Range limits and habitat associations of Eastern Whip-poor will (*Antrostomus vociferous*) and Chuck-wills-widow (*Antrostomus carolinensis*) across eastern Nebraska

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Nongame Bird Program

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Cover photo: Eastern whip-poor will at Great Swamp Management Area, Rhode Island - May 2017. Photo by Stephen J. Brenner

An important step in effectively conserving species of concern is defining their distributions and habitat associations. Eastern Whip-poor-will (*Antrostomus vociferous*; EWPW) and Chuck-will's-widow (*Antrostomus carolinensis*; CWWI) are insectivorous birds whose breeding ranges cover much of eastern North America. Similar to other nightjars, both species are primarily active at night. EWPW and CWWI sing loudly between dusk and dark and consequently, are more often heard than seen. During the day, both species roost on or near the ground and each is cryptically-colored and are rarely detected by observers. Because of their behavior and life history, both species are infrequently and inconsistently detected by observers and by traditional avian monitoring programs such as the Breeding Bird Survey (BBS). As a result, less is known about EWPW and CWWI's abundance, distribution, habitat use and demographics throughout their range compared to more visible avian species. This is especially the case in less populated areas with fewer observers or areas that have not been formally surveyed. Both of these circumstances apply to most of Nebraska and, as a result, the distribution of nightjars in the state is poorly known.

EWPW is the more northerly of the two species, breeding in deciduous and mixed woodlands from northern Alabama and Mississippi to southern Canada west to the eastern Great Plains (Cink et al. 2020). In Nebraska, EWPW breeding range includes the extreme southeast, Missouri, lower Platte and lower Niobrara river corridors (Silcock and Jorgensen 2020a). EWPW are species of conservation concern because populations have declined across their range over the past 50 years. 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 reductions in food resources (insects) due to pesticides may also be a factor (Cink et al. 2020).

CWWI occurs in similar habitat as EWPW. CWWI breeding range is restricted to the southeastern United States (Straight and Cooper 2020). Nebraska is at the northern periphery of the species' breeding range and it is primarily restricted to southeastern part of the state (Silcock and Jorgensen 2020b). CWWIs apparently expanded their range into Nebraska during the mid-20th Century (Silcock and Jorgensen 2020b). 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.

Defining the distribution of CWWI and EWPW is important because the species status in the state are poorly known, both species are conservation priorities and because Nebraska lies on the northwest fringe of the CWWI range and the western edge of EWPW range (Silcock and Jorgensen 2018a, 2018b). In 2019, we surveyed a large swath of the known ranges of these species within the state. We completed over 200 point count surveys. We successfully determined habitat associations of nightjars in the state, and confirmed the presence and abundance of EWPW and CWWI in areas of the state with assumed breeding individuals. Following this work, we establish survey points in areas that were outside of the current known regular range of CWWI and EWPW in Nebraska (as defined by Silcock and Jorgensen 2020a, 2020b), but where landscape context and available woodland habitat appear to meet the minimum requirements of the species (Brenner and Jorgensen 2019). The main objectives for this project in 2020 were to survey landscapes with relatively large tracts of oak woodland outside of the known ranges of CWWI and EWPW in Nebraska and to confirm/revise with additional survey points and modeling the habitat and land cover associations of EWPW and CWWI occurrence throughout eastern Nebraska.

METHODS

Route Selection

The primary objective for a second year of surveys was to determine the extent of the ranges of CWWI and EWPW in Nebraska. We conducted most surveys in 2019 in or around areas where the species were previously detected or known to occur. Most of these areas were not formally or systematically surveyed before 2019, and thus the abundance and extent of nightjar occurrence within these areas was largely unknown. Building on our results from 2019, we planned surveys during 2020 in areas outside of the known breeding ranges of these species and at locations where nightjars have not been documented, but which have similar landscape and habitat compositions and are in relatively close proximity to known areas of occurrence.

