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Summer Roost-Tree Selection by a Male Indiana Bat on the Fernow Experimental Forest

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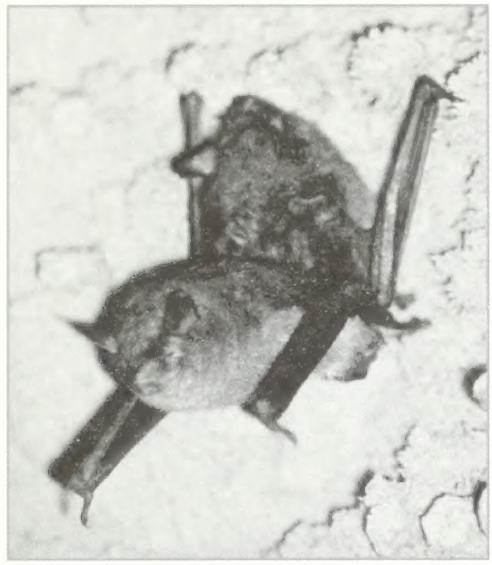

Abstract

We attached a radio transmitter to an adult male Indiana bat (*Myotis sodalis*) in June 2001 on the Fernow Experimental Forest in the Allegheny Mountains of north-central West Virginia. The bat was tracked for 4 successive days before the transmitter failed. The bat roosted in three living trees over the study period. Two roosts used for a single night each were in large shagbark hickories (> 45 cm d.b.h.); the roost used for two successive nights was located in a large sugar maple (69.1 cm d.b.h.). Roost trees were characterized by large areas of exfoliating bark and all were canopy-dominant within surrounding stands. One shagbark hickory was a residual tree left following a patch clearcut 6 years earlier. Although few inferences can be drawn from one Indiana bat, many characteristics of this individuals's roost selections in the central Appalachians were consistent with tree roosts observed in other regions during the non-hibernation period of this species.

The majority of the Indiana bat's (*Myotis sodalis*) winter hibernacula and summer maternity range is in the lower Ohio Valley and Ozark Plateau of the Midwest (Menzel et al. 2001b). However, there are 92 Priority II and III hibernacula of this endangered species in the central and southern Appalachians from northeastern Alabama to central Pennsylvania (Humphrey 1978; USDI Fish and Wildl. Serv. 1999; Menzel et al. 2001b). Summer maternity activity of female Indiana bats is believed to be rare in forest habitats in the central Appalachians of Virginia and West Virginia (Brack et al. 2001; Owen et al. 2001). However, most male Indiana bats remain in the

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hibernacula vicinity and use trees and snags as day roosts during late spring, summer, and early fall. Accordingly, protection of tree roosts and forested habitat around Indiana bat hibernacula in the Appalachians is important to safeguard males from direct mortality and/or harmful modification of their roosting and foraging habitat.

Within the central and southern Appalachians, published roost research on male Indiana bats has been limited to a study of immediate post-hibernation emergence in the Ridge and Valley of western Virginia (Hobson and Holland 1995) and two pre-hibernation studies conducted just before and during fall "swarm" on the Cumberland Plateau in eastern Kentucky (Kiser and Elliot 1996; MacGregor et al. 1999). Although critical for natural resource managers in a region where forest management is substantial on private lands (DiGiovanni 1990) while decreasing rapidly on public lands (Ford et al. 2000), there are few data on roost characteristics of male Indiana bats during the non-hibernation spring and summer seasons. The objective of this study was to provide preliminary data on male Indiana bat day roosts in the central Appalachians of West Virginia and relate those findings to current forest management practices.

Study Area and Methods

We examined summer day roosts of a male Indiana bat on the Fernow Experimental Forest, a 1,900-ha research forest located in Tucker County, West Virginia. Elevations in this portion of the Allegheny Mountains subsection of the Unglaciated Appalachian Mountains and Plateau Physiographic Province generally range from 600 to 1300 m. Topography is characterized by steep side slopes with broad ridge tops and narrow valleys (Fenneman 1938). The climate is cool and moist with annual precipitation exceeding 155 cm (Madarish et al. 2002). On upland sites, mature (> 70 years), second-growth Allegheny/northern hardwood forests are dominated by American beech (*Fagus grandifolia*), sugar maple (*Acer saccharum*), red maple (*A. rubrum*), black cherry (*Prunus serotina*), northern red oak (*Quercus rubra*), yellow birch (*Betula alleghaniensis*), black birch (*B. lenta*), Fraser magnolia (*Magnolia fraseri*), and basswood (*Tilia americana*). Riparian areas on the Fernow are dominated by eastern hemlock (*Tsuga canadensis*) and rosebay rhododendron (*Rhododendron maximum*). Because the Fernow is designated as a forestry research area, it contains younger forest stands (< 10 years) that originated from clear- and deferment cutting and older stands altered by diameter-limit and selection cutting.

