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Inter-annual roost site fidelity of a White-throated Sparrow (*Zonotrichia albicollis*) on the non-breeding grounds

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ABSTRACT

The survival of overwintering White-throated Sparrows (*Zonotrichia albicollis*) during the non-breeding season depends on the conservation of adequate foraging habitat as well as spatially discrete roosting sites comprised of dense vegetation. Although we know that many bird species occupy the same general roosting areas year after year, the degree of inter-annual roost site fidelity for individuals represents an important knowledge gap. The roost location data described in this paper represent a continuation of a previously published roost ecology study conducted in 2023. Here we provide additional natural history notes related to the inter-annual habitat use and roost site selection of an after-second-year, white-striped male that we tracked for 2 consecutive years (19 Jan–2 Mar 2023, and 19 Jan–29 Feb 2024; 68 total roosts [27 nights in 2023 and 41 nights in 2024]). We observed a 100% overlap of this individual's 2024 non-breeding core roost home range within its 2023 core roost home range. Perhaps even more noteworthy was the observation that this individual sparrow occupied the same exact roost site as it did in 2023, a Japanese honeysuckle (*Lonicera japonica*) bush, for 37 nights during the non-breeding season in 2024. Although we recognize that inference from our study is limited to the roosting behavior of one individual sparrow, we suggest that these observations highlight the need for future research initiatives to explore the conservation implications of microhabitat preferences at inter-annual roost sites for other migratory songbirds outside of the breeding range.

KEYWORDS

Home range; habitat; radio telemetry; roost; sparrow; winter

PALABRAS CLAVE

Ámbito hogareño; descanso; gorrión; hábitat; invierno; radio telemetría

Fidelidad interanual de sitio de descanso de un gorrión Zonotrichia albicollis en su rango no-reproductivo

RESUMEN

La supervivencia de *Zonotrichia albicollis* en el invierno durante la etapa no-reproductiva depende de la conservación del hábitat de forrajeo adecuado, así como de sitios de descanso espacialmente discretos conformados por vegetación densa. Sin embargo, aunque sabemos que muchas especies de aves ocupan las mismas áreas generales de descanso año tras año, el grado de fidelidad de sitio de

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descanso interanual para individuos representa un importante vacío de conocimiento. Los datos de ubicación de descanso descritos en este artículo representan una continuación de un estudio ecológico de descanso publicado previamente, el cual fue desarrollado en 2023. En este documento proveemos notas de historia natural adicionales relacionadas con el uso interanual de hábitat y la selección de sitio de descanso de un ave con más de dos años de vida, un macho de franja blanca, que rastreamos por dos años consecutivos (19 de enero – 2 de marzo de 2023 y 19 de enero – 29 de febrero de 2024; un total de 68 descansos [27 noches en 2023 y 41 noches en 2024]). Observamos una superposición de 100% en el núcleo de ámbito hogareño en el rango no-reproductivo del individuo en 2024 con su mismo núcleo de ámbito hogareño en 2023. Quizás aún más digno de notar fue la observación de que este individuo de gorrión ocupó el mismo sitio exacto de descanso en 2024, una enredadera de arbusto de *Lonicera japonica*, que había usado por 37 noches en 2023. Aunque reconocemos que la inferencia de nuestro estudio está limitada al comportamiento de descanso de un solo individuo de gorrión, sugerimos que estas observaciones destacan la necesidad de iniciativas futuras de investigación para explorar las implicaciones de conservación de preferencias de microhábitat en sitios de descanso usados interanualmente para otras aves canoras migratorias fuera de su rango reproductivo.

Effective migratory bird conservation strategies require an understanding of habitat associations throughout the entire year (Marra et al. 2015). In North America, the breeding grounds have historically received more attention for both research and conservation initiatives. Thus, for many North American birds that migrate to geographically distinct non-breeding grounds, our understanding of non-breeding habitat associations is somewhat lacking (Faaborg et al. 2010; La Sorte et al. 2017). However, for several species of North American sparrows (Passerelidae) that are classified as short-distance migrants, non-breeding habitat associations have been studied extensively (Pulliam and Mills 1977; Ginter and Desmond 2005; González et al. 2023). Many of these species spend the non-breeding season hundreds of kilometers south of their breeding grounds, and researchers in the southern portion of the United States have been studying non-breeding habitat associations and foraging behaviors for decades. Banding data have demonstrated a high degree of inter-annual site fidelity for overwintering sparrows (Winder et al. 2012), and diurnal observations of color-banded individuals have allowed researchers to explain complex flocking behaviors and social dominance hierarchies of sparrows on the non-breeding grounds (Schneider 1984; Madsen et al. 2023). Radio-telemetry methods have also been employed to describe detailed roosting habitat associations for sparrows during the non-breeding season (Ginter and Desmond 2005; Macías-Duarte and Panjabi 2013; González et al. 2023).