We identified survey areas by creating a relative probability of use map for focal nightjars (EWPW and CWWI) in eastern Nebraska. We used coefficients from the top-performing landscape-level models using data collected in 2019 on existing landcover data to create a predictive map (Fig 1). We extracted land cover percentages within 4km^2 units from a series of 2,000 random locations in eastern Nebraska. These values were used with the 2019 model to obtain relatively probability values of nightjar presence across the study area. We included only a small portion of the area surveyed in 2019 in this predictive model as a coarse visual validation of the relative probabilities produced from our model. We then placed routes in blocks of higher relative probability (> 0.25) that were also logistically feasible to survey. Within these higher probability blocks, we placed specific point locations along roads that were closest to any wooded areas.

Survey Protocol

We followed the general methodology of the Nightjar Survey Network (http://www.nightjars.org). We conducted point counts on moonlit nights during the time of the breeding season with the highest moon brightness (2020 study period: 30 April —14 May, 29 May – 13 June). All surveys began 30 minutes after sunset and ended at least 30 minutes before sunrise. We conducted between 5-11 counts along each survey route, with stops separated by at least 1.6 kilometers. At each stop, observers 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 remained the focus of this study and are the only species used in statistical analysis.

Statistical Analysis

We followed the data preparation procedures and modeling techniques from the previous nightjar report (Brenner and Jorgensen 2019). Briefly, we used generalized linear models (GLMs) with 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

used the highest ranked GLM models from the 2019 analysis (Brenner and Jorgensen 2019) to analyze land cover impact on nightjar presence at the two most relevant spatial scales: 1km and 4km. At both scales, model coefficients included percent cover of upland woodland, cropland, wetland, and prairie.