Portions of the Fernow and surrounding landscape in eastern West Virginia are underlain by the Greenbrier Limestone strata (Madarish et al. 2002) with karst formations and numerous caves. Locally, several of these caves serve as minor hibernacula for Indiana bats. Big Springs Cave, located near the center of the Fernow, annually winters approximately 200 male and female Indiana bats. During the summer maternity season, female Indiana bats probably are absent throughout most of the Allegheny Mountains of West Virginia, including the Fernow (Owen et al. 2001). Male Indiana bats that hibernate in Big Springs Cave remain in and around the Fernow (≤ 25 km radius) during the spring, summer and fall where they day roost in trees (L. E. Thomasma, USDA Forest Service, commun.). As a result, timber harvests for research purposes on the Fernow are limited to October 1 through April 30 to avoid "take" of an endangered species through habitat modification or direct mortality that could occur by felling an occupied roost tree.[1]

On 16 June, 2000, at approximately 2200 hr, we captured a male Indiana bat with a single mist net placed over Elklick Run near the center of the Fernow Experimental Forest. We confirmed species identification by the presence of a keeled calcar and short toe hairs that did not extend beyond the knuckle or claw (Whitaker and Hamilton 1998). The bat had the following measurements: forearm 38 mm, ear 8.5 mm, tragus 6 mm, and mass 7.0 g. We assigned the bat to the adult age class by examining the degree of epiphyseal-diaphyseal fusion (Anthony 1988; Racey 1988). We attached a 0.51-g model LB-2 radio transmitter (Holohil Systems Ltd., Woodlawn, ON)[2] to the hair between the bat's scapula using Skin Bond® surgical adhesive (Pfizer Hospital Products Group, Largo, FL). Transmitter mass was approximately 7 percent of the bat's body weight, slightly in excess of the recommended 5 percent of body mass (Aldridge and Brigham 1988). We used LA12-Q AVM receivers (AVM Instruments, Colfax, CA) and folding, three-element Yagi antennas to locate the Indiana bat's day roosts. The bat was tracked for 4 successive days before the transmitter was shed.

At each day roost or within a 10-m-radius circular plot with the roost as plot center, we recorded roost-tree species, d.b.h. (cm), height (m), snag class, bark-cover

[1]Adams, M. B., Knibbs, J., Rodrigue, J. L., Edwards, P. J., Wood, F., Ford, W. M., Kochenderfer, J. A., Schuler, T. M., Crews, J. 2000. Fernow Experimental Forest: environmental impact statement, Final Rep. On file at the Northeastern Research Station, Newtown Square, Pennsylvania.

[2]The use of trade, firm, or corporate names in this report is for the information of the reader. Such use does not constitute an official endorsement or approval by the USDA Forest Service of any product or service to the exclusion of others that may be suitable.

Table 1.—Summer day-roost characteristics for an adult male Indiana bat on the Fernow Experimental Forest, Tucker County

Variable	Roost 1	Roost 2	Roost 3	Mean	SE
Tree species	*C. ovata*	*C. ovata*	*A. saccharum*		
d.b.h. (cm)	45.5	68.0	69.1	60.9	7.7
Height (m)	32.5	30.0	25.8	29.4	2.0
Snag class	1	I	I		
Bark cover	IV	IV	IV		
Linearized aspect	2.7	3.5	3.9	3.4	0.4
Slope (%)	38	57	83	59.3	13.1
Elevation (m)	800	800	702	767.2	32.9
Stand type	N. Hardwood	N. Hardwood	N. Hardwood		
Canopy cover	III	I	V		
Midstory layer	IV	V	III		
Seedling layer	I	II	II		
Litter depth	II	II	III		
Distance (m) to:					
Nearest water	243	85	53	127.2	58.7
Elklick Run	740	803	618	720.3	54.4
Nearest road	43	49	13	35.0	11.2
Capture site	868	905	643	805.3	82.0
Big Springs Cave	1275	1588	1980	1614.3	204.2

