Filling in key knowledge gaps in the ecology of grassland birds that winter in New Mexico

Chestnut-collared Longspur by Alyssa DeRubeis

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Bird Conservancy of the Rockies

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Executive Summary

During winter 2024–2025, we investigated winter habitat use, site persistence, and spring migration patterns of priority grassland bird species in eastern New Mexico, focusing on Chestnut-collared Longspurs (*Calcarius ornatus*) and Grasshopper Sparrows (*Ammodramus savannarum*). Fieldwork took place within two priority habitats identified in New Mexico's State Wildlife Action Plan, the Great Plains Shortgrass Prairie and the Chihuahuan Semi-Desert Grassland, at The Nature Conservancy's Milnesand Prairie Preserve and Bitter Lake National Wildlife Refuge.

We deployed 40 radio transmitters (30 CTT hybrid-powered, 10 Lotek battery-powered) on captured birds, including 39 Chestnut-collared Longspurs (10 females, 29 males) and one Grasshopper Sparrow. Overall, 25 tagged birds (63%) were subsequently detected by 39 unique Motus receiver stations across the central flyway. Detection rates were higher for CTT tags (70%) than for Lotek tags (40%). Detection rates between sexes differed as a function of age class for CTT tags; young males (in the second year age class) were detected for more days than were young females, but the opposite pattern held true for older birds (i.e., older females [in the after second year age class] were detected for more days than were older males).

Winter site persistence varied among individuals, with some birds detected regularly for more than a month at the Motus station nearest to the banding site and others detected intermittently. Spring migration commenced as early as mid-March, with arrivals on breeding grounds by mid-April. Males migrated earlier than females, and younger males departed earlier than older males. Migration routes included both a western path through the Texas Panhandle and an eastern route through central Kansas and Nebraska. A notable concentration of detections occurred in the northeastern Texas Panhandle, suggesting strong migratory connectivity at that location; detections elsewhere were more diffuse.

These findings demonstrate the value of automated radio telemetry for understanding nonbreeding-season ecology and migration dynamics of grassland birds. The data help to elucidate regional and seasonal patterns of use of critical overwintering areas, in addition to temporal and spatial patterns of migration. This information can help guide conservation planning for declining grassland bird populations across the full annual cycle.

Acknowledgements

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Introduction

Populations of grassland birds have declined 53% since the 1970s, more than any guild of North American avifauna (Rosenberg et al. 2019). Decreases are particularly steep for species such as Sprague's Pipit (*Anthus spragueii*), Thick-billed Longspur (*Ryncophanes mccownii*), Chestnut-collared Longspur (*Calcarius ornata*), and Baird's Sparrow (*Centronyx bairdii*) which have experienced population losses of up to 90% (Sauer et al. 2017). This suite of declining grassland birds winter in the Chihuahuan Desert of the southwestern United States and northern Mexico. Steep declines are thought to be driven by grazing mismanagement, shrub encroachment, increased drought, and unregulated conversion to agriculture (Pool et al. 2014). Unfortunately, the migratory and wintering (nonbreeding) ecology of these species is still poorly studied, particularly at a landscape scale. As such, vital information about migration ecology and connectivity has been highlighted as a need in multiple conservation planning documents including the U.S. Fish & Wildlife Service (USFWS) Full Annual Cycle Grassland Bird Conservation Plan (Somershoe 2018) and Chihuahuan Desert Grassland Bird Conservation Plan (Pool et al. 2012). In order to conserve grassland bird populations, full annual cycle approaches that can characterize stopover sites, occupancy dynamics, movement patterns, track survival, and identify migratory connectivity are still needed (Drum et al. 2015, Somershoe 2018).

The Motus Wildlife Tracking System (Motus; http://www.motus.org) consists of a network of automated radio telemetry stations which can detect and log the locations of animals tagged with lightweight coded radio transmitters as they pass within range of a station (i.e., ~15-kilometer radius; Taylor et al. 2017). The use of this technology is flexible as well as collaborative; a small-scale network of Motus stations can autonomously gather positions on tagged birds in a pasture or restoration site, and stations can be installed across a larger region by multiple researchers to accurately track nomadic movements within a season or large-scale movements throughout the annual cycle. Motus can help fill identified critical information gaps by enabling researchers to characterize animal migration phenology, identify key stopover locations, estimate migratory connectivity, and quantify seasonal estimates of survival.

On the nonbreeding grounds, Motus can inform patterns of within-season movement and habitat use, which is vital given that grassland birds respond dynamically to variations in precipitation and vegetation. The goal of this study was to document winter site use, migration timing, and migratory connectivity of priority grassland bird species in eastern New Mexico. Between January and May 2025, we deployed radio transmitters on overwintering grassland birds and tracked their movements using Motus. By comparing detections among sexes and age classes, and mapping detections across the migration corridor, we aimed to identify patterns in residency, departure timing, and stopover use. These results address critical knowledge gaps in the nonbreeding ecology of grassland birds in the southern Great Plains and will help guide targeted conservation actions for these rapidly declining species.

Methods

Study Area

The study was conducted in eastern New Mexico within two priority habitat types identified in New Mexico's State Wildlife Action Plan (NMDGF 2016): the Great Plains Shortgrass Prairie (M053) and the Chihuahuan Semi-Desert Grassland (M087). These open grassland systems are characterized by low-growing native grasses, scattered shrubs, and a climate of hot summers and cold, dry winters. The Nature Conservancy's Milnesand Prairie Preserve, one of the focal sites for this study, protects a large expanse of intact shortgrass prairie. The Bitter Lake National Wildlife Refuge (NWR), another study site, encompasses a mosaic of desert grasslands, wetlands, and riparian habitats along the Pecos River. Each study site hosts one of BCR's many Motus receiver stations: GPCD Milnesand Prairie Preserve (https://motus.org/data/receiverDeployment?id=10150), and GPCD Bitter Lake (https://motus.org/data/receiverDeployment?id=9827).

