019 nightjar survey season. Shaded gray areas are the BULs used for site selection.

Analysis

We plotted all EWPW and CWWI detections along with each survey point in ArcGIS. Each nightjar detection had an associated direction and distance from a survey point recorded by the observers during the surveys. We treated these points as approximations and not actual locations of individual birds because all sightings were auditory and likely imprecise as detections were at night. However, these approximations were useful in determining the general area (within 100 m) where different individual calling birds were located. This allowed us to differentiate potential differences in habitat use, particularly when both species were detected from the same point.

We created circular buffers around each approximated nightjar location and at each survey point where no birds were detected using the buffer tool in ArcGIS. We used state land cover data in ArcGIS (Bishop et al. 2009) to classify and calculate the percent of total area of various land cover types within these buffers. We defined broad categories of land cover that had the most ecological relevance to the species of interest. These categories of classification included Cropland (corn, soy, fallow ag land, etc.), Developed (man-made structures and towns), Open Water (rivers, lakes), Prairie (grasslands, prairies, pasture), Upland Woodland (predominately oak woodland), and Wetland Various (bottomland forests, swamp areas). We created circular buffers with four different sizes of increasing radii around each point at 500 m, 1000 m (1 km), 4000 m (4 km), and 8000 m (8 km). We calculated percent area of each land cover category at each scale.

At the smaller scales (500 m and 1 km), we created buffers around each detection/approximate nightjar location and each point with no detection. At the larger scales (4 km and 8 km), there was a large amount of overlap between all points when analyzed individually. We therefore analyzed land cover at the 4 km and 8km scales by grouping all points (both approximate detection locations and count locations with no

detections) either by the entire route, or by splitting the routes into 2 or 3 sections where there would be no overlap between buffers. We used generalized linear models (GLMs) in Program R (R Core Team 2018), using a binomial response variable (0 = no birds detected, 1 = nightjar detected) to test the impact of different land cover types on whether or not a nightjar was detected at different points and at different spatial scales. We selected models with the four most relevant land cover types to test at different scales, excluding open water and developed land categories, as these were the least abundant land cover types and of little practical use to our focal species. We recognize that because we surveyed each point only once that we may have missed birds at some points due to imperfect detection. However, this is the first year of this study and we believe conducting this exploratory analysis is useful in improving future surveys.

RESULTS

We completed a total of 207 points between May 12 – June 13. We detected EWPW and/or CWWI at 53 points (25.6% of counts) and had 154 points with no detections. We detected a total of 65 EWPW and 36 CWWI. All of our CWWI detections were in the extreme southeastern portion of our study area limited to Jefferson, Gage, Pawnee, and Richardson counties. EWPW were more widespread, occurring in all areas that had CWWI (except Gage county), with highest concentrations in the Middle Niobrara BUL (Fig. 2). Additionally, we had two observations of COPO and five of CONI during our surveys (Table 1), although we observed many more CONI incidentally before our surveys began.

Table 1. Total detections by species and highest count at one route during 2019 nightjar surveys.

Species	Total Detections	Highest Single Route Count (County)
Eastern Whip-poor-will (*Antrostomus vociferous*)	65	9 (Pawnee/Keya Paha)
Chuck-will's-widow (*Antrostomus carolinensis*)	36	8 (Pawnee)
Common Nighthawk (*Chordeiles minor*)	5	2 (Pawnee)
Common Poorwill (*Phalaenoptilus nuttallii*)	2	2 (Keya Paha)

At the two smallest scales (500 m and 1 km), the probability of a nightjar being present significantly increased with increasing percent woodland cover (500 m; $z = 4.0$, $p < 0.001$, 1 km: $z = 6.4$, $p < 0.001$, Table 2). Increasing percentages of cropland within 1 km significantly decreased the probability of a nightjar being present ($z = -3.1$, $p = 0.002$, Table 2). At the home range and immediate landscape scale (500 m and 1 km), EWPW were detected in areas that had more upland woodland and less cropland than CWWI on the same scales (Fig. 3 and Fig. 4).

At the route scale (8 km), habitat composition did not significantly affect the probability of a nightjar being present (all land cover types; $z \leq 1.4$, $p \geq 0.16$). There was a significant impact of increasing cropland leading to a lower probability of nightjar presence at the 4 km landscape scale ($z = -2.1$, $p = 0.035$, Table 2). There was wide variation in percent cover between areas with CWWI or EWPW detection at the largest landscape scale (Fig. 6), including percent upland woodland (EWPW = 15.0 ± 3.8%, CWWI = 10.2 ± 2.3%) and cropland cover (EWPW = 25.9 ± 5.8%, CWWI = 29.7 ± 6.2%).

