AMERICAN KESTREL WINTERING LOCATION IDENTIFIED USING A GLOBAL POSITIONING SYSTEM DATA LOGGER

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The ability to track animal movements has been integral for answering the most basic and complex of ecological questions. Tracking devices have evolved over time, starting with very high frequency (VHF) units that require field personnel to physically locate and track animals, to transmitters that require communication with cellular towers and cellular phones, to platform terminal transmitters, which provide locations to researchers via a remote, satellite-enabled internet download. As a result of technological advances including reduced overall mass of the device, prolonged battery life, and improved aerodynamic design, tracking devices are now deployed on smaller animals. However, despite these technological improvements, the ratio of transmitter mass to body mass remains an issue when selecting a tracking device with sufficient battery life for small raptors. In the United States, to minimize the potential for negative impacts to tracked birds, researchers typically do not exceed 3% of the body mass of the bird with tracking equipment and the associated harness. Tracking devices for large raptors that are below maximum mass thresholds and have sufficient battery life have long been available for use when research objectives include documenting spatial movements. However, for meeting similar objectives in the study of small raptors, there are few tracking devices that meet these same mass ratio and battery requirements. Low-mass tracking options do exist but they are typically VHF, and battery life is limited to a few weeks. Small VHF transmitters are satisfactory for answering questions over a brief time period, such as seasonal survival (Roth et al. 2005) or to facilitate observations on behavior (Roth and Lima 2007). For researchers wishing to track small migrant raptors throughout their annual cycle, options are still limited.

As part of a research project focused on American Kestrels (Falco sparverius; hereafter “kestrel”) in northwestern Wyoming (Craighead Beringia South 2018), we wanted to identify nonbreeding-season locations for kestrels nesting in Teton County, Wyoming (43°51.216’N, 110°37.884’W). Breeding Bird Survey data show a significant decline of breeding kestrels in Wyoming from 1966 to 2015 (period trend = −1.01, 95% CI = −1.87; −0.10) and in the Northern Rockies Bird Conservation Region (period trend = −1.88, 95% CI = −2.53; −1.21), which includes Teton County (Sauer et al. 2017). Our objectives were to identify the distance kestrels travelled on migration, to identify where kestrels spent the nonbreeding season, and to estimate kestrel winter home-range sizes. Kestrels nesting in Teton County are migratory, but prior to our study, nonbreeding-season locations were unknown.

We trapped kestrels during the 2015 and 2017 nesting seasons using bal-chatri traps (Berger and Mueller 1959), mist nets with a decoy owl (Steenhof et al. 1994), and by hand in nest boxes. Male kestrels typically weigh between 80 and 143 g, whereas females typically weigh between 86 and 165 g (Smallwood and Bird 2002); therefore, we needed a device and harness material that weighed between 2.4 and 5.0 g, and that could be programmed to collect locations a few months after deployment. We used PinPoint 10 Global Positioning System (GPS) data loggers (hereafter referred to as “tags”; Lotek Wireless Inc., Newmarket, Ontario, Canada), which weighed 1.7 ± 0.2 g after they were prepared for use on kestrels. We used 2.5-mm Teflon ribbon for the harness material and attached the transmitters using a backpack-style attachment technique (Buehler et al. 1995) with a leather breast patch and brass ferrules to secure the GPS tag in place. The mass of the harness, breast patch, and brass ferrules was 1.5 g before trimming to fit each captured bird, for a total mass of the tag of 3.0–3.4 g. We measured the mass of all kestrels prior to tag deployment to ensure they met the mass requirements to carry the tags. The PinPoint GPS tags stored locations on the tracking device. Therefore, re-trapping tagged individuals was necessary to retrieve the movement data. To relocate tagged individuals, we searched territories where kestrels were captured, and we searched surrounding territories during the 2016–2018 breeding seasons. After we downloaded the data, we used

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the adehabitatHR package in R (Version 3.4.2, R Core Team 2017) to estimate minimum convex polygons (MCP) to represent nonbreeding-season home range.

When we purchased the GPS tags in 2015, they possessed battery life for approximately 18 locations. We programmed the tags to record two locations in November and December, six locations in January and February, and eight locations in March and April for a total of 32 potential locations. We programmed this unequal distribution of locations across months because we wanted to capture potential movement throughout the nonbreeding season but, with the limited battery life, focus on gathering locations during what we considered the peak nonbreeding season in January and February. We considered March and April bonus months and did not expect to receive any locations but wanted to use any remaining battery power, so we programmed the tags to collect 8 locations per month.