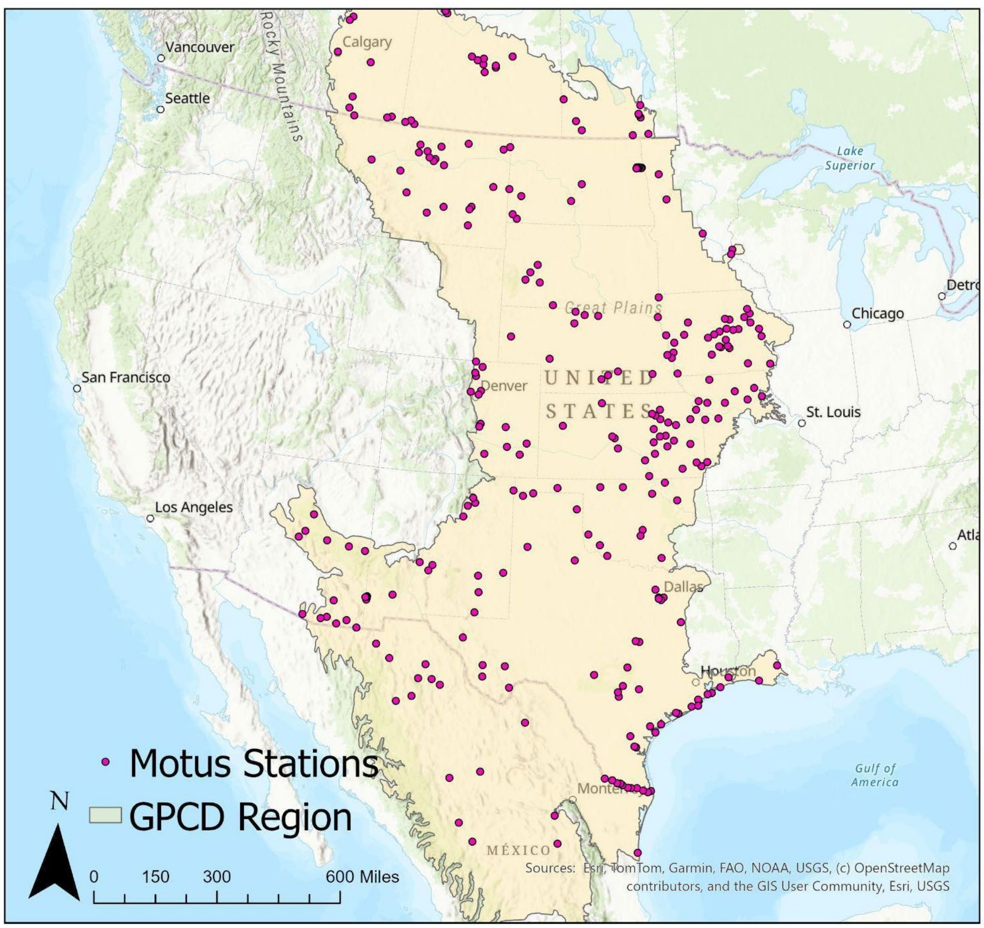

Figure 1. The Great Plains-Chihuahuan Desert ecoregion. Points show the locations of Motus receiver stations within the region.

Tag Deployment

During December 2024-February 2025, our field crew attempted to capture birds within grassland and shrubland habitat at Milnesand and Bitter Lake NWR with the intent to tag individuals with Motus transmitters. We used multiple mist-netting techniques based on experience and knowledge of each species' distinct behaviors. This included active flush-netting, a technique where multiple field technicians or volunteers form a semi-circle up to 200m away from two or more 12m-long mist nets. This capture team walks slowly flushing birds towards the nets. We used props like bamboo poles to disturb grass and bamboo or livestock flags and brightly colored fabric discs to redirect birds in flight and reduce the number of target birds that escape the flush net zone. To capture longspurs, we placed mist nets near water sources such as cattle ponds. We used 2.6m tall mist-nets with 30-36mm black mesh, supported with ½ in galvanized steel poles set on rebar temporarily driven into the ground and/or staked to guy lines. Immediately following the bird capture event, all rebar was removed immediately; all holes were filled in as possible; and any disturbed rocks and woody debris were placed back in their original locations.

After capture, we removed each bird from the net and placed the bird in a cloth bag in a quiet location buffered from direct sun or wind. We banded each bird with a uniquely numbered United States Geological Survey aluminum band, collected data on bird size (wing and tail length) and condition (fat, mass), and collected feather samples for inclusion in the Bird Genoscape Project at Colorado State University. We outfitted the individuals with a lightweight (~.6g) coded radio tag, either Lotek NanoTags (model # NTQB2-5-1) transmitting at 166.380MHz, or Cellular Tracking Technologies (CTT) HybridTags transmitting at 434MHz. We attached the tags to birds using a figure-eight leg loop harness (Rappole and Tipton 1991) of 1mm nylon-coated elastic or "Stretch Magic" plastic thread, depending on the transmitter type. We fitted birds with custom-sized harnesses to minimize movement, restriction, entanglement in vegetation, or transmitter loss. We used a square knot with a crimp bead to secure the loose ends of the harness before clipping the free ends of the material. Birds were not tagged if all materials, including aluminum bands, exceeded 3-4% of the birds' body weight. Birds were processed and then released within ~200m of their capture location. Immediately post-release, all tagged individuals were observed to ensure that they demonstrated strong flight.

All capture, banding, tagging, and sample collection occurred under Bird Conservancy of the Rockies' Federal Bird Banding Permit #22415 and New Mexico Department of Game and Fish Scientific Permit #3864. In addition, all banding protocols were reviewed and approved by Bird Conservancy's Institutional Animal Care and Use Committee.

