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Winter Roost-site Selection by Seminole Bats in the Lower Coastal Plain of South Carolina

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Abstract - The winter roost-site selection of most North American foliage-roosting bats is relatively unknown. We examined winter roost-site selection of Seminole bats (*Lasiurus seminolus*) in the Lower Coastal Plain of South Carolina during January 2004. Seminole bats used a variety of day-roost structures including the canopy of overstory hardwood trees, hanging vines, pine needle clusters suspended from understory vegetation, and leaf litter on the forest floor. Although reported for red bats (*L. borealis*), this is the first report of Seminole bats roosting in forest floor leaf litter. Winter roost selection differed from previous observations of summer roosts, which consisted almost exclusively of live overstory pine (*Pinus* spp.) trees. Roost-site selection in winter likely is related to ambient temperature and optimizing exposure to solar radiation during the day. Management decisions in southeastern forests should consider seasonal changes in roosting behavior to minimize adverse impacts on forest bats.

Introduction

Information on seasonal changes in roosting behavior of forest bats is lacking in the published literature. Many North American bat species migrate to warmer latitudes or hibernate in caves or human-made structures during winter. As a result, most bat research in temperate climates traditionally has been conducted during summer. Forest managers have relied heavily on summer data to create year-round management strategies for many bat populations. Although important, results from summer studies concerning roost-site selection may not apply in other seasons.

Studies on roosting ecology of tree-roosting bats during summer indicate a selection for larger trees when compared to random structures (Crampton and Barclay 1998; Menzel et al. 1998, 2000; Vonhof and Barclay 1996). However, the limited research on winter roost selection suggests that many tree-roosting species alter roost-site selection during colder weather, presumably selecting locations with more suitable thermal conditions. Indiana bats, *Myotis sodalis* (Miller and Allen, 1928), which select snags as summer-day roosts, switch to mines and caves as winter hibernacula (Kurta and Rice 2002). Red bats, *Lasiurus borealis* (Müller, 1776), typically roost in the foliage of hardwood trees during summer (Hutchinson and Lacki 2000, Menzel et al. 1998), but have been

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observed winter-roosting in deciduous leaf litter in five states: Arkansas, Illinois, Missouri, South Carolina, and West Virginia (Boyles et al. 2003, Mager and Nelson 2001, Moorman et al. 1999, Rodrigue et al. 2001, Saugey et al. 1998), suggesting this to be common roosting strategy for this species (Boyles et al. 2003). The winter ecology of other foliage-roosting bats remains relatively unknown. We report here on observations of roosting habitat selection by Seminole bats, *L. seminolus* (Rhoads, 1895), in winter.

Methods

This study was conducted on property owned by the MeadWestvaco Corporation in Charleston, Colleton, and Dorchester Counties, SC. The study area is managed using MeadWestvaco's ecosystem-based forestry approach (G.C. Muckenfuss, MeadWestvaco Corp., pers. comm.). This system creates a landscape consisting of multiple age classes and timber types, both pine and hardwood, in various stages of succesional development, providing a diversity of habitats across MeadWestvaco's ownership.

Bats were captured in January 2004 using mist-nets set over small ponds. We attached 0.43-g radio-transmitters (Biotrack, Ltd., Wareham, UK) to the back of Seminole bats using Skin Bond surgical adhesive (Smith and Nephew Products, Inc., Largo, FL). Transmitter load did not exceed 5% of the bats body mass (Aldridge and Brigham 1988). Day roosts were located daily using TRX 2000S receivers (Wildlife Materials, Inc., Carbondale, IL) and 3-element Yagi antennas. We calculated roosting home ranges by the Minimum Convex Polygon method using the Convex Hull Extension in ArcView (Jenness 2004). Ambient temperatures were recorded using HOBO data loggers (Onset Computer Corp., Bourne, MA).

Results and Discussion

We radio-tracked 3 male Seminole bats to 15 unique roost locations from 3 to 19 January 2004. Winter roost structures included the canopy of overstory hardwood trees (n = 5), hanging vines in the overstory (n = 2), Spanish moss (*Tillandsia usneoides* Linnaeus, 1762) in the overstory (n=1), pine needle clusters suspended from understory vegetation (n = 6), and pine leaf litter (n = 1). Our results differ from previous reports of Seminole bat winter roosts. Constantine (1958) reported Seminole bats winter-roosting exclusively in or on pendant clumps of Spanish moss in southwest Georgia. Jennings (1958) also collected Seminole bats in Spanish moss during winter months throughout Florida. We were able to detect a greater variety of roost structures using radio-telemetry than previous researcher that relied only on observational techniques.