We deployed five GPS tags during the 2015 nesting season and an additional four during the 2017 nesting season. Three of the GPS tags were deployed on males and six were deployed on females. We did not deploy any tags during the 2016 nesting season because we wanted to confirm the tags deployed in 2015 functioned properly and were resilient to potential biting by kestrels. We deployed six GPS tags on breeding kestrels using nest boxes and three on kestrels using natural cavities. We targeted kestrels nesting in boxes to increase our probability of recapture, but we had low nest-box occupancy rates in 2015, so we also captured birds using natural cavities. We chose natural-cavity-nesting kestrels for GPS tags at random from a pool of 16 in our study area.

In 2016, we visually relocated two kestrels with GPS tags, one male and one female, and we recaptured the male but were unable to capture the female. Both relocated individuals nested in natural cavities. The male was recaptured in the same territory it had used the year prior, and the female was within a territory where we deployed a GPS tag during the year prior. We did not relocate any individuals with GPS tags in 2018. The GPS tag that we recovered had 16 total locations spanning 103 d beginning 4 November 2015 and ending 15 February 2016. All locations from the GPS tag were located in the state of Guerrero, 124.0 km southwest of Mexico City, Mexico, which is straight-line distance of 2970.8 km from the bird’s breeding territory (Fig. 1). The estimated wintering MCP of the tracked kestrel was 0.02 km².

Using tracking devices to identify long-distance movements made by small raptors remains difficult despite many advances in tracking technology. We successfully used a programmable device to obtain GPS-quality data from a migrant kestrel. The information that we collected represents the first confirmed kestrel migrating from breeding grounds in Wyoming, and the first confirmed kestrel breeding in Wyoming to have spent the nonbreeding season in Mexico. Between 1960 and 2016, there were approximately 325,000 kestrels banded in North America, including 761 from Wyoming (Peterjohn and Nakash 2017). Of the 325,000 banded kestrels, 14 that were banded during summer months (i.e., the breeding season) were recovered in Mexico during winter months (i.e., the nonbreeding season), none of which were kestrels banded in Wyoming (Peterjohn and Nakash 2017). However, banding data have shown an apparent relationship between kestrels born or nesting in the western United States and wintering in Mexico (Peterjohn and Nakash 2017), which our tracking data support. Despite the challenges of relocating and recapturing kestrels in our study, the precision and quality of the location data were much better using GPS tags than relying on band recoveries alone.

In addition to identifying the location where the kestrel spent the nonbreeding season, the GPS tag also allowed us to estimate nonbreeding-season home-range size. The nonbreeding-season home-range estimate we acquired from the tracked kestrel was very small. We were restricted to estimating the home range using only 16 locations; however, these locations were acquired over 103 d. Although we would prefer more locations to estimate home-range size, we note that 15 locations were sufficient to estimate the home-range size of breeding Swainson’s Warblers (Limnothlypis swainsonii; Anich et al. 2009); thus our home-range estimate may provide an accurate assessment of nonbreeding-season space use for this American Kestrel. There is very little information on kestrel home-range or territory sizes, especially using tracking data of any kind, let alone during the nonbreeding season. Through direct observation, breeding territory sizes have been estimated as 0.24 km² (Bowman et al. 1987) and 0.82 km² (Smith et al. 1972), although 1 km² is often used to describe breeding-season home-range size (Miller and Smallwood 1997, Brown et al. 2014). We are not aware of any estimates of nonbreeding-season home-range size.

Overall, the constraints of battery life and the difficulty of relocating and recapturing kestrels made the success of our overall effort somewhat disappointing. The technology provided by the PinPoint tags was adequate in gathering location data and the tags resisted the abuse of at least two of the nine kestrels we outfitted. We are unsure whether the birds with GPS tags that we did not recapture died, nested elsewhere, or simply shed the tag. Although all territories were occupied the year following tag deployment, we did not have the resources to attempt capture of birds in territories where GPS tags were deployed but tags were not seen the following year to assess whether the territory occupants were banded. In one case, we did capture a female nesting in a box where a GPS tag was deployed the year prior and it was a different female, therefore the fate of the GPS-tagged female remained unknown. The GPS tags that we used for this study, although perhaps not ideal for birds that are difficult to recapture, can be of use in certain applications such as assessing breeding-season home-range size of individuals nesting in boxes (i.e., birds that are easily recaptured). As tracking technologies advance, the opportunity to use new tracking technologies will drastically improve our ability to assess not only nonbreeding-season
Figure 1. Breeding-season location and nonbreeding-season location of one male American Kestrel tracked using a GPS data logger. The inset shows all nonbreeding-season locations (n = 16) from the GPS tag and the estimated nonbreeding-season minimum convex polygon. The kestrel was captured at the breeding-season location.
locations but also migratory pathways, migration timing, survival during the breeding and nonbreeding seasons, and efficacy of using transmitters or data loggers to monitor kestrel movement over a long time period.

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LITERATURE CITED


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