Data Collection, Filtering, and Visualization

Whenever a tagged bird passed within range of a Motus receiver station, the station recorded a detection. The detection data were automatically uploaded via WiFi or cellular connectivity to Motus servers for storage and processing. We downloaded data from the Motus servers using the motus R package (version 6.1.1; Birds Canada 2024) and R (version 4.4.2; R Core Team 2024) on July 25, 2025.

We verified metadata downloaded from Motus by checking it against our banding data spreadsheet to check for any data entry errors, and then resolved any discrepancies.

We filtered detections using a custom R script, following guidelines outlined in the Motus R package documentation. Motus detections are grouped into “runs”, which consist of a series of consecutive detections of a tag recorded on a single antenna at a single receiver station. Very short runs have a high probability of being false positive detections. We discarded any detections with a run length of less than two for CTT tags, and less than four for Lotek tags to remove any false positives. We also discarded detections that occurred prior to the time of tag deployment or that occurred outside of the known ranges of the tagged species. We visually inspected a map of detections for each bird to check for any additional implausible detections.

We plotted detections using the ggplot2 R package (version 3.5.1; Wickham 2016). We processed spatial data using the sf R package (version 1.0-19; Pebesma 2024) and produced maps using the Leaflet R package (version 2.2.2; Cheng 2024).

Results

Tag Deployment and Detections

At Bitter Lake NWR, we scouted suitable grassland areas, but were unable to capture any of the target species. At Milnesand Prairie Preserve, we successfully deployed 40 tags on two species of grassland birds (Table 1). We captured and tagged 39 Chestnut-collared Longspurs and one Grasshopper Sparrow (Figure 2), including 10 female and 29 male longspurs. Twenty-seven of the longspurs were older adults (i.e., in at least their second winter or older), nine were younger adults (i.e., in their first winter), and three were adults for which we were unable to determine a finer-scale age class. The Grasshopper Sparrow was an adult of unknown fine-scale age and unknown sex.

For a complete breakdown of tags deployed, including species, tag type, date of deployment, and number of receivers by which the tag has been detected, please visit the Motus website at https://motus.org/data/projectTags?id=747.

Figure 2. An adult Grasshopper Sparrow (photo by Trenton Voytko).

We deployed 30 hybrid-powered tags (CTT) and 10 battery-powered tags (Lotek). Twenty-five (63%) of the individuals were later detected by Motus automated receiver stations, all of which were Chestnut-collared Longspurs (Table 1, Table 2). The birds were detected by 30 unique receivers, averaging two receivers per bird. We detected birds for an average of 8 days each, ranging from 0 to 19 days detected (Table 1). We detected more tags manufactured by CTT (21 out of 30, 70%) compared to Lotek (4 out of 10, 40%), and the CTT tags resulted in more detections (average of 287 detections per bird compared to 59 for Lotek). The CTT tags were detected by slightly more stations (average of 3.8 stations per bird compared to 3.3 for Lotek).

The average number of days on which each individual was detected was lower for Lotek tags compared to CTT tags, regardless of age (Figure 3). For CTT tags, males and females were detected for a similar number of days only for birds in the after-second-year age class, and females were detected on fewer days than were males for the other age classes. In particular, the difference was striking for second year birds, where males were detected more than double the number of days as females were.

Table 1. Number of tags deployed on grassland priority birds in eastern New Mexico during winter 2024-2025 and subsequent detections.

Species	Age	Sex	Manufact-urer	Tags Deployed	Tags Detected (%)	Total Detections	Detections per Tag (Average)	Days Detected (Average)	Receivers Which Detected Birds (Total)	Receivers Which Detected Birds (Average)
Chestnut-collared Longspur	After Hatch Year	F	CTT	1	1 (100%)	191	191.0	13.0	2	2.0
Chestnut-collared Longspur	After Hatch Year	M	CTT	1	1 (100%)	379	379.0	19.0	4	4.0
Chestnut-collared Longspur	After Hatch Year	M	Lotek	1	1 (100%)	93	93.0	3.0	6	6.0
Chestnut-collared Longspur	After Second Year	F	CTT	5	3 (60%)	1749	583.0	11.7	13	4.3
Chestnut-collared Longspur	After Second Year	M	CTT	17	13 (76%)	2847	219.0	8.9	23	1.8
Chestnut-collared Longspur	After Second Year	M	Lotek	5	1 (20%)	61	61.0	1.0	2	2.0
Chestnut-collared Longspur	Second Year	F	CTT	3	1 (33%)	21	21.0	4.0	1	1.0
Chestnut-collared Longspur	Second Year	F	Lotek	1	0 (0%)	0	0.0	0.0	0	0.0
Chestnut-collared Longspur	Second Year	M	CTT	3	2 (67%)	659	329.5	11.4	7	3.5
Chestnut-collared Longspur	Second Year	M	Lotek	2	2 (100%)	46	23.0	1.0	3	1.5
Grasshopper Sparrow	After Hatch Year	U	Lotek	1	0 (0%)	0	0.0	0.0	0	0.0
Total				40	26 (63%)	6046	211	8.1	30	2.9

Table 2. Summary of birds detected by the Motus network as of July 25, 2025.

Age classes include ASY: after second year; SY: second year; and AHY: after hatch year. Fat was scored using the following rubric: 0 = no fat; 1 = Trace (<5%); 2 = Light (5-33%); 3 = Half (33-66%); 4 = Filled (66-100%).