Radio-telemetry studies of overwintering Savannah Sparrows (*Passerculus sandwichensis*), Vesper Sparrows (*Pooecetes gramineus*), and White-throated Sparrows (*Zonotrichia albicollis*) have revealed high levels of roost site fidelity, and ecologically significant roost habitat preferences, which differ from diurnal foraging locations (Ginter and Desmond 2005; Macías-Duarte and Panjabi 2013; González et al. 2023).

Researchers have also used radio-tracking methods to identify important roost sites and document inter-annual roost site fidelity for high-use communal roosting areas for Savannah Sparrows (Ginter and Desmond 2005). These studies have been important for locating communal roosting areas, but it remains unclear whether individuals use the same roosts year after year, or how inter-annual familiarity with available roost habitats in a given area contributes to survival. Here we report two consecutive years of radio-telemetry data to describe inter-annual roost site fidelity for one overwintering White-throated Sparrow on the non-breeding grounds. We compared home range estimates and habitat use of this same individual over two consecutive years of tracking and describe microhabitat associations with respect to land use and habitat management considerations.

Methods

Study area

We conducted our study at Harding University's Gilliam Biological Research Station in White County, Arkansas, USA (35°14′16″N, 91°52′08″W). At the time of study, the property was mostly forested, comprised of oak (*Quercus* spp.), sweetgum (*Liquidambar styraciflua*), and loblolly pine (*Pinus taeda*) in the overstory, with dense patches of greenbriar (*Smilax* spp.) in the understory (González et al. 2023). Surrounding properties were mostly agrarian, consisting of large, mowed pastures for livestock, but also contained fencerows with brushy patches of White-throated Sparrow roost habitat such as eastern red cedar (*Juniperus virginiana*), blackberry (*Rubus* spp.), Japanese honeysuckle (*Lonicera japonica*), and autumn olive (*Elaeagnus umbellate*; González et al. 2023).

Bird capture/processing

In January (2023 and 2024) we captured White-throated Sparrows opportunistically using strategically placed mist nets near foraging areas on the edge of a powerline right-of-way (González et al. 2023). Upon capture, we fitted birds with a federally issued aluminum leg band and recorded morphometric measurements: unflattened wind-chord length (mm), tail length (mm), culmen length (mm), mass (g), age (second year [SY] or after second year [ASY]), and color morph (tan-striped or white-striped), following criteria as described in Pyle (2022). We attached a 0.6 g radio transmitter (custom-made by Blackburn Transmitters, Nacogdoches, Texas, USA) using a modified figure-eight leg loop harness (Streby et al. 2015). In addition to the standard processing protocol outlined above, we also fitted all birds with a unique color band combination in 2024 to allow observers to visually identify individuals from a distance. Additionally, because White-throated Sparrows are not sexually dimorphic, we collected contour feathers for genetic sex determination and performed genetic sex determination using PCR as outlined in Bento Lab (2021). All birds were captured and handled under the Federal Banding Permit #24138, Arkansas Scientific Collection Permits # 020820233, and #021620242, and Harding University Institutional Animal Care and Use Committee guidelines (protocol #2021-01). In the present manuscript, we report roost data for one individual White-throated Sparrow (an ASY, white-striped male) that was captured and radio-tracked for 2 consecutive years. The data described in this report represent a continuation of a previously published roost ecology study (González et al. 2023).

Radio telemetry

We used TRX-1000 receivers and three-element directional Yagi VHF antennas (Wildlife Materials Inc., Murphysboro, Illinois, USA) to track the radio-tagged bird to its roost locations from 19 January–2 March 2023 and from 19 January–29 February 2024. We recorded the GPS location (5 m accuracy) of each roost site and noted whether we detected evidence of communal roosting behavior (e.g., chirping and wing flapping of nearby individuals). To avoid any potential observer effects on bird behavior or roost site selection, we did not begin tracking until ≥30 min after sunset (1800-2200 h CST).