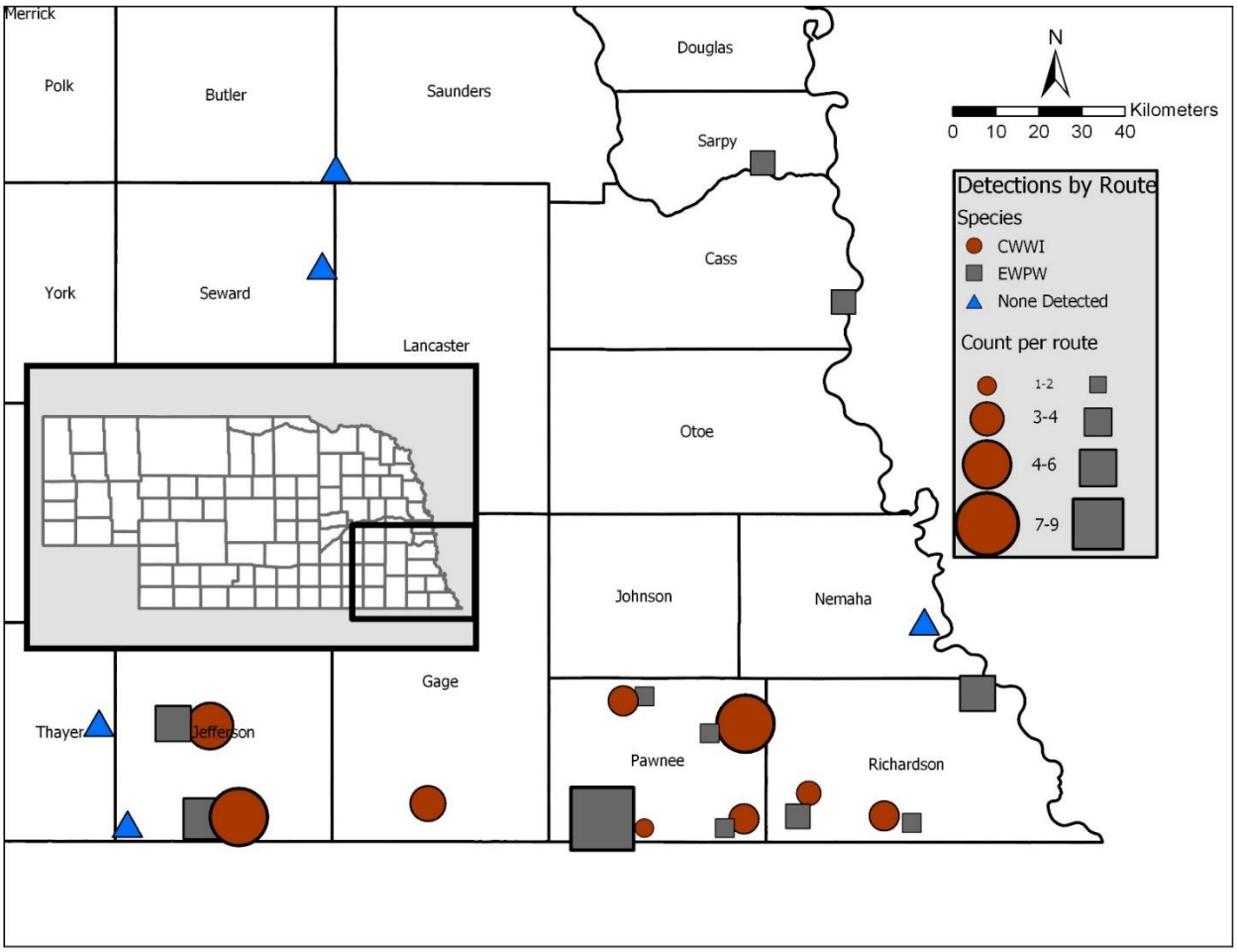

Figure 2a. General locations of routes with nightjar detections in southeastern Nebraska. Red circles represent CWWI, and gray boxes represent EWPW. The size of each symbol corresponds to the number of individuals of each species that was encountered on each route.