class, site aspect, elevation (m), surrounding forest-stand community, canopy cover, midstory and woody-seedling density, litter depth, and distance (m) to nearest water, to Elklick Run, to nearest road, to the capture site, and to Big Springs Cave. We used a laser rangefinder to determine roost height and the distance to the nearest road. Site aspect was linearized using (1-cosine[aspect degrees] + 1-sine[aspect degrees]) with values increasing from mesic, northern aspects to xeric, southwestern aspects (Odom et al. 2001). Following Maser et al. (1979), we assessed snags from 1-7, with 1 a live tree and 7 a decomposing broken bole. We rated bark-cover class as I (none), II (< 10 percent), III (10-25 percent) and IV (> 25 percent). We grouped visual estimates of canopy cover, midstory density, and woody-seedling and herbaceous groundlayer density in five classes: I (0-5 percent), II (5-25 percent), III (26-50 percent), IV (51-75 percent), V (76-95 percent), and VI (96-100 percent). We rated litter depth as I (none), II (≤ 2.54 cm), III (2.55-6 cm), and IV (> 6 cm). We calculated elevation and distances from roosts to nearest water, Elklick Run, capture location, Big Springs Cave, and other roost trees using ArcView 3.2 GIS (ERSI, Redlands, CA).

Results and Discussion

Over a 4-day period, we tracked the male Indiana bat to three different roosts (Fig.1), all of which were Stage 1 live trees with abundant exfoliating bark (> 25 percent bole surface area) and no visible cavity or wound (Table 1). Roosts 1 and 2 were large shagbark hickories (*Carya ovata*) used by the bat for 1 day each (Table 1). Roost 3 was a large sugar maple that was used by the bat for 2 successive days (Table 1). All roosts were located in mesic Allegheny/northern hardwoods communities on sites with northwest to northeast aspects (Table 1). Roosts 1 and 3 were in mature forest stands characterized by numerous large trees. Roost 2 was a residual tree in a patch clearcut. The stand had been harvested in 1995 and was dominated by abundant woody regeneration 3 to 4 m high. Roosts 1 and 3 were canopy-dominant trees, though neither extended above the canopy. Each day roost was < 50 m from a road, < 300 m to the nearest water, < 1,000 m to Elklick Run and the capture site, and < 2,000 m to Big Springs Cave (Table 1). Distances from Roost 1 to Roost 2, Roost 2 to Roost 3, and Roost 1 to Roost 3 were 340, 477, and 705 m, respectively.