Species	Tag ID	Deploy Date	Age	Sex	Date of First Detection	Date of Last Detection	Number of Days Detected	Number of Days Between First and Last Detection	Number of Detections	Number of Receivers Which Detected This Individual	Bird Mass (g)	Fat Score	Wing Chord (mm)	Tag Manufacturer
Chestnut-collared Longspur	82785	1/26/25	ASY	F	4/8/25	4/11/25	2	75	500	4	19.8	2	84	CTT
Chestnut-collared Longspur	83247	1/26/25	ASY	M	2/16/25	4/21/25	8	85	511	4	19.9	1	84	CTT
Chestnut-collared Longspur	83262	1/26/25	ASY	M	1/29/25	1/29/25	1	3	8	1	18.7	0	80	CTT
Chestnut-collared Longspur	83545	1/26/25	ASY	M	2/9/25	4/23/25	10	87	296	6	20	2	88	CTT
Chestnut-collared Longspur	82782	1/27/25	ASY	M	3/9/25	4/23/25	8	86	349	6	20.1	1	85	CTT
Chestnut-collared Longspur	82979	1/27/25	SY	F	2/2/25	3/6/25	4	38	21	1	19.2	2	80	CTT
Chestnut-collared Longspur	83044	2/4/25	ASY	F	2/26/25	5/4/25	18	89	1012	8	19.5	3	80	CTT
Chestnut-collared Longspur	83312	2/4/25	ASY	F	3/2/25	4/20/25	5	75	237	4	20.4	2	79	CTT
Chestnut-collared Longspur	82787	2/4/25	ASY	M	3/1/25	4/1/25	8	56	137	2	20.6	1	85	CTT
Chestnut-collared Longspur	82797	2/4/25	ASY	M	2/16/25	4/11/25	6	66	163	4	20	2	82	CTT
Chestnut-collared Longspur	83035	2/4/25	ASY	M	2/9/25	4/27/25	10	82	215	4	19.3	1	84	CTT
Chestnut-collared Longspur	82802	2/4/25	SY	M	2/10/25	4/12/25	5	67	307	4	19.1	1	83	CTT
Chestnut-collared Longspur	82744	2/8/25	ASY	M	3/7/25	4/29/25	8	80	436	6	19.7	3	84	CTT
Chestnut-collared Longspur	82780	2/9/25	ASY	M	4/8/25	4/8/25	1	58	41	2	19.4	1	83	CTT

Species	Tag ID	Deploy Date	Age	Sex	Date of First Detection	Date of Last Detection	Number of Days Detected	Number of Days Between First and Last Detection	Number of Detections	Number of Receivers Which Detected This Individual	Bird Mass (g)	Fat Score	Wing Chord (mm)	Tag Manufacturer
Chestnut-collared Longspur	82793	2/9/25	ASY	M	4/11/25	4/15/25	2	65	155	3	18.6	0	86	CTT
Chestnut-collared Longspur	51776	2/14/25	ASY	M	3/5/25	4/25/25	14	70	268	6	22	3	85	CTT
Chestnut-collared Longspur	82740	2/16/25	AHY	F	2/28/25	4/12/25	13	55	191	2	18.6	0	80	CTT
Chestnut-collared Longspur	82899	2/16/25	AHY	M	2/27/25	4/14/25	19	57	379	4	19.3	0	86	CTT
Chestnut-collared Longspur	84113	2/16/25	AHY	M	4/20/25	4/23/25	3	66	93	6	20.4	1	85	Lotek
Chestnut-collared Longspur	82742	2/16/25	ASY	M	3/5/25	4/16/25	14	59	249	4	19.6	0	81	CTT
Chestnut-collared Longspur	84085	2/16/25	ASY	M	4/12/25	4/12/25	1	55	61	2	19.5	3	85	Lotek
Chestnut-collared Longspur	82982	2/16/25	SY	M	2/25/25	4/25/25	17	68	352	4	18.6	0	79	CTT
Chestnut-collared Longspur	84061	2/16/25	SY	M	4/16/25	4/16/25	1	59	32	1	22.2	4	85	Lotek
Chestnut-collared Longspur	84160	2/16/25	SY	M	4/24/25	4/24/25	1	67	14	2	21.8	3	84	Lotek
Chestnut-collared Longspur	82978	2/17/25	ASY	M	2/25/25	3/18/25	7	29	19	1	19.6	2	86	CTT