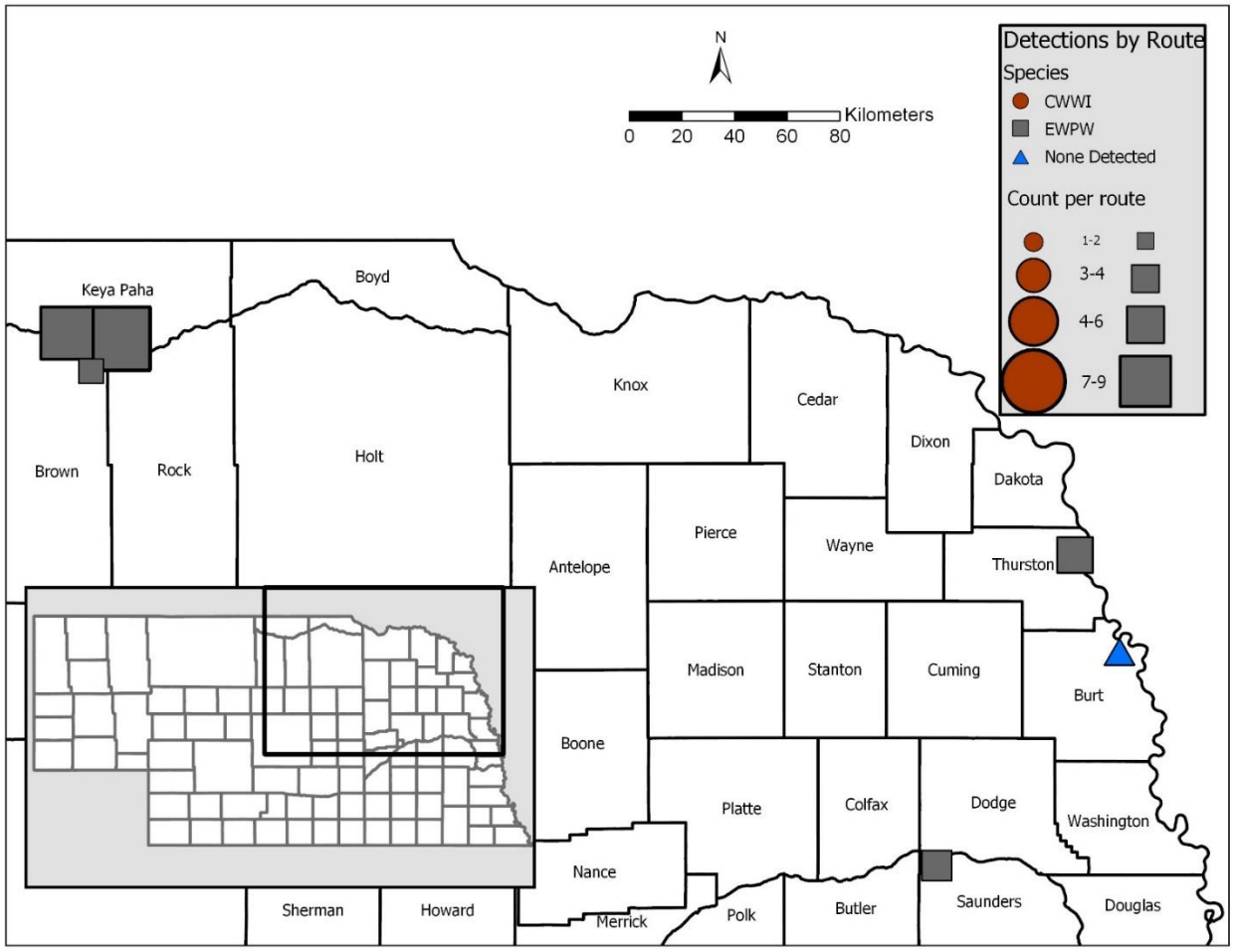

Figure 2b. General locations of nightjar detections in northeastern Nebraska. Red circles represent CWWI, and gray boxes represent EWPW. The size of each symbol corresponds to the number of individuals of each species encountered on each route.

