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Who Knew? First *Myotis sodalis* (Indiana Bat) Maternity Colony in the Coastal Plain of Virginia

Michael J. St. Germain¹, Andrew B. Kniewski¹, Alexander Silvis¹, and W. Mark Ford^{1,2,*}

Abstract - We report the first confirmed *Myotis sodalis* (Indiana Bat) maternity colony in Virginia, discovered at Fort A.P. Hill Military Reservation in Caroline County along the Piedmont-Coastal Plain Fall Line. Acoustic surveys conducted in 2014 indicated likely presence of Indiana Bats on the installation. Subsequent focal mist-netting during May–June 2015 resulted in capture of 4 lactating females that we subsequently radio tracked to a maternity colony site containing at least 20 individuals. The core roosting-area was comprised of *Pinus taeda* (Loblolly Pine) snags with abundant exfoliating bark and high solar exposure. This forest patch was adjacent to a large emergent-shrub wetland and within a larger matrix of mature, mid-Atlantic hardwood forests. The site where we found the colony location is 140 km east of the nearest known hibernaculum and is outside of the previously documented extent of this species' occurrence.

Myotis sodalis (Miller and Allen) (Indiana Bat) is a federally endangered species that is patchily distributed in the US from the Midwest and upper mid-South to the Northeast (US Fish and Wildlife Service 2007). Within the Mid-Atlantic region, the species' documented range occurs primarily in the central Appalachians (Ford and Chapman 2007). In Virginia, both sexes hibernate in caves in the winter (Powers et al. 2015). During summer, males roost singly and often in close proximity (<25 km) to hibernacula (Ford et al. 2002), whereas females sometimes migrate substantial distances (>150 km) from hibernacula to maternity colonies (Cryan and Veilleux 2007, Gardner and Cook 2002, Kurta 2010, Rockey et al. 2013) or they may remain relatively close (<10 km; Keyser and Ford 2006). Maternity colonies generally consist of fewer than 100 individuals (Harvey 2002). Characteristic maternity roost-trees or snags where females give birth and raise their young are taller than the surrounding canopy or in a bole within a canopy gap with high solar exposure, have large diameters, and have sloughing or exfoliating bark (Britzke et al. 2006, Callahan et al. 1997, Watrous et al. 2006). Indiana Bats have been observed in numerous species of trees or snags, particularly *Carya ovata* (K. Koch) (Shagbark Hickory) and *Acer saccharum* ((Marshall) (Sugar Maple) in much of the hardwood-dominated portion of its distribution (Jachowski et al. 2016, Menzel et al. 2001), whereas *Pinus* spp. (pine) snags with bark peeling off the bole are common day-roosts in the southern Appalachians and into the mid-South and lower Tennessee Valley (Britzke et al. 2003; D. Krusac, USDA Forest Service, Atlanta, GA, pers. com.)

Members of the maternity colony have a non-random social-structure network and often use multiple roost-trees throughout the season (Kurta et al. 2002, Silvis et al. 2014), within or in close proximity (< 3 km) to riparian habitats (Bergeson et al. 2013; Carter 2006; Kinowski and Gehrt 2014; Menzel et al. 2001, 2005). Several Indiana Bat hibernacula have been documented in the western mountains of Virginia and neighboring West Virginia, including US Fish and Wildlife Service Priority II hibernacula (Powers et al. 2015, US Fish and Wildlife Service 2007); however, prior to this study, no confirmed Indiana Bat maternity colony had been documented in Virginia (Virginia Department of Game and Inland

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Fisheries 2009), and very few had been found either in West Virginia or Maryland (Johnson and Gates 2009, Keyser and Ford 2006).