Bats roosting in overstory hardwood trees were located near the top of the canopy on small branches near clusters of dead leaves, within Spanish moss, or on vines hanging from overstory branches. When observed roosting in the understory, Seminole bats typically roosted underneath clusters of pine needles that had fallen from overstory trees and had become suspended on low-hanging vines or branches of understory hardwood trees. The needles formed a roof-like mat over and surrounding the roosting bat. The single bat observed roosting on the forest floor was approximately 1 cm below the pine leaf litter. Canopy roosts typically were located near the edge of older, open mixed pine-hardwood stands, whereas roosts within pine needle clusters and pine leaf litter were located in the interior of young, dense loblolly pine stands.

In comparison to winter-roosts observed in the present study, previous examinations of summer-roosts indicate that Seminole bats almost exclusively select for live overstory pine trees (Menzel et al. 1998, 1999, 2000). We observed similar roost-site selection in our study area during summer 2003, with all 49 Seminole bat day-roosts observed located in the canopy of live loblolly pines (C.D. Hein, unpubl. data). The observed changes in roost site selection between seasons likely are related to ambient temperature and optimizing exposure to solar radiation during the day. Lack of foliage on hardwood trees in winter may allow bats to maximize the amount of solar radiation received on warmer days.

Differences in roosting home range between summer and winter also were evident. We compared the roosting areas for 3 male Seminole bats from summer 2003 and 3 male Seminole bats from winter 2004. Although sample sizes were small, winter roosting area is noticeably larger when compared to the roosting area used in summer. The mean area was 0.62 ha (SE ± 0.16, range 0.43–0.95 ha) in summer and 23.02 ha (SE ± 12.61, range 3.32–46.52 ha) in winter. During winter, bats may require larger areas to acquire the resources they need. Roost locations in winter, for a given bat, were observed in various habitat types across the landscape (i.e., older hardwood stands and young pine stands) compared to summer roosts which were generally located within the same pine stand.

Seminole bats selected roosts in the canopy of large overstory hardwood trees and in vines on nights with a minimum nightly temperature greater than 10 °C. Generally, as minimum nightly temperature dropped below 10 °C, bats selected roosts that provided additional shelter. During the coldest period of the study, when minimum nightly temperatures ranged from 3.7 °C to -6.8 °C, two of the three bats selected roosts on or near the forest floor. One male was tracked to a pine needle cluster hanging 0.5 m off the forest floor, and a second male was observed roosting within the pine leaf litter. This leaf litter roost was located approximately 140 m away from the previous roost site. The third bat was observed roosting in the canopy of an overstory hardwood tree within a clump of Spanish moss. Roost sites close to and on the forest floor offer warmer ambient temperatures and protection from wind during the coldest winter periods. Results from winter studies involving Three-toed Box Turtles, *Terrapene carolina triunguis* Agassiz, 1857 (Reagan 1974) and ground beetles (Lam and Pedigo 2000) showed the importance of a buffering habitat (i.e., leaf litter) in the survival of over-wintering animals by avoiding extreme temperature fluctuations during colder months.

When implementing management practices typically conducted in winter, managers should consider seasonal differences in roosting behavior of forest bats. The use of understory trees and leaf litter as roosts in winter suggests that prescribed fire, a common forestry/wildlife management technique in southern forests (Carter et al. 2002), may adversely affect bat populations. Several studies have reported bats being driven from leaf litter roosts during prescribed burns (Moorman et al. 1999, Rodrigue et al. 2001). Many bat species have a low tolerance for roost disturbance. Such disturbance expends critical winter fat stores (Trani 2002) and increases vulnerability to daytime predators (Carter et al. 2002). Winter burns also may result in direct mortality of torpid bats roosting on or near the ground (Harvey and Saugey 2001). In winter, many bats hibernate or enter prolonged periods of inactivity. Bats may take up to 30 minutes to arouse from such states (Thomas et al. 1990), making it difficult to reach a body temperature and activity level sufficient to escape fire (Carter et al. 2002). However, the relationship between temperature and roost site selection may be useful in planning prescribed burns to avoid times when bats are most vulnerable.

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