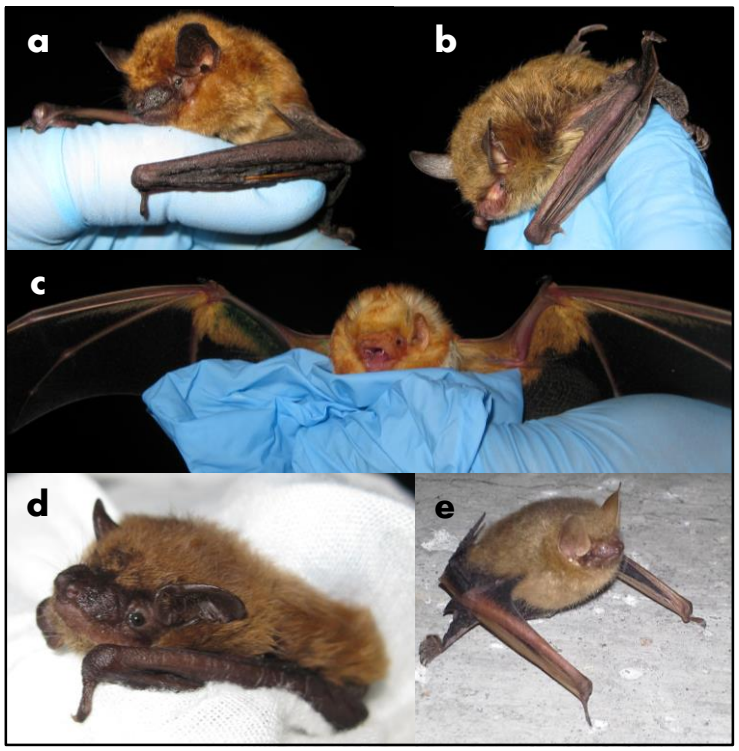
RESEARCH BRIEF

Relationships between bat occupancy and habitat and landscape structure along a savanna, woodland, forest gradient in the Missouri Ozarks

Clarissa A. Starbuck, Sybill K. Amelon, and Frank R. Thompson III. 2014. Wildlife Society Bulletin. doi: 10.1002/wsb.512

MANAGEMENT IMPLICATIONS

- It is important to consider the needs of each individual species in land management because bat species have differing morphological characteristics and habitat requirements
- Evening bats were most positively associated with habitat features characteristic of savannas and woodlands but, in general, all species had high occupancy rates across savanna, woodland, and forest habitat types
- While it is essential to meet local habitat requirements when managing for bats, landscape-scale conditions also influence bat site occupancy



Photos by Clarissa Starbuck

This study examined site occupancy across savanna, woodland, and forested habitats for a) big brown, b) northern long-eared, c) eastern red, d) evening, and e) tri-colored bats. All bats studied but the northern long-eared bat are large with a high body mass to wing ratio and better suited to open habitats.

Habitat degradation, urbanization, deforestation, and, especially, white-nose syndrome are all contributing factors to declining bat populations in eastern oak forests. Because bats often forage and roost in forests, management activities, like prescribed burning and mechanical thinning for savanna and woodland restoration, may influence these behaviors. As land managers develop restoration projects, it is important to consider bats and other wildlife when establishing management objectives.

The authors of this study examined the relationships between big brown (*Eptesicus fuscus*), northern long-eared (*Myotis septentrionalis*), eastern red (*Lasiurus borealis*), evening (*Nycticeius humeralis*), and tri-colored (*Perimyotis subflavus*) bat site occupancy and characteristics of habitat, landscape, and land management across savannas, woodlands, and forests. They hypothesized that site occupancy would vary among bat species due to differences in their physical and echolocation characteristics. For instance, all bats except the northern long-eared are relatively large with a high body mass to wing area ratio (also known as wing loading) and longer, narrower wings (higher aspect ratio), and are frequently found in open habitats (Loeb and O'Keefe 2006, Loeb and Waldrop 2008, and Armitage and Ober 2012). The authors also expected site occupancy to be affected by proximity to water and roads, urban and forested land cover, tree density, and vegetation composition (coniferous vs. deciduous).