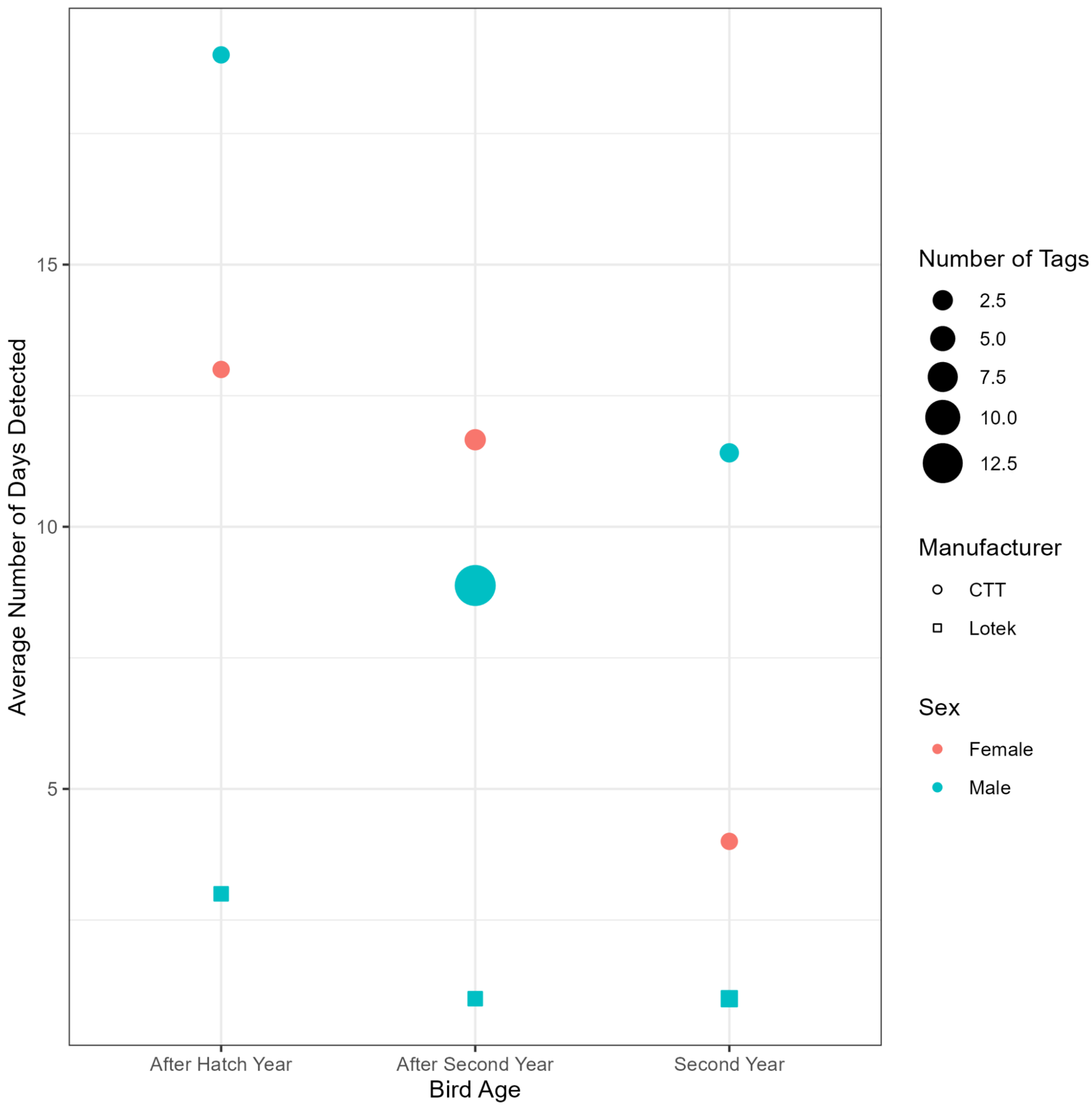

Figure 3. Average number of days that birds were detected by age, sex, and tag manufacturer, scaled by the number of tags in each group.

Age classes include After Hatch Year (an adult bird of undetermined age), After Second Year (an older adult in its second winter or later), and Second Year (a younger adult in its first winter).

Site Persistence

We detected seventeen of the tagged birds at the nearest Motus receiver station, "GPCD Milnesand Prairie Preserve" (Figure 4). All the individuals were detected by antenna L3, a 6-element yagi oriented Northwest towards our main tagging site at 316°. Four individuals were also picked up by additional antennas, including the antennas facing east (96°, three individuals), and Southwest (216°, 2 individuals).

Individuals showed varying patterns of residency in the vicinity of the station, ranging from frequent, regular detections persisting for more than a month, to intermittent, irregular detentions with more than a week in between.