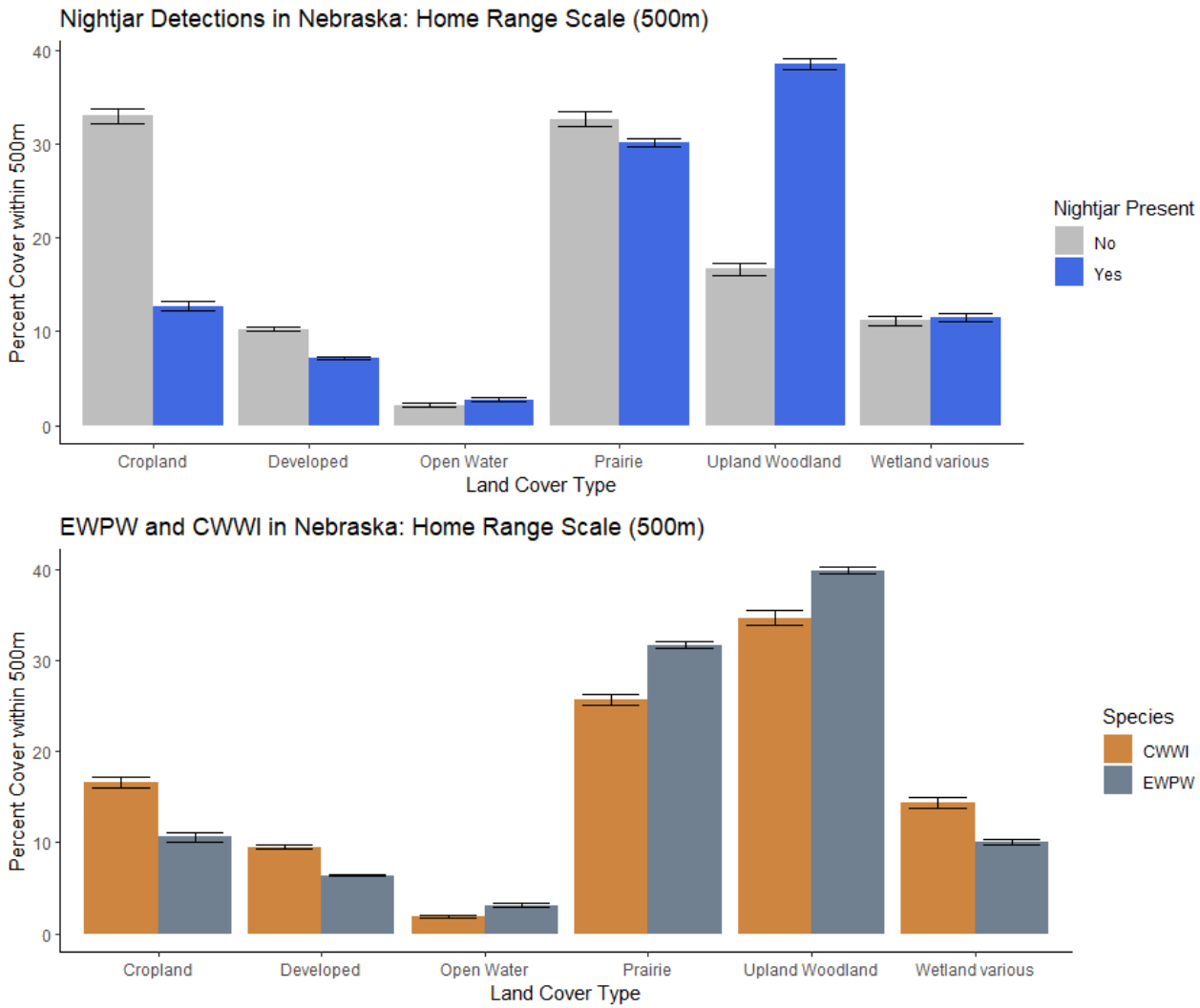

Figure 3. Percent land cover between survey points where at least one nightjar was detected and survey stops that did not detect any nightjars (upper); and percent land cover between points that detected Chuck-will's-widow (CWWI) and stops that detected Eastern Whip-poor-will (EWPW, lower). Land cover was measured as percent area within circles with a 500 m radius.

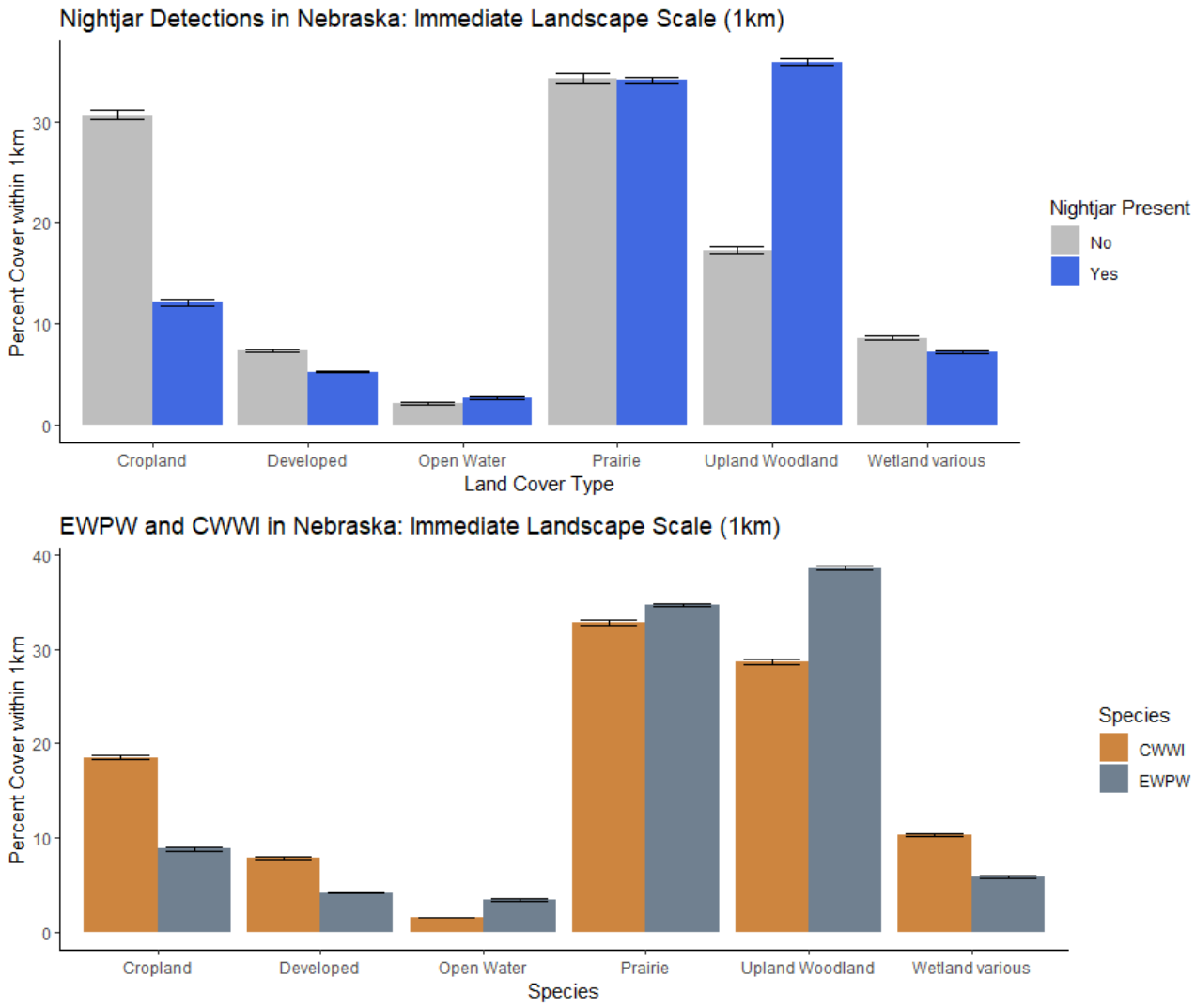

Figure 4. Percent land cover between survey points where at least one nightjar was detected and survey stops that did not detect any nightjars (upper); and percent land cover between stops that detected Chuck-will's-widow (CWWI) and stops that detected Eastern Whip-poor-will (EWPW, lower). Land cover was measured as percent area within circles with a 1 km radius.