Spatial analysis

We calculated home ranges for White-throated Sparrow roosts using bivariate normal 95 and 50% kernel density estimation (KDE) methods within the package *adehabitatHR* (Calenge 2020) in program R (R Development Core Team 2022) and classified the 50% KDE contour as the "core" roost home range for each individual. We incorporated the optimal bandwidth for each calculated KDE home range using adaptive, data-driven contour smoothing and applied the smoothed cross-validated plug-in method (hpi) in package *ks* (Duong 2014). Because roost preferences are multi-faceted, and White-throated Sparrows can occupy more than one core roost on the non-breeding grounds (González et al. 2023), we only estimated KDE home range for the individual with > 25 unique nights of roost data. To calculate the percent overlap in core roost home range between seasons, we used the Overlay Analysis tool within the geoprocessing toolbox in QGIS (QGIS Development Team 2022).

Results

We recaptured and tracked the same individual White-throated Sparrow, an ASY, white-striped male, for 2 consecutive years (19 Jan–2 Mar 2023, and 19 Jan–29 Feb–2024). We recorded roost locations for this individual for a total of 68 nights (27 nights in 2023 and 41 nights in 2024). In 2023, this bird used two core roosting areas (Fig. 1). One core roosting area contained two primary roost sites: a brushy fence-row of thick blackberry brambles, and a tangle of Japanese honeysuckle growing on a fence (González et al. 2023). The other core roosting area in 2023 was a communal roost in a planted row of eastern red cedar trees. In 2024, this same individual only occupied one core roosting area, and it was contained entirely within the boundary of the 2023 50% KDE core roost home range polygon. Furthermore, >95% of this individual's 2024 roost locations were contained within the boundary of the 2023 core (Fig. 1). Additionally, > 90% of the 2024 roost locations (37 out of 41 nights) were in the same roost, a honeysuckle bush, that this bird also occupied in 2023 (Fig. 2).

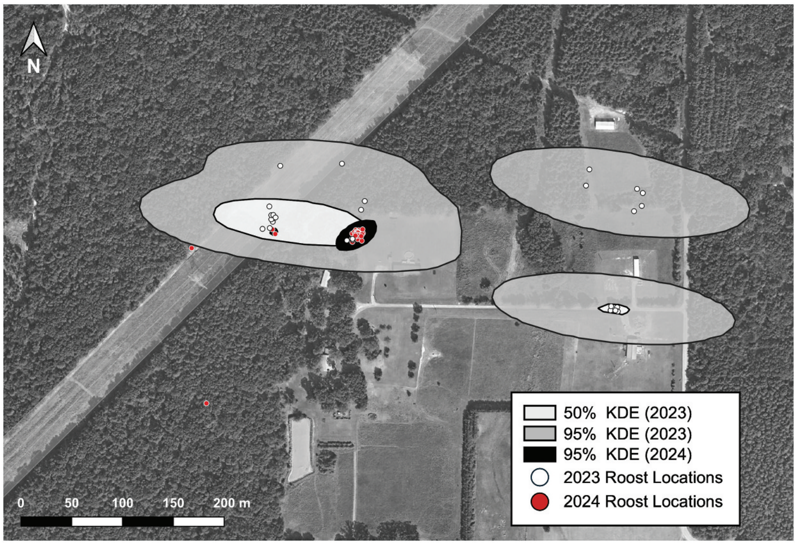

Figure 1. Roost locations (circles) and home range estimates (polygons) for an after second year (ASY), male White-throated Sparrow (*Zonotrichia albicollis*). Light gray polygons with black outlines depict the 50% Kernel Density Estimation (KDE) core roost home range for 2023. Dark gray polygons with black outlines represent the 95% KDE roost home range for 2023. The black polygons represent the 95% KDE roost home range for 2024. The 50% KDE core roost home range for 2024 is not visible, because it is obscured beneath the 2024 roost locations. Red circles with black outlines represent 2024 roost locations ($N = 41$) recorded from 19 Jan–29 Feb 2024. White circles with black outlines ($N = 27$) represent 2023 roost locations recorded from 19 Jan–2 Mar 2023. Data were collected at the Gilliam biological research station, Arkansas, USA.