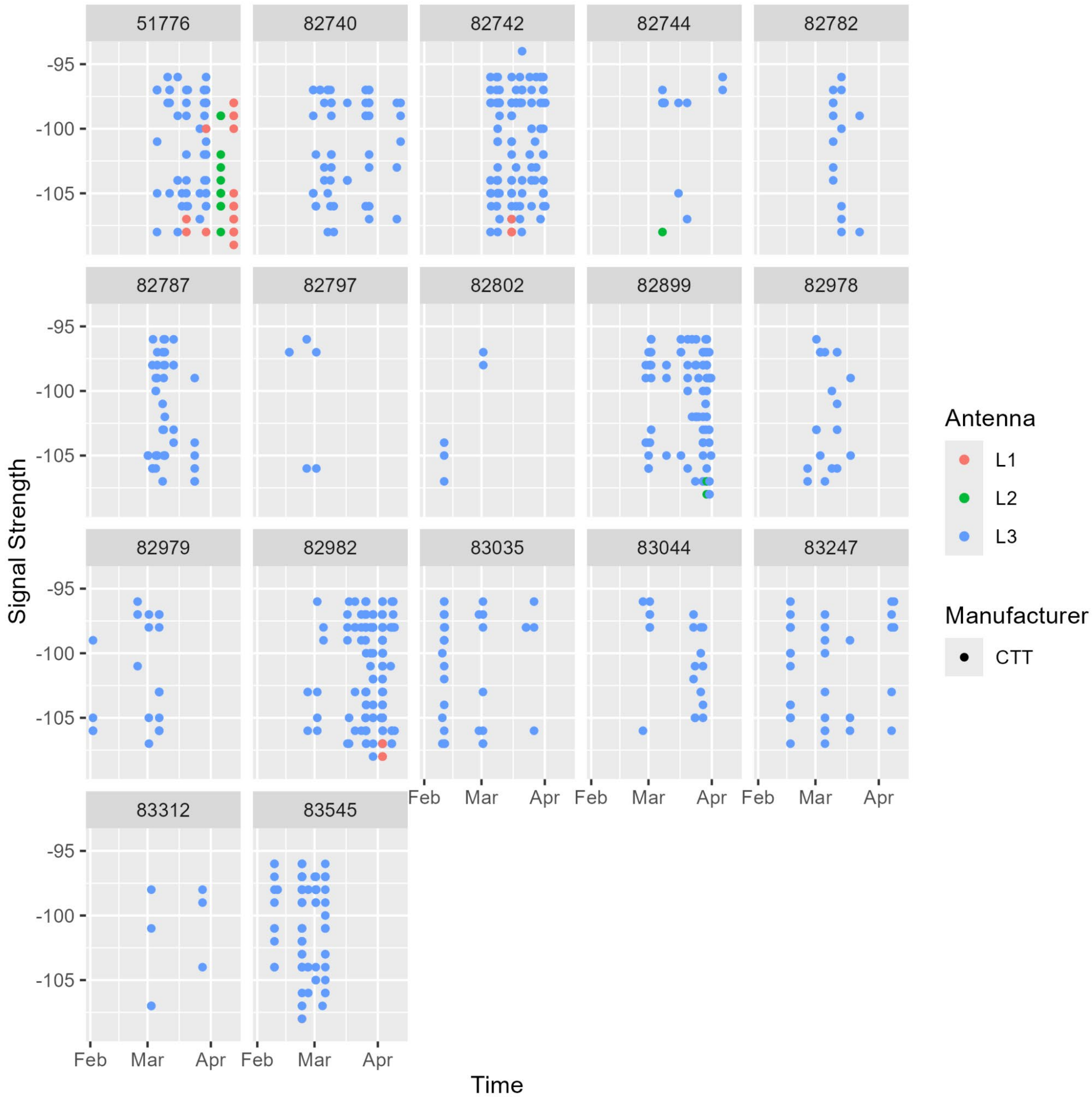

Figure 4. Signal strength of tags detected by the GPCD Milnesand Prairie Preserve Motus Station during late winter-early spring 2025.

Spring Migration

We observed evidence of individuals commencing their spring migration as early as mid-March, and arriving on the breeding grounds as early as mid-April (Figure 5). We observed differences among age and sex classes in the timing of detection at some stations, especially those in Montana. Males were detected earlier than females, and younger males were detected earlier than older males (Figure 5).

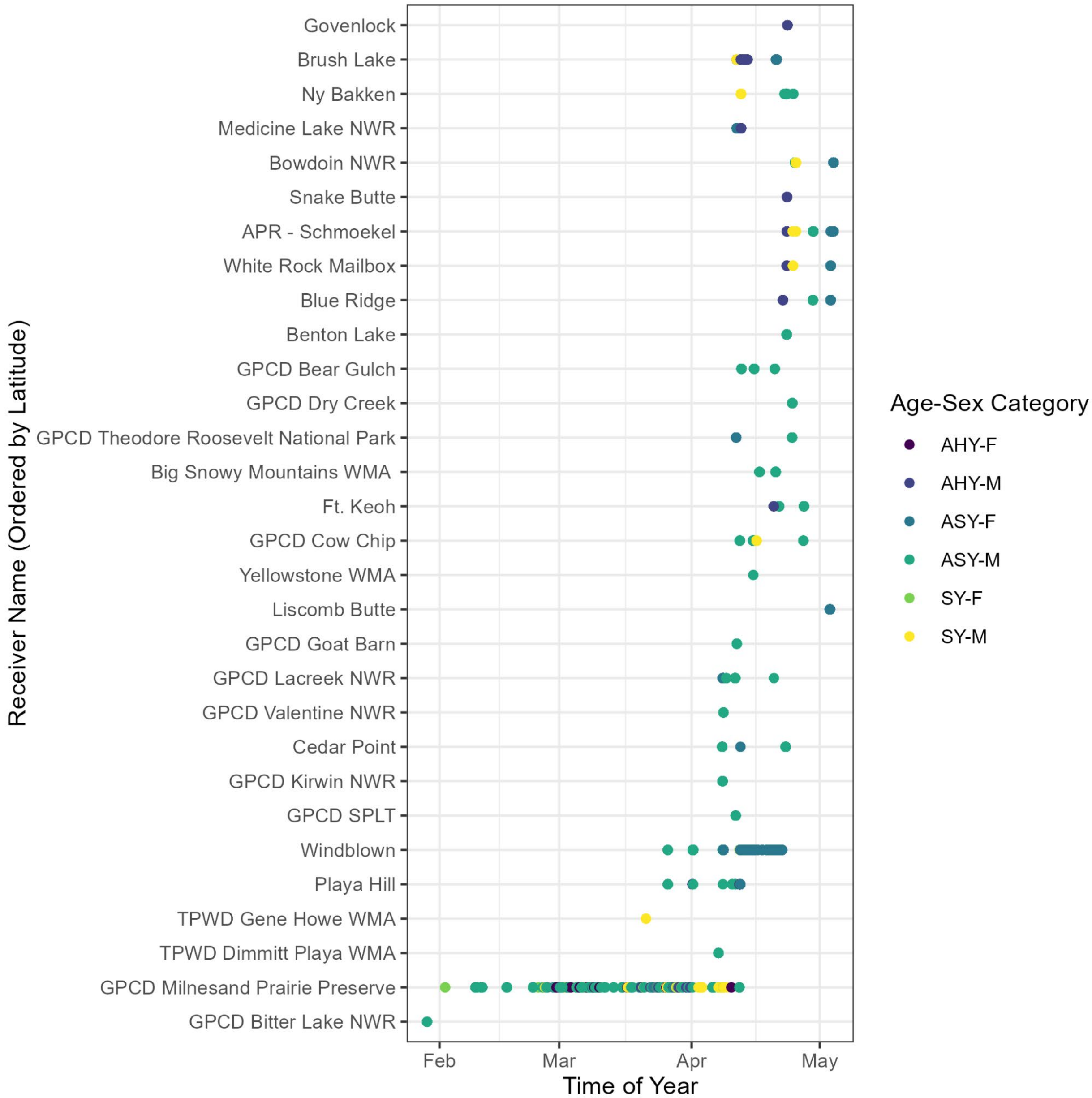

Figure 5. Timing of detection by age and sex class at Motus receiver stations during the northward spring migration journey.

Migration Routes

Following their departure from Milnesand Prairie Preserve, we detected the birds at 30 unique stations during their spring migration (Figure 6). Detections occurred in Texas, Oklahoma, Kansas, Colorado, Nebraska, South Dakota, North Dakota, Montana, and Saskatchewan. Several individuals took a migration path that included the western Texas panhandle, while others were detected taking a more easterly route through central Kansas and Nebraska.