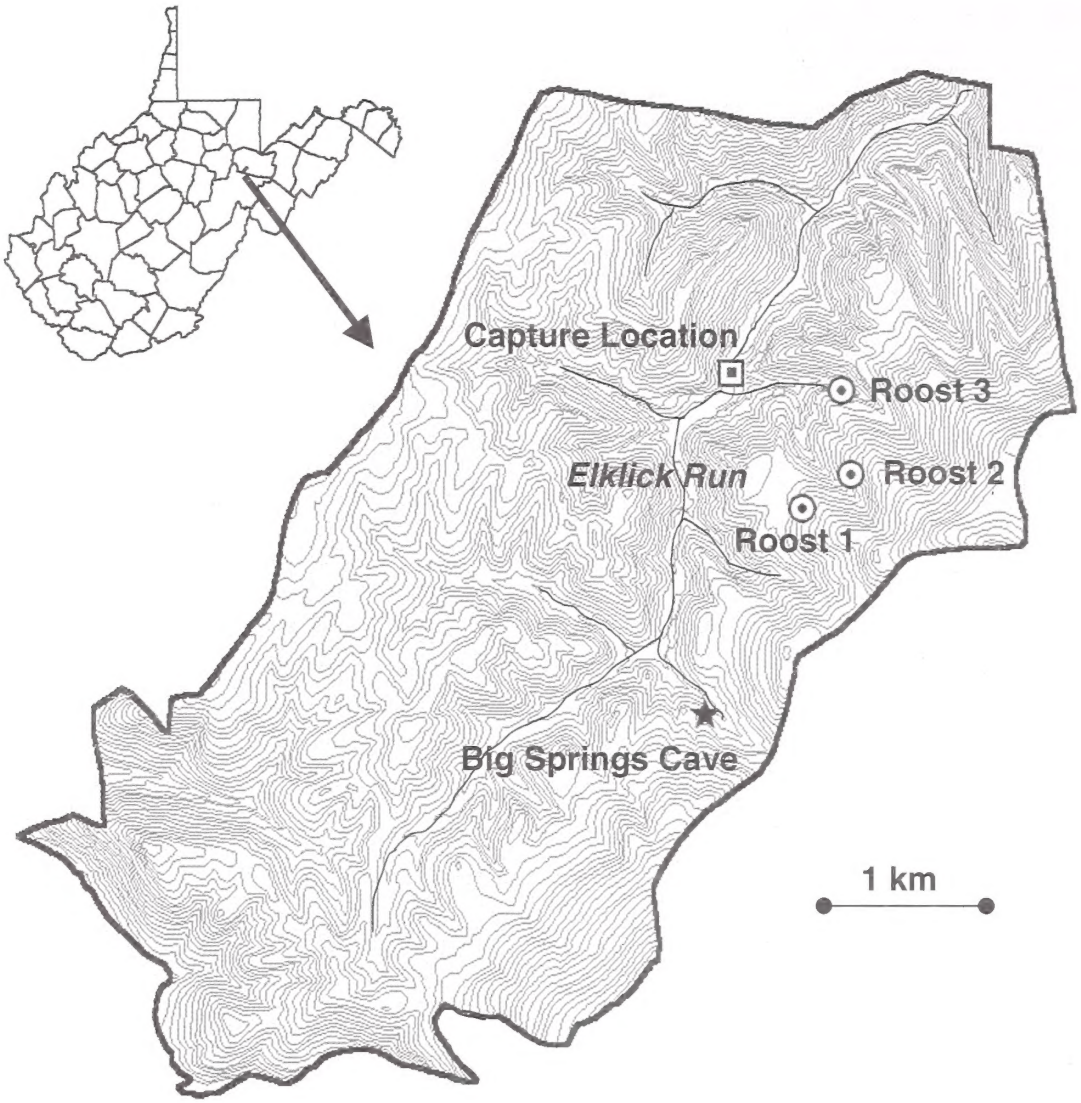

Figure 1.—Capture site and day roosts of a male Indiana bat in relation to Big Springs Cave and Elklick Run on the Fernow Experimental Forest in West Virginia.

Tree-roosting bats generally select trees that are larger in diameter and taller than the surrounding stand (Sasse and Perkins 1996; Vonhof and Barclay 1996; Callahan et al. 1997; Foster and Kurta 1999). Although both male and female Indiana bats show large rangewide variation in the size (8 to 86.6 cm d.b.h) and types of trees or snags chosen for roosts (Menzel et al. 2001b), Kurta et al. (1996) found that roost trees tended to be larger on average than other trees in the surrounding stand. The three roosts on the Fernow were similar to or larger than the majority of live trees or dead snags used by females at maternity roosts in the Midwest (Gardner et al. 1991; Kurta et al. 1996; Callahan et al. 1997) or as day roosts for males in the early spring or late fall in the Appalachians (Hobson and Holland 1995; Kiser and Elliot 1996; MacGregor et al. 1999). Female bats often choose a large tree or snag that extends to the canopy or above to take advantage of increased solar exposure that keeps the roost warm and aids the growth and development of juvenile bats (Menzel et al 2001a). Presumably, male Indiana bats roosting in and around Big Springs Cave are not so constrained because all three roosts were situated on more northern (cooler) aspects. Callahan et al. (1997) speculated that male Indiana bats seek cooler roosts to conserve energy. Other measured variables such as canopy cover were similar to or within ranges reported for tree roosts from throughout the Indiana bat's distribution (Menzel et al. 2001b).