Bat occupancy was assessed at 369 points across 26 sites in the Missouri Ozark Highlands that had a history of management with prescribed burning and mechanical thinning. To determine occurrences of bat species, echolocation calls were recorded, identified, and analyzed at each site in the summers of 2010, 2011, and 2012. Site characteristic variables including the number of small stems, saplings, poletimber, and sawtimber per hectare; recent fire frequency (10 years prior); land cover classification (forest, open, or urban) within 2 km and 16 km; distance to water and roads. Climatic data were used to develop site occupancy models describing relationships between habitat

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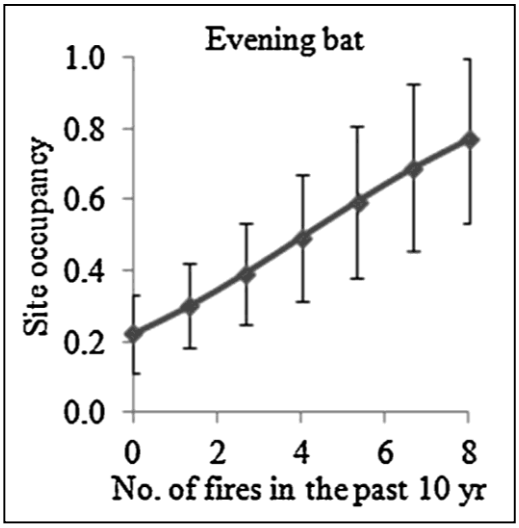
variables and site occupancy.

Overall, site occupancy was high at >60% and species generally occurred across the entire range of savanna, woodland, and forest habitats. Evening bats preferred stands with low densities of poletimber and sawtimber, greater small-stem densities, and greater fire frequency; which are characteristics of managed savanna and woodlands. This corroborates other studies that have found increasing bat activity in pine forests with higher frequency of prescribed fire (see Loeb and Waldrop 2008 and Armitage and Ober 2012 for more information). Site occupancy of big brown, eastern red, and tri-colored bats had no relationship with frequency of fire. Similarly, these bats were not associated, positively or negatively, with savannas or woodlands, although other studies have reported a correlation between these bats and open habitats (see Ford et al. 2006 and Loeb and O'Keefe 2006 for more information). Eastern red bat site occupancy decreased with increasing distance to roads, further indicating the importance of open habitat to this species. Northern long-eared bats had a slightly positive relationship with poletimber density and negative relationship with sawtimber density, but occupancy remained 60–80% across the range of tree densities in savanna, woodlands, and forests.



Probability of occupancy across the range of number of fires in the past 10 years for the evening bat in the Missouri Ozark Highlands, USA, 2010-2012.

Cover type (forest, open, and urban) at the landscape scale (16 km radius from acoustic detection points) was a significant predictor variable of site occupancy for all five focal bat species. It is common for bats to roost and forage across large areas and distances utilizing a variety of roosts and food resources. For instance, it is not unusual for big brown bats to travel up to 11 km to forage. Urban areas may lack vegetative structure and insect abundance and thus bat activity is lower in these sites. Site occupancy was significantly reduced for northern long-eared, evening, and tri-colored bats with increasingly urban areas.

Increasing forest cover at a 16 km radius positively affected big brown, eastern red, and northern long-eared bat occupancy, but negatively affected evening and tri-colored bats. Big brown and eastern red bats have been found in open and urban habitats more often than other species, though they are known to roost in tree canopies during the breeding season and the leaf litter in the winter. Northern long-eared bats, in particular, roost and forage in mature forests and are less frequently found in fragmented landscapes. Site occupancy of evening bats increased as stem density decreased perhaps as a result of transitional areas from open land (e.g. glades, prairies) to savannas and woodlands, for which these bats are best suited. Although stem density was not a significant predictor for tri-colored bat site occupancy, these bats are commonly found in open habitats, which may explain the decline in site occupancy in forested and urban landscapes. This is parallel to a similar study by Ethier and Fahrig (2011) who also noted lower relative abundance of tri-colored bats with increasing forest cover.

The authors recommend that land managers consider individual bat species in their management plans as habitat and landscape preferences differ among species. Because conditions of land cover at a 16 km radius were important to bat occupancy, it is suggested that landscape-scale composition and structure be considered in management decisions, even where species-specific and local habitat conditions are met.

FOR FURTHER READING

Armitage, D. W., and H. K. Ober. 2012. The effects of prescribed fire on bat communities in the longleaf pine sandhills ecosystem. Journal of Mammalogy 93:102-114.

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Loeb, S. C., and T. A. Waldrop. 2008. Bat activity in relation to fire and fire surrogate treatments in southern pine stands. Forest Ecology and Management 255:3185-3192.

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