Discussion

Radio telemetry data from the same individual White-throated Sparrow over two consecutive non-breeding seasons indicated a high degree of both intra- and inter-annual roost site fidelity. We observed 100% overlap of the 2024 core roost home range within the 2023 core roost home range, and this individual sparrow occupied the same exact roost site as it did in 2023 (a honeysuckle bush) for 37 nights during the non-breeding season in 2024. Although we recognize that inference from our study is limited to the roosting behavior of one individual sparrow, and we recognize that habitat use can be a misleading indicator of habitat value (Van Horne 1983), it is also important to note that a better understanding of inter-annual microhabitat roost site preferences may have important conservation implications for species with complex annual habitat requirements such as migratory songbirds. Thus, we posit that an inter-annual assessment of roost site selection for this individual is both noteworthy and relevant to current conservation concerns.

The primary roost site for this individual White-throated Sparrow in 2024 was a small patch of vining Japanese honeysuckle on a wire fence (Fig. 2). Although this roost was not a heavily used communal roost location, the sparrow in this study occupied this particular roost during both the 2023 and 2024 non-breeding seasons. The potential wildlife benefits of Japanese honeysuckle have been discussed in the past (Handley 1945), but we do not intend to imply that Japanese honeysuckle is the ideal roosting habitat for White-throated

Figure 2. This small patch of vining Japanese honeysuckle (*Lonicera japonica*) on a metal fence served as a primary roost location for an individual White-throated sparrow (*Zonotrichia albicollis*) for two consecutive non-breeding seasons (2023 and 2024). This photograph was taken at the Gilliam Biological Research Station, Arkansas, USA.

Sparrows, nor do we recommend that landowners propagate this species on their property to provide roosting habitat for birds. In our study system, invasive shrubs are most likely selected as roosting cover because the same qualities that allow those species to choke out native vegetation also produce dense thickets of cover that can provide thermal regulation and predator protection for roosting birds (González et al. 2023). These functions can also be provided by native plants, such as blackberry and cedar, which were also used as roosting habitat by this individual White-throated Sparrow for a total of 20 nights during the two-year tracking period. Thus, we posit that the most important takeaway from this case study of high inter-annual roost site fidelity is not entirely linked to vegetation type (although this seems to play a role), but rather the reliability of known roost sites and the associated survival implications for nonresident birds on the non-breeding grounds.

Vegetative structure and habitat quality are typically good predictors of non-breeding site occupancy for migrant songbirds on the non-breeding grounds (Wunderle and Latta 1999; Latta and Faaborg 2001), but our data also suggest that individuals may even exhibit non-breeding microhabitat preferences, territoriality, and roost site fidelity for a specific tree or bush, similarly to what would be expected of a nesting individual on the breeding grounds. In both years of our study (2023 and 2024), a different radio-tagged individual initially occupied the honeysuckle roost (Fig. 2), but the ASY, white-striped, male usurped the roost and occupied that location for the remainder of the tracking period. In 2023 the ASY, white-striped, male displaced a SY tan-striped individual (we did not perform genetic analyses to determine sex in 2023), and in 2024 the displaced individual was an ASY, white-striped female. White-throated Sparrows exhibit territorial behavior on the non-breeding grounds with respect to foraging home ranges (Falls and Kopachena 2020). Furthermore, intraspecific dominance hierarchies on the non-breeding grounds have been documented in other migratory species (Wunderle and Latta 1999; Latta and Faaborg 2001). Based on the inter-annual roost preferences we observed for this individual White-throated Sparrow over 2 consecutive years of tracking, we suggest that nonresident birds may also exhibit some level of hierarchy and dominance with respect to roost site selection. Roosting habitat selection has been directly correlated with the survival of overwintering Baird's and Grasshopper sparrows (Pérez-Ordoñez et al. 2022). Furthermore, we know that poor habitat quality during the non-breeding season can have direct impacts on annual survival, as well as carry over effects into the breeding season (Sherry and Holmes 1996; Marra et al. 1998; Newton 2004). If microhabitat structure or inter-annual habitat continuity, such as consistent and reliable roosts, are important for the annual survival of migrant songbirds, these topics may be potential foci for future research or conservation initiatives.

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Disclosure statement

No potential conflict of interest was reported by the author(s).

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AI statement

Generative AI was not used in the production of this manuscript.

Author contributions

CRediT: **M. Elisa González**, **Patrick J. Ruhl**: conceptualization, data curation, investigation, writing and editing of this manuscript.

Ethics statement

All birds were captured and handled under the Federal Banding Permit #24138, Arkansas Scientific Collections Permits # 020820233, and #021620242, and Harding University Institutional Animal Care and Use Committee guidelines (protocol #2021-01).

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