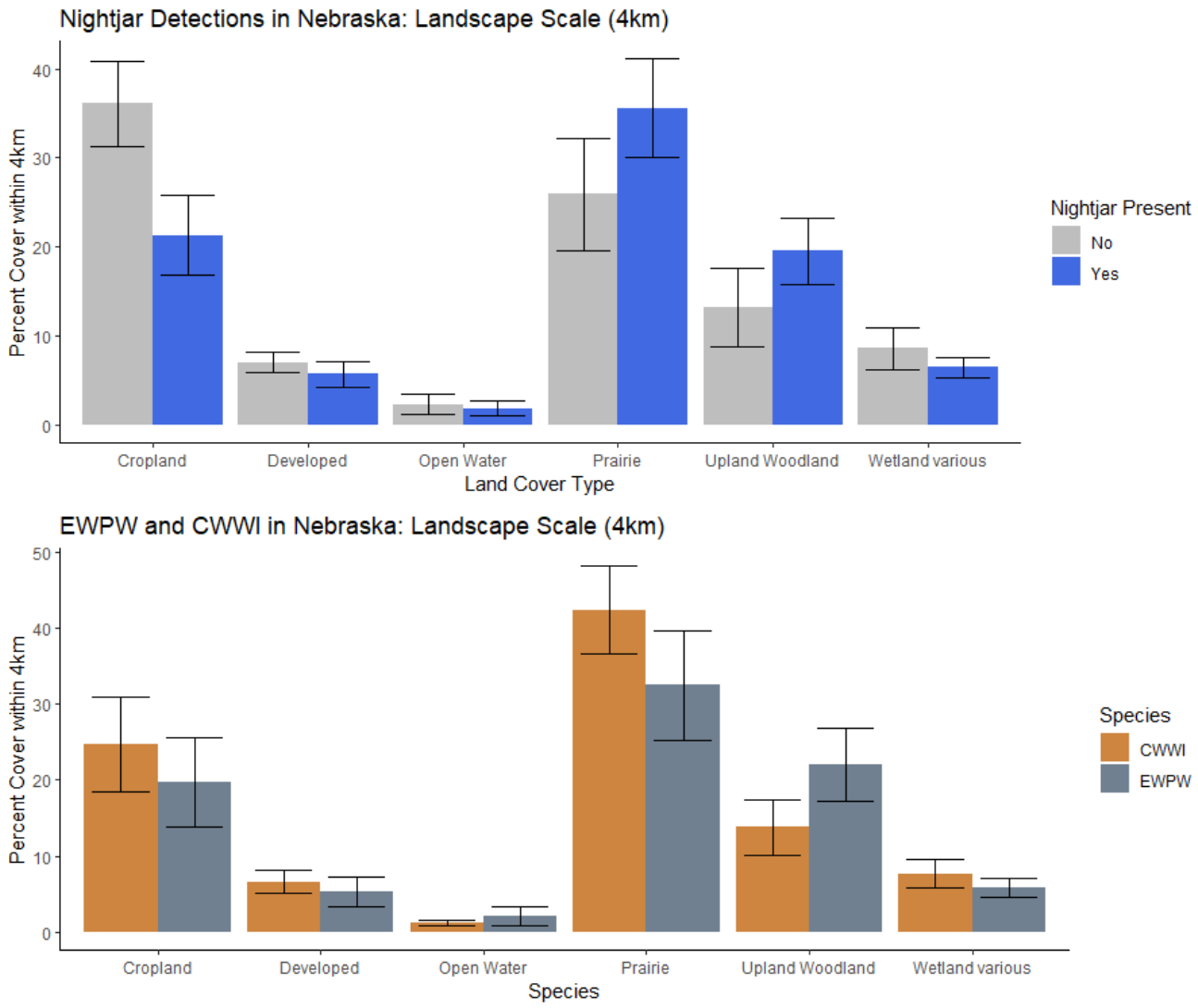

Figure 5. Percent land cover between survey stops where at least one nightjar was detected and survey stops that did not detect any nightjars (upper); and percent land cover between stops that detected Chuck-will's-widow (CWWI) and stops that detected Eastern Whip-poor-will (EWPW, lower). Land cover was measured as percent area within circles with a 4 km radius.