Rangewide, Indiana bats show an affinity for roost trees with exfoliating bark (Rommé et al. 1995; Callahan et al. 1997). Menzel et al. (2001b) identified snags of 23 tree

species used by Indiana bat as day roosts. Shagbark hickory, noted for extensive amounts of exfoliating bark, was the lone live species often used for roosts (Humphrey et al. 1977; Gardner et al. 1991; Callahan et al. 1997). The large sugar maple identified as a roost also had a substantial amount of exfoliating bark. Because shagbark hickory is such a minor forest component within the Fernow's Allegheny/northern hardwood type, male Indiana bats might be showing strong preference for this tree species. Unfortunately, in the absence of even-age silviculture and with continued fire suppression, heavy seeded, shade-intolerant species such as shagbark hickory continue to decrease in importance on the Fernow and surrounding landscape (Schuler and Gillespie 2000). However, the large increase in dominance of sugar maple across the Fernow partially could offset losses of shagbark hickory.

Regardless, it seems appropriate to retain large live trees or dead snags within predetermined radii around Indiana bat hibernacula in the central and southern Appalachians where males may roost in spring through early fall, and to prohibit forest harvesting within that area during the non-hibernation season (Kiser and Elliot 1996). Within these hibernacula zones and at the appropriate season, two-age or deferment harvests (Miller et al. 1995; Johnson et al. 1998) that retain large shagbark hickory, sugar maple, or other trees with exfoliating bark would provide timber products and adequate regeneration while protecting the Indiana bat and its habitat.

Spatially, the locations of the three day roosts relative to where the male Indiana bat was captured on its presumed foraging area along Elklick Run are well within the ranges of > 200 m to 2 km from day roosts to foraging areas reported in the literature (Humphrey et al. 1977; Kurta et al. 1993; Menzel et al. 2001b). On an Appalachian landscape somewhat comparable to the Fernow, Hobson and Holland (1995) observed a 1-km distance between male Indiana bat day roosts and riparian-zone foraging areas in western Virginia during the post-hibernation period in spring. Acoustical survey sampling has indicated that Indiana bats on the Fernow forage extensively along Elklick Run during the summer.[3,4] Distances between observed roost trees also were within ranges reported for day roosts in the early fall on the Cumberland Plateau (MacGregor et al. 1999). Our observation that the male Indiana bat we tracked used three day roosts over 4 days was consistent with frequent roost switching (1 to 2 days) observed for male Indiana bats in the pre-swarm period in the fall on the Cumberland Plateau (Kiser and Elliot 1996; MacGregor et al. 1999). Additional research and monitoring is needed to determine whether the midsummer roost characteristics we observed are representative of male Indiana bats on the Fernow and/or similar to pre- and post-hibernation data collected from other portions of the central and southern Appalachians.

[3]Owen, S. F., Menzel, M. A.; Ford, W. M.; Edwards, J. W.; Menzel, J. M.; Chapman, B. R.; Wood, P. B.; Miller, K. V. Bat activity in managed and unmanaged forest and riparian zones in the Allegheny Mountains. In preparation.

[4]W. M. Ford, unpublished data on file at Northeastern Research Station, Parsons, West Virginia.

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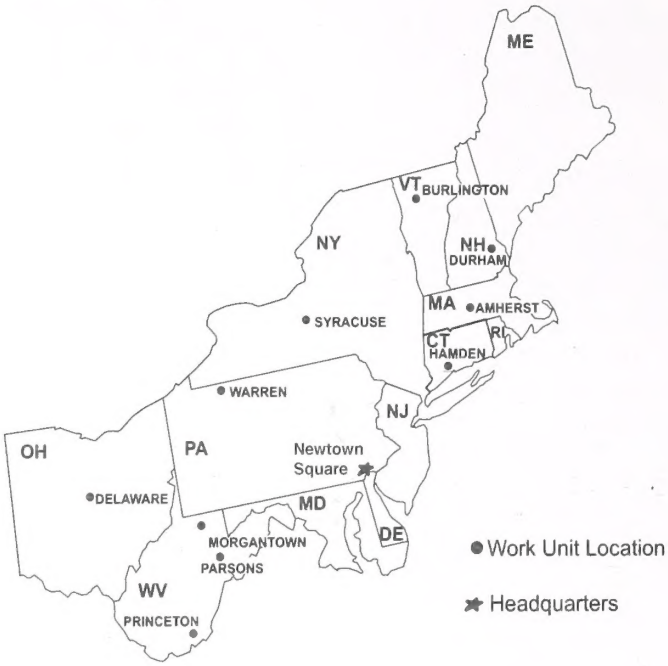

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