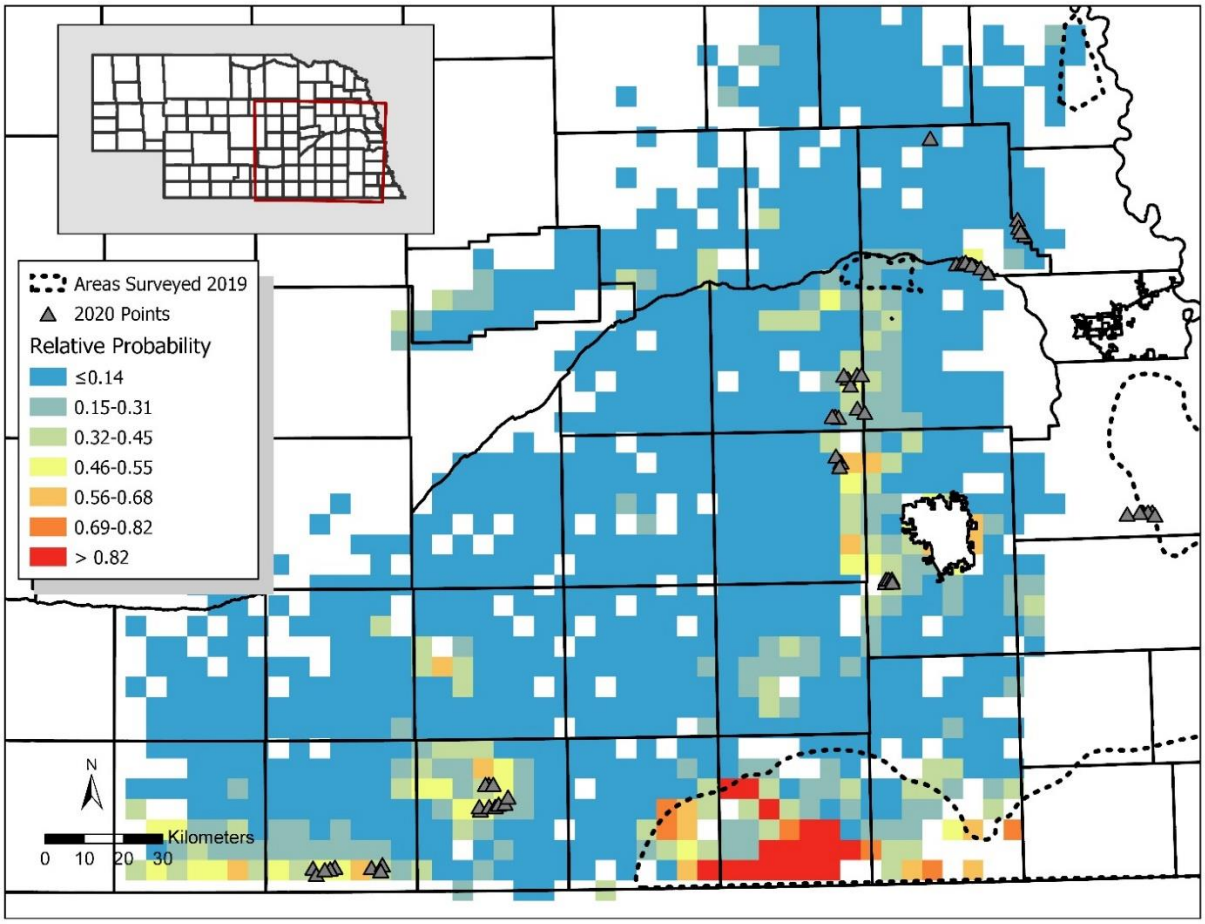

Figure 1. Location of 2020 surveys (gray triangles) layered over predicted focal nightjar probability based on 2019 survey results.

RESULTS

We completed a total of 52 points between 6 May – 8 June. We detected only EWPW at 4 points (7.7% of counts) and had 48 points with no detections. We detected 4 EWPW in total. Additionally, we had one observation of CONI during our surveys (Table 1). We did not detect any nightjars in counties where birds had not been detected in 2019. Our limited detections came in areas in close proximity (< 12 km) to previous nightjar reports or known breeding areas.

Table 1. Total detections by species and highest count at one route during 2020 nightjar surveys.

Species	Total Detections	Highest Single Route Count (County)
Eastern Whip-poor-will (*Antrostomus vociferous*)	4	2 (Seward)
Chuck-will's-widow (*Antrostomus carolinensis*)	0	-
Common Nighthawk (*Chordeiles minor*)	1	1 (Lancaster)
Common Poorwill (*Phalaenoptilus nuttallii*)	0	-

Landcover coefficients for the 1km and 4km GLM models did not change dramatically once data from 2020 was added to the analysis. All land cover coefficients that had a positive or negative influence on focal nightjar presence remained either positive or negative with the inclusion of the 2020 surveys. Overall, the likelihood that either of the focal nightjar species was present increased with the amount of upland woods, prairie and wetlands within 1km, and decreased with increasing amounts of croplands within 1km. At the larger landscape level, nightjar likelihood increased with increasing amounts of upland woods and prairie within 4km, and decreased with increasing amount of cropland and wetland cover at the same scale.

Table 2. Highest-ranking models of percent land cover at two different scales where nightjars were detected and where nightjars were not detected in 2019 and 2020. Values in () are beta estimates for each land cover type. * denotes significant ($p<0.05$) impact on probability of nightjar presence.

Model Scale	Parameter Estimates	Year
1 km (Immediate Landscape)	*Croplands(-0.026),*Upland Woods(0.059), Prairie (0.015), Wetlands (0.018)	2019
	*Croplands(-0.018),*Upland Woods(0.061), *Prairie (0.024), Wetlands (0.025)	2020
4 km (Landscape)	*Croplands(-0.089), Upland Woods (0.060), Prairie (0.034), Wetlands (-0.172)	2019
	Croplands(-0.050), *Upland Woods(0.112) *Prairie(0.071), Wetlands (-0.114)	2020