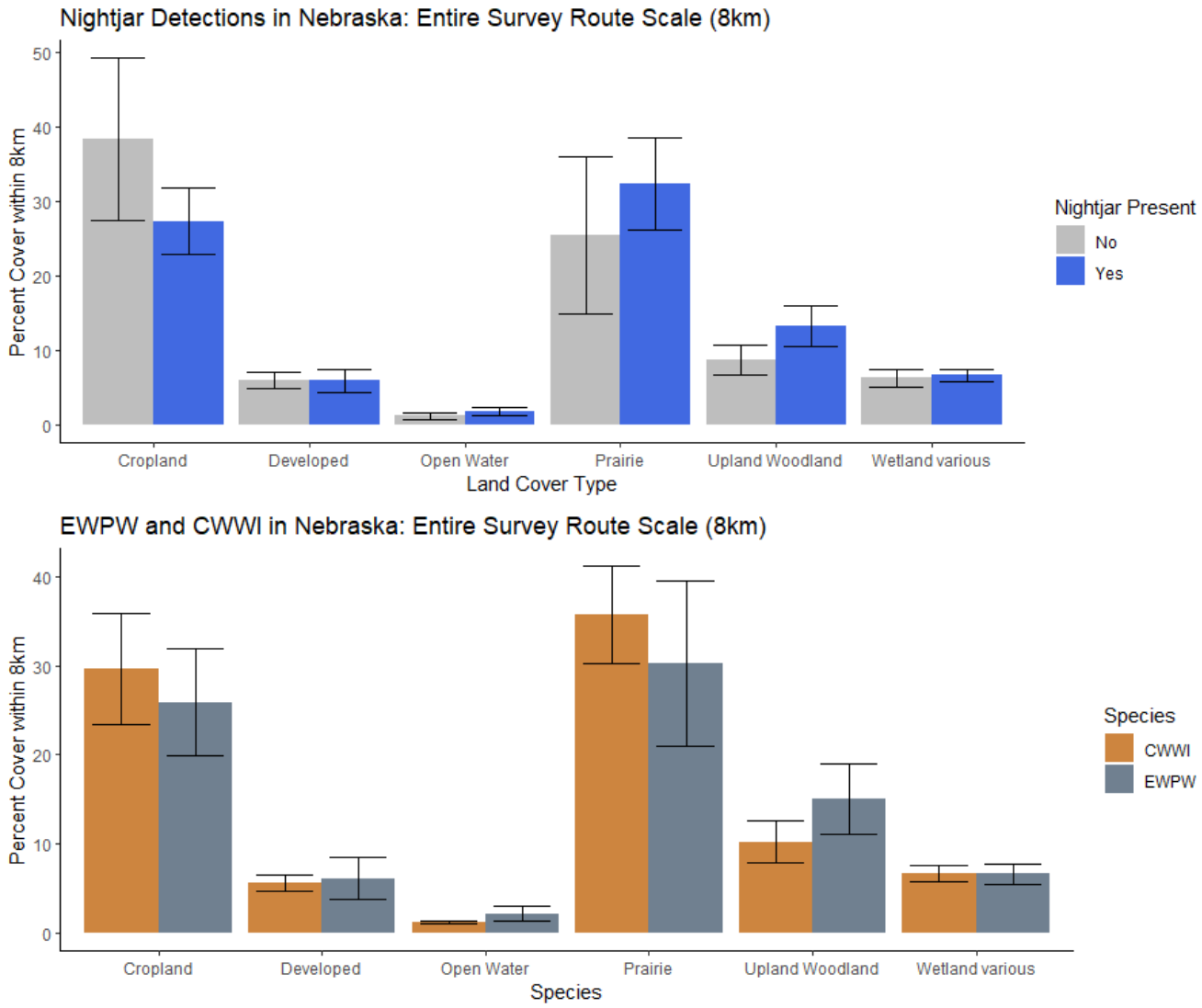

Figure 6. Percent land cover between survey stops where at least one nightjar was detected and survey stops that did not detect any nightjars (upper); and percent land cover between stops that detected Chuck-will's-widow (CWWI) and stops that detected Eastern Whip-poor-will (EWPW, lower). Land cover was measured as percent area within circles with an 8km radius.

Table 2. GLM results and model comparison of percent land cover at four different scales where nightjars were detected and where nightjars were not detected. Values in () are beta estimates for each land cover type. * denotes significant ($p<0.05$) impact on probability of nightjar presence. Bolded are highest ranking models by AIC testing for each scale.

Model Scale	Parameter Estimates	AIC
500 m (Home Range Scale)	**Croplands (-0.014),*Upland Woods(0.057), Prairie (0.002), Wetlands (0.005)**	**919.5**
	*Croplands (-0.019),*Upland Woods(0.059)	1151.3
1 km (Immediate Landscape)	***Croplands(-0.026),*Upland Woods(0.059), Prairie (0.015), Wetlands (0.018)**	**1432.7**
	*Croplands(-0.041),*Upland Woods(0.04)	1560
4 km (Landscape)	***Croplands(-0.089), Upland Woods (0.06), Prairie (0.034), Wetlands (-0.172**)	**59.5**
	*Croplands(-0.103), Upland Woods(0.019)	59.9
	Prairie(0.04), Wetlands (-0.08)	71.1
8 km (Entire Route)	**Croplands(-0.065), Upland Woods(0.146)**	**30.6**
	Croplands (-0.014), Upland Woods (0.315), Prairie (0.085), Wetlands (0.537)	32.1
	Upland Woods(0.069), Wetlands (-0.141)	69.0

Incidental Observations

We detected a total of 46 owls of four different species during our counts. We detected 32 Barred Owls (*Strix varia*), 11 Great-horned Owls (*Bubo virginianus*), 1 Eastern Screech-Owl (*Megascops asio*), and 2 Northern Saw-whet Owls (*Aegolius acadicus*). The Northern Saw-whet Owl detections were of particular interest, as this species is a scarce breeder within the state outside of the western panhandle (Silcock and Jorgensen 2018c). The region where these birds were recorded (middle Niobrara River valley, Keya Paha and Brown counties) has long-suspected to have breeding activity, but no previous breeding-season detections have been recorded.