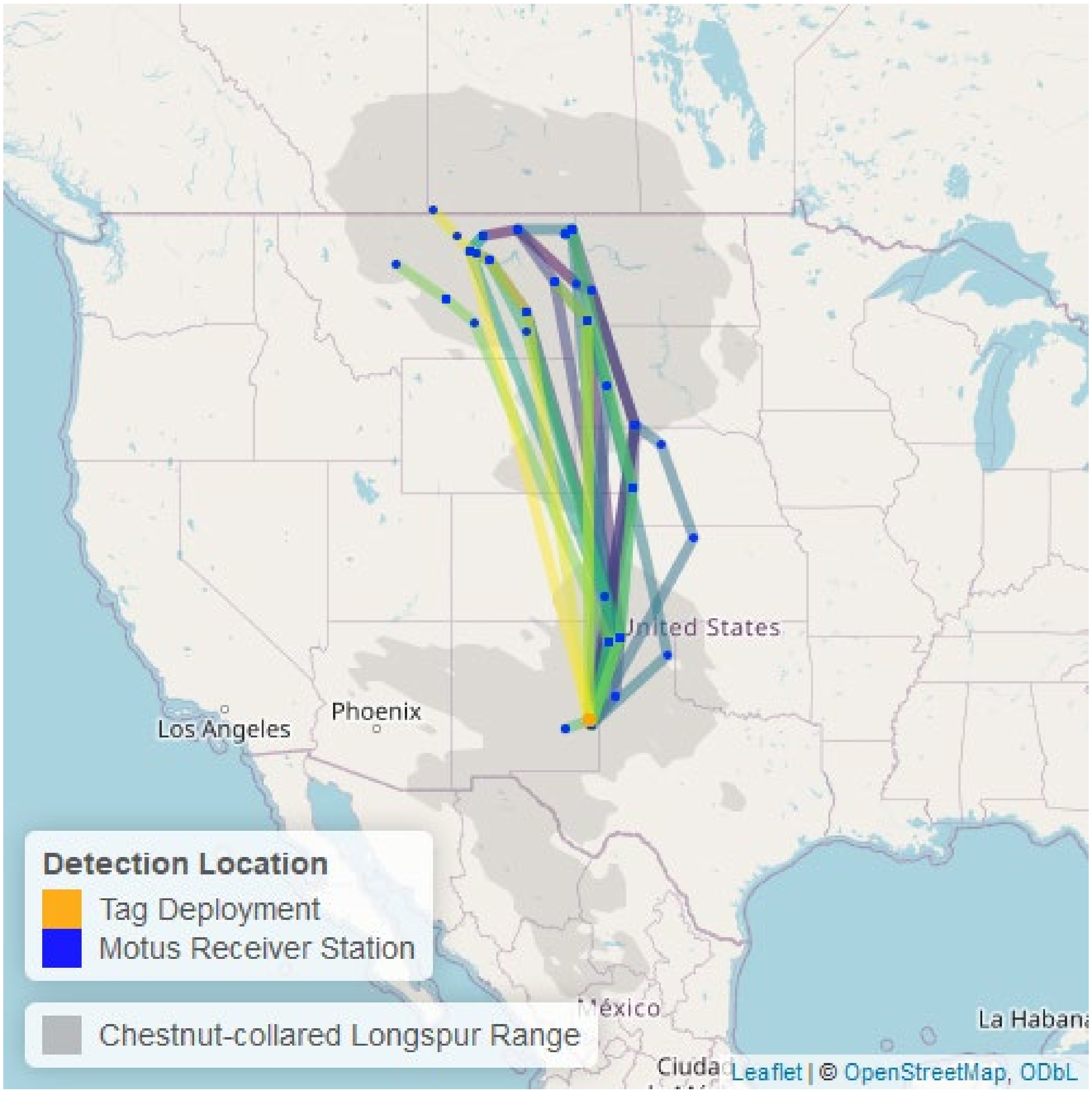

Figure 6. Detections of Chestnut-collared Longspurs during spring migration via the Motus network. The orange dot shows the tag deployment location in eastern New Mexico. Blue dots show the locations of Motus receiver stations which detected the birds. Each colored line connects detection locations for an individual bird; however, these lines do not indicate actual flight paths.

Migratory Connectivity

We detected differing levels of migratory connectivity during the spring migration. Migratory connectivity was strong in the northeastern Texas panhandle, where nearly half (12 out of 25) of the individuals were detected (Figure 7). In contrast, migratory connectivity was diffuse for the remainder of the spring migration, with an average of 2.1 individuals detected at the other stations (range 1-5).