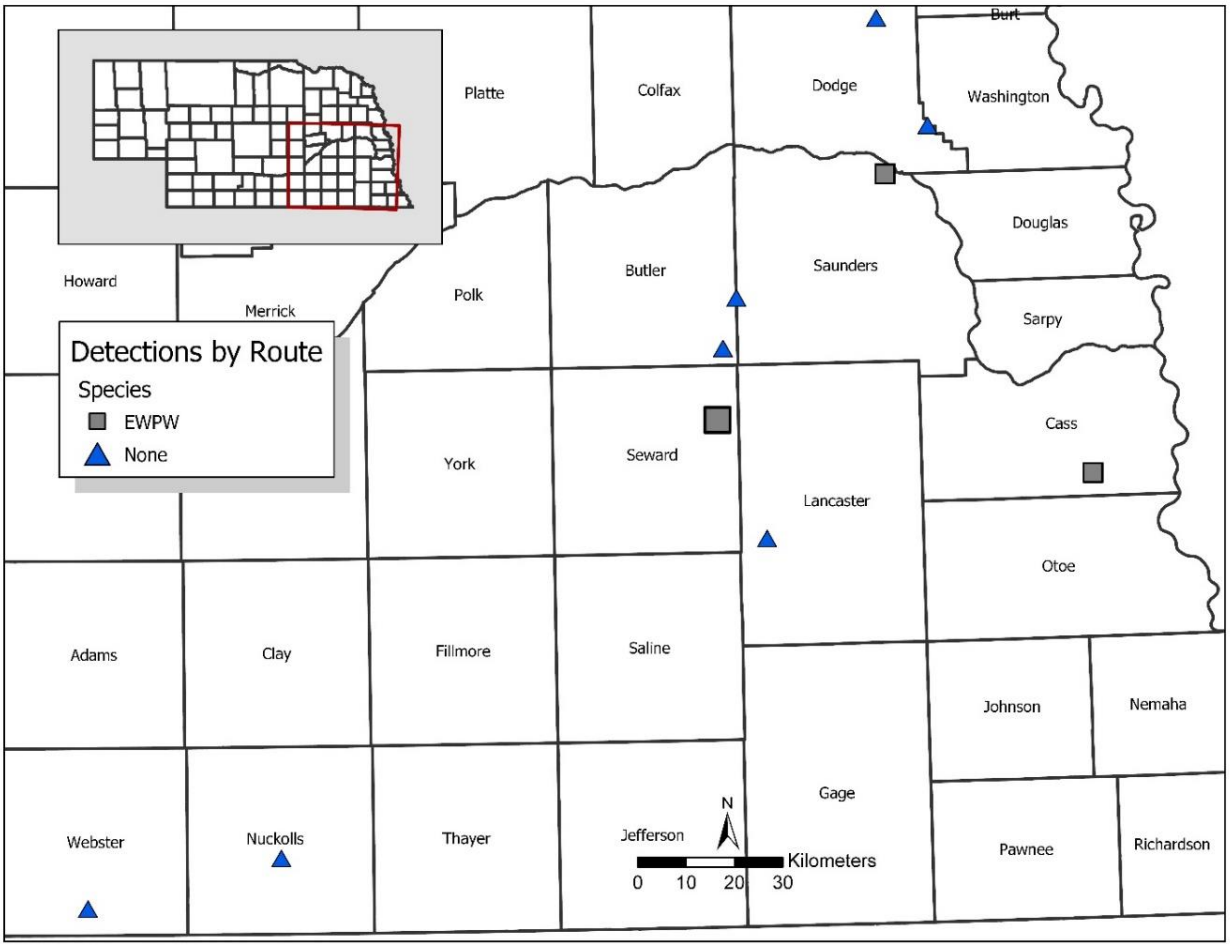

Figure 2. Results from each route of nightjar surveys in 2020. Symbols cover the general locations of route points and are not exact to detections/non-detections.

Incidental Observations

We detected 18 owls of three different species during our counts. We detected 12 Barred Owls (*Strix varia*), four Great-horned Owls (*Bubo virginianus*) ,and two Eastern Screech-Owls (*Megascops asio*).