Although not the focus of this study, Common Nighthawks were most abundant in the late afternoon and crepuscular time periods throughout the study area. Cherry County, June 2019. Photo by Stephen J. Brenner

DISCUSSION

Our initial results conform with what is generally known about each species' distribution within the state and their overall habitat requirements. CWWI clearly have a stronghold in the southeastern portion of the state but are likely sparse and irregular elsewhere, even in areas with apparently suitable woodland habitat. The results from our surveys match with the distribution as presented by the Birds of Nebraska – Online (Silcock and Jorgensen 2018a). EWPW appear to be more abundant along the major river corridors and have a much wider distribution than CWWI in Nebraska. Overall, nightjars were detected in areas with more woodland habitat and less agricultural and human development. While there were some differences between the amount of land cover between points with CWWI and EWPW at the 500 m and 1 km scales, much of what we observed would be expected at smaller spatial scales, particularly at the home range scale (500 m). These habitat associations have been documented before in both species, with CWWI exhibiting more tolerance toward agricultural landscapes and EWPW occupying areas with larger tracts of woodland (Cink et al. 2017).

The extent and impact of interspecific interactions between EWPW and CWWI in Nebraska remains inconclusive to negligible, as we detected both species at only 8 of 53 points where nightjars were present (15%). However, we detected both species on 8 of the 16 (50%) routes where birds were present (Fig 2), and at least three of the routes that detected only EWPW were in areas where CWWI is considered locally rare or casual (e.g. middle Niobrara region and Saunders county; Silcock and Jorgensen 2018a). Thus, it is likely that the general habitat preferences and landscape-level habitat associations are relatively similar for both species in the state.

Occurrence and management implications in Nebraska

Most of the 2019 surveys occurred in areas where both species have been detected previously. However, by monitoring systematically and incorporating land cover data and habitat associations, we have a much higher confidence of the range, distribution, and numbers of each species in Nebraska in these areas.

At the route scale (8 km radius), there were no significant differences of any land cover category between areas with birds and areas without. This is likely due to the relative uniformity at such a large scale and the high likelihood that cropland would be the dominant land cover type anywhere in eastern Nebraska. Additionally, our routes were initially established around areas with minimum areas of upland woodland to support nightjars, which would naturally create similarities in land cover amongst all routes. Lastly, our largest spatial scale (area of circle with 8 km radius = 20,000 ha) is likely too large to be of biological relevance to our focal species. Generally, a relevant landscape size is anywhere between 4-9 times larger than the average dispersal distance of a species (Jackson and Fahrig 2012). Dispersal distances in nightjars are largely unknown and average home range sizes for EWPW vary, averaging 2.8-11.5 ha in some studies (Cink et al. 2017) to 22-75 ha in other studies with maximum reports up to 282 ha (Wilson 2003). Thus, we could consider any areas ranging from 28 ha – 2,540 ha as potentially relevant landscape sizes. Given this wide variation in home range estimates, our analysis at the 1 km (314 ha) and 4 km (5,000 ha) scales encompass the most extreme estimates of landscape size for both species of nightjars, and our analysis at the 500 m scale (area of circle with 500 m radius = 78.5 ha) encompasses most average estimates of home range size for EWPW.

Recent literature suggests EWPW are impacted by both local and landscape-level habitat composition. In West Virginia, EWPW were more likely to occupy areas of low-elevation mixed forests, edges, and were influenced by landscape factors ~2 km from their location (Slover and Katzner 2016). Our results agree with previous studies and suggest that the landscapes surrounding suitable but limited oak woodlands in Nebraska could be impacting the distribution and abundance of EWPW and CWWI. Specifically, the suitability of a woodland is likely to decrease if it is in a landscape dominated by row crop agriculture.

This is an important finding that has potentially important implications for both of these species at the edge of their ranges. We found EWPW at most surveys that had large amounts of woodland habitat, but this species also appears limited by cropland and will likely not expand given that much of the eastern portion of Nebraska is dominated by agriculture (Schneider et al. 2011). Additionally, as CWWI populations are also declining in their core range but expanding in parts of their northern and western range edges, we would expect CWWI populations to expand in Nebraska. However, we did not detect any CWWI outside of the southeastern portion of the state. We recognize we may have missed a few individuals in the northern or central portion of the state during the survey period or in areas we did not survey where CWWI are known to occasionally occur (i.e. Dakota and Cedar counties). However, we would still expect individuals of an expanding population to be present annually in most areas of suitable habitat, versus irregular occurrences at low numbers in isolated pockets.

There was no difference between the amount of cropland within 4 km at points that detected CWWI and at points that detected EWPW, indicating a similar lack of settlement in landscapes dominated by agriculture. While woodlands are essential for EWPW and CWWI, percent cropland had more impact than woodland cover on nightjar presence at the 4 km scale in all models (Table 2). Our results indicate that these woodlands must also be in the proper landscape context in order to be used by nightjars. This puts

an increased importance on large oak woodland tracts in the southeastern portion of Nebraska, particularly in wooded areas surrounded by prairies.

Future Directions

We will continue surveys in 2020 using the same protocols from this year. Site selection will be refined and we will focus on areas that were not surveyed in 2019. Specifically, we plan to establish points in area that would be considered outside of the current known range of CWWI and EWPW in Nebraska, but in areas where landscape context and available woodland habitat appear to meet the minimum requirements of the species. Certain areas that were surveyed in 2019 may be resampled again in order to account for any bias associated with counts that were conducted at the extreme early and late ends of the survey period.