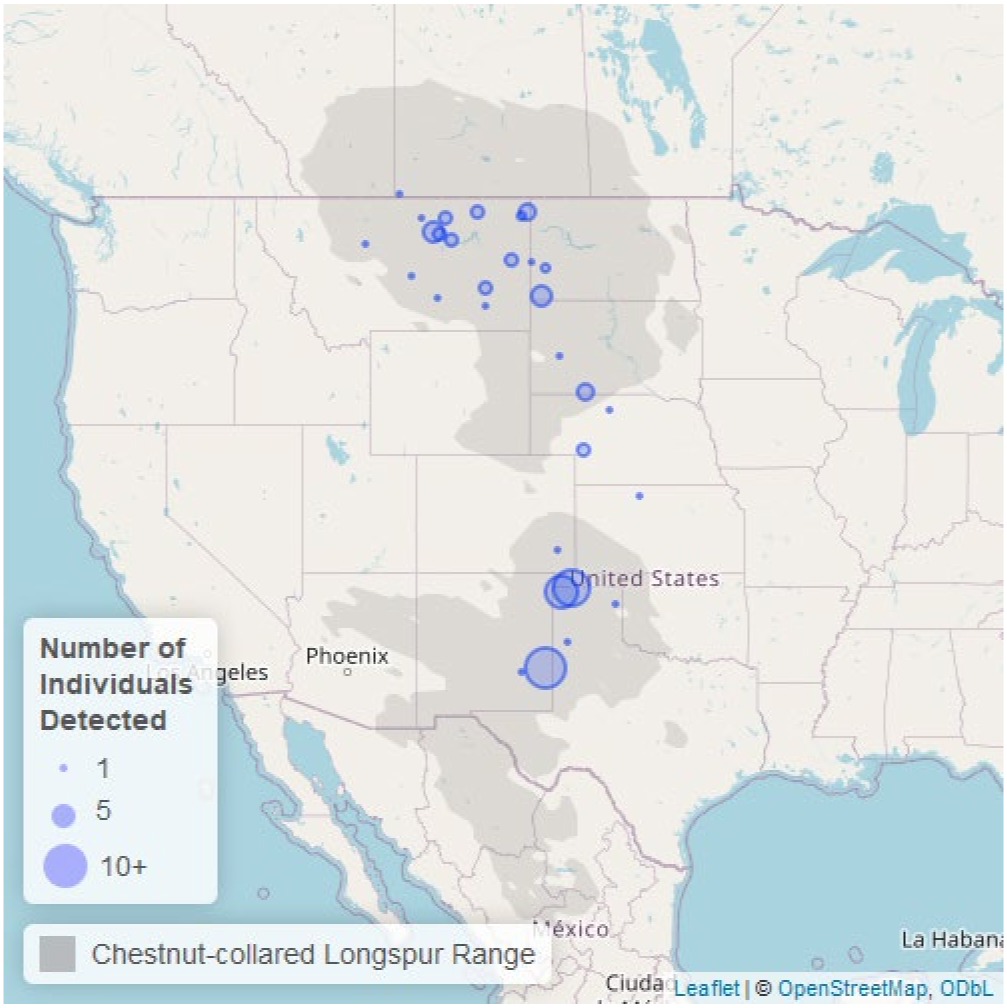

Figure 7. Chestnut-collared Longspur detections during spring migration via the Motus network. Blue circles show the location of Motus receiver stations which detected the birds. The size of each circle is scaled by the number of individuals that each station detected.

Discussion

Our tag deployment and tracking efforts during winter 2024–2025 provided valuable insights into the winter behavior and spring migration patterns of Chestnut-collared Longspurs in eastern New Mexico. Although we were unable to capture birds at Bitter Lake National Wildlife Refuge, the successful deployment of 40 tags at Milnesand Prairie Preserve allowed us to monitor individual movements with a high degree of spatial and temporal resolution.

We originally intended to tag up to 106 grassland birds; however, due to the nomadic nature of wintering grassland birds, we were unable to meet this goal. We began the field season in mid-December and had many days in the field looking for our target species and attempting to capture them. Early on, the species were not present in very high numbers. Through January, numbers slowly increased, and by the end of January, we started having success capturing the birds. This was unexpected for us - we thought we'd be able to capture birds as soon as the field season began. This finding highlights a continued research need to better understand how grassland birds are moving throughout the nonbreeding season. Their movements are complicated by their nomadism not only within a single season, but also from year to year as they use different landscapes depending on grassland condition based on precipitation. ,

The overall detection rate of 65% was encouraging, especially considering the challenges of winter deployments. The performance difference between tag manufacturers was notable. CTT tags outperformed Lotek tags across nearly all metrics, including number of detections, number of receiving stations, and days detected. Given these differences, it is important to account for tag manufacturer when making comparisons among age and sex classes.

Variation in detection rates among age and sex classes suggests biological differences in behavior and movement, potentially influenced by differential survival, stopover dynamics, or migration routes. Among birds with known fine-scale age classes (after second year and second year), the sexes showed opposite patterns depending on age. Second year (younger) males were detected for longer durations than second year females, particularly when tagged with CTT units. For after second year individuals, females were detected for longer durations than males. The stark difference in detection days between age classes as a function of sex suggests sex-based behavioral divergence that warrants further investigation, possibly related to differences in residency duration at stopover sites or migration routes.

We observed strong but intermittent site fidelity to the Milnesand area during winter, with several birds showing persistent detections over extended periods at the nearest Motus receiver. This pattern reinforces the importance of this site as overwintering habitat for the species and supports its continued conservation. However, a number of birds were not detected by the Milnesand station, which suggests that these individuals' core wintering area was outside of the detection range of this station. The pattern of intermittent detections at Milnesand also suggests that these birds were also using the wider landscape. This highlights the importance of conserving and restoring large, intact areas of suitable grassland habitat in southeastern New Mexico in order to fully support wintering grassland bird populations.

Spring migration tracking revealed wide-ranging connectivity across the central flyway, with birds traveling as far as Saskatchewan. While migration routes varied, a notable concentration of detections occurred in the northeastern Texas Panhandle, suggesting this area functions as a key stopover or corridor for northbound migrants. In contrast, the remainder of the route showed diffuse connectivity, indicating broader dispersal across the migration landscape.

Timing of migration was influenced by both age and sex, with males generally migrating earlier than females, and younger males departing earlier than older ones. These patterns may reflect a strategy for early territory establishment on breeding grounds, a behavior documented in other migratory passerines.

Overall, these results demonstrate the utility of the Motus network and miniaturized tag technology for understanding grassland bird ecology. Continued investment in tag deployment, receiver coverage, and multi-year tracking will further illuminate critical aspects of migratory behavior and inform conservation planning across the full annual cycle of these declining species. In particular, denser Motus station arrays across southern and eastern New Mexico coupled with additional tag deployments and surveys can help us better understand nonbreeding season movements, site fidelity, and migratory dynamics.

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