DISCUSSION

Our objective for this field season was to confirm or expand our knowledge of the range and distribution of EWPW and CWWI in Nebraska. Ultimately, we did not encounter any nightjars in areas that were away from locations where birds were detected in 2019. However, the lack of detections in new regions still provides valuable data on the distribution of these species in the state. By surveying in low-probability or previously unsurveyed areas, we defined with greater confidence the true range of these species in the state. Furthermore, this also allows us or others to make conclusions about range expansions by nightjars into these regions, if they were to occur in the future. We cannot fully exclude the possibility that we simply failed to detect nightjars in these areas due to some unknown error. However, we find this outcome unlikely given the consistency with which multiple surveys by multiple individuals failed to detect any birds in several extralimital areas.

Despite many of the 2020 surveys producing no nightjar detections, the additional surveys provided data that was used to refine our models for land cover associations on nightjar presence in the state. While the model coefficients and our understanding of the system did not alter given the presence of new data, this should also serve as a confirmation of the known patterns of nightjar occurrence in Nebraska. The likelihood that a nightjar will occupy suitable habitat declines with increasing row-crop agriculture on the landscape, both on an immediate (1 km) and landscape (4 km) scale. Additionally, we reinforced the importance of woodland, prairie, and wetland cover to EWPW and CWWI presence on the 1 km scale, and the importance of woodland and prairie on the 4 km scale. The impact of the amount of upland woods on the 4km scale increased in the most recent iteration of our models, both in the near doubling of the coefficient value and it now being a significant term in the model (Table 2).

Recent research on nightjars in Ontario, Canada also found that larger forested patch sizes, wetlands, and limited agriculture on the landscape is associated with increased EWPW occupancy (Vala et al. 2020). These findings align with our results, particularly on the 1 km scale, with the only exception being wetland cover had a non-significant negative impact at the large (4 km) landscape scale for nightjar presence in our area. This is likely because we combined EWPW and CWWI detections in our analysis, which would also explain the larger impact that prairie cover had in our system on nightjar presence. Also, both EWPW and CWWI likely benefit from open spaces within a landscape for foraging (Akresh and King 2016, Straight and Cooper 2020, Vala et al. 2020), and in eastern Ontario and boreal forest regions, wetlands are a more predominate land cover type compared to grasslands. In the Great Plains, grassland cover far exceeds that of wetlands, and thus both types of habitat are providing similar resources for nightjars in the different regions. Furthermore, both nightjars are primarily restricted to upland deciduous woodland in Nebraska, areas where natural wetlands typically do not occur. Ultimately, analysis in both northeastern forests and from our work in the Great Plains confirm landscape-level impacts on nightjars and the overall importance of intact and continuous tracts of woodlands in these systems, particularly within agricultural landscapes.

After two years of extensive surveys across the eastern portion of the state, we have made progress understanding the extent of nightjar distribution in Nebraska. The stronghold for both CWWI and EWPW is in the southeast portion of the state, particularly in areas with extensive woodlands with ample prairie and grasslands. EWPW are also quite numerous along the central Niobrara river, extending westward to the far eastern portion of Cherry county. While smaller numbers of each species occur in other pockets of the region, the potential expansion of either species is likely limited extensively by habitat availability. However, our coverage of these areas in northern Nebraska was limited in 2019 and 2020 due to flooding impacts and restrictions caused by the COVID-19 pandemic, respectively. Additional surveys in these areas could provide needed information about EWPW abundance.

Our analysis found clear associations with not only large tracts of upland woodland (a naturally uncommon habitat in the state), but with forested areas in landscapes with limited row-crop agriculture. These habitat and landscape-related associations have been observed in other areas for EWPW (Vala et al 2020), but also explain our inability to detect birds outside of southeastern Nebraska. Despite the presence of suitable (albeit limited) wooded areas along the Republican river in southern Nebraska, these areas were either a) not extensive or large enough to support nightjars or b) too far west to have been colonized by breeding individuals or c) a combination of both factors. We still expect wayward individuals to occur in this region and even further west at habitat remnants far from the current range (Harlan county reservoir, Swanson reservoir), but do not expect regular breeding to occur at these locations.

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