ACKNOWLEDGEMENT

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LITERATURE CITED

Akresh. M.E. and D.I. King. 2016. Eastern Whip-poor-will breeding ecology in relation to habitat management in a Pitch Pine-Scrub Oak barren. Wildlife Society Bulletin. 40: 97-105.

Bishop, A., J. Liske-Clark, and R. Grosse. 2009. Nebraska landcover development. Great Plains GISPartnership, U.S. Fish and Wildlife Service, Grand Island, Nebraska, USA.

Blackburn, T.M., K.J. Gaston, R.M. Quinn, and D. Gregory. 1999. Do local abundances of British birds change with proximity to edge range? Journal of Biogeography. 26: 493-505.

Brigham, R. M., J. Ng, R. G. Poulin, and S. D. Grindal. 2011. Common Nighthawk (*Chordeiles minor*), version 2.0. In The Birds of North America (A. F. Poole, Editor). Cornell Lab of Ornithology, Ithaca, New York, USA. https://doi.org/10.2173/bna.213

Brown, J.H., D.W. Mehlman, and G.C. Stevens. 1995. Spatial variation and abundance. Ecology 76: 2028-2043.

Cink, C.L., P. Pyle, and M.A. Patten. 2017. Eastern Whip-poor-will (Antrostomus vociferus), version 3.0. In The Birds of North America (P. G. Rodewald, Editor). Cornell Lab of Ornithology, Ithaca, New York, USA. Retrieved from Birds of North America: https://birdsna.org/Species-Account/bna/species/whip-p1

Duckworth, R.A. and A.V. Badyaev, 2007. Coupling dispersal and aggression facilitates the rapid range expansion of a passerine bird. Proceedings of the National Academy of Sciences. 104: 15017-15022.

Jackson, H.B. and L. Fahrig. 2012. What size is a biologically relevant landscape? Landscape ecology. 27: 929-941.

Jorgensen, J.G., L.R. Dinan, M.A. Brogie, W.R. Silcock, J. Rink, C. Klaphake, and G. Steinauer. 2014. Breeding Bird Diversity, Abundance and Density at Indian Cave and Ponca State Parks, Nebraska 2012-2014. Nongame Bird Program of the Nebraska Game and Parks Commission, Lincoln, Nebraska, USA.

Mollhoff, W.J. 2016. The Second Nebraska Breeding Bird Atlas. Bull. Univ. Nebraska State Museum Vol 29. University of Nebraska State Museum, Lincoln, Nebraska, USA.

Nauman, E. D. 1925. The Whip-poor-will: its prospects of survival in southern Iowa. Wilson Bulletin 37: 203-206.

R Core Team 2018. R: A language and environment for statistical computing. R Foundation for Statistical Computing. Vienna, Austria. <https://www.R-project.org/>.

Ryan, K.C., Knapp, E.E., Varner, J.M., 2013. Prescribed fire in North American forests and woodlands: history, current practice, and challenges. Frontiers in Ecology and the Environment 11: e15–e24.

Sauer, J. R., D. K. Niven, J. E. Hines, D. J. Ziolkowski, Jr, K. L. Pardieck, J. E. Fallon, and W. A. Link. 2017. The North American Breeding Bird Survey, Results and Analysis 1966 - 2015. Version 2.07.2017 USGS Patuxent Wildlife Research Center, Laurel, Maryland, USA

Schneider, R., K. Stoner, G. Steinauer, M. Panella, and M. Humpert. 2011. The Nebraska Natural Legacy Project: State Wildlife Action Plan 2nd ed. Nebraska Game and Parks Commission, Lincoln, Nebraska, USA.

Silcock, W.R., and J.G. Jorgensen. 2018a. Chuck-will's-widow (*Antrostomus carolinensis*), Version 1.0. In Birds of Nebraska —Online. www.BirdsofNebraska.org

Silcock, W.R., and J.G. Jorgensen. 2018b. Eastern Whip-poor-will (*Antrostomus vociferus*), Version 1.0. In Birds of Nebraska — Online. www.BirdsofNebraska.org

Silcock, W.R., and J.G. Jorgensen. 2018c. Northern Saw-whet Owl (Aegolius acadicus), Version 1.0. In Birds of Nebraska — Online. www.BirdsofNebraska.org

Slover, C.L. and T.E. Katzner. 2016. Eastern Whip-poor-wills (Antrostomus vociferous) are positively associated with low elevation forest in the central Appalachians. Wilson Journal of Ornithology 128: 846-856.

Straight, C.A. and R.J. Cooper. 2012. Chuck-will's-widow (Antrosomus carolinensis), version 2.0. In The Birds of North America (A. F. Poole, Editor). Cornell Lab of Ornithology, Ithaca, New York, USA. https://doi.org/10.2173/bna.499

Wilson, M.D. 2003. Distribution, abundance, and home range of the whip-poor-will (*Caprimulgus vociferus*) in a managed forest landscape. Master's Thesis: The College of William and Mary, Virginia, USA.

Woods, C. P., Csada, R. D. and R. M. Brigham. 2005. Common Poorwill (*Phalaenoptilus nuttallii*), version 2.0. In The Birds of North America (A. F. Poole, Editor). Cornell Lab of Ornithology, Ithaca, New York, USA. https://doi.org/10.2173/bna.32