In 2014, we initiated an extensive acoustic survey of Fort A.P. Hill, a 30,060-ha US Army installation along the Piedmont–Coastal Plain physiographic province boundary (Fall Line) near Bowling Green in Caroline County, VA (Fig. 1). We used Anabat II systems (Titley Scientific, Columbia, MO) in zero-crossing format (Corben 2002) to collect acoustic data. We analyzed call data using the USFWS-approved software program Kaleidoscope Pro v2.0.7 (Wildlife Acoustics, Maynard, MA), and Echoclass v.3.1 (US Army Engineer Research and Development Center, Vicksburg, MS). Results of analyses using both programs indicated the likely presence of Indiana Bats at several locations on Fort A.P. Hill. Subsequent visual examination of calls in the Analook Version 3.7 viewer (Titley Scientific, Columbia, MO) supported automated-identification results as having echolocation characteristics indicative of Indiana Bats. We conducted focal mist-netting in the spring and mid-summer of 2015 at areas with acoustic detections, and captured 4 lactating female Indiana Bats. We used surgical cement (Perma-Type Company, Inc., Plainville, CT) to attach transmitters (LB-2X, Holohil Systems, Ltd., Carp, ON, Canada) to the dorsal surface between the scapulae of these females (Johnson et al. 2010) and tracked them using TRX-2000 receivers (Wildlife Materials, Inc., Murphysboro, IL). Transmitters weighed 0.27 g and were <5% of the body mass of radio-tagged bats, as recommended by Aldridge and Brigham (1988).

We tracked these bats to 9 roosts. Based on 6 exit counts and daily location data, we observed that these females were part of an active maternity colony and found that the core roost-area consisted of 5 roosts, with 4 additional roosts ~1 km away (Fig. 2); first date of capture was 13 May 2015. This maternity colony is ~140 km east of the nearest known hibernaculum in Virginia (Highland County; Powers et al. 2015) and 150 km south of the Carroll County, MD, observation of Indiana Bat maternity activity by Johnson and Gates (2009). Although we were unable to determine the full extent of colony membership, we observed 20 individuals emerging from 3 roosts on the same evening. Individual tree exit-counts ranged from 2 to 14 individuals. Using the minimum convex polygon method (Menzel et al. 2006) within ArcGIS 10.3 (ESRI, Redlands, CA), we estimated that the whole roosting area was

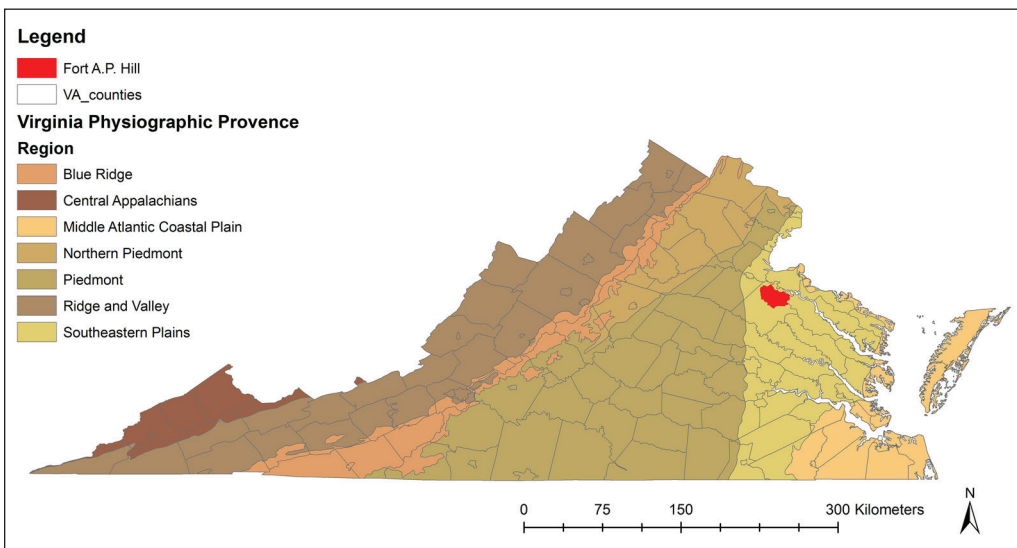


Figure 1. Location of Fort A.P. Hill and active *Myotis sodalis* (Indiana Bat) maternity colony (2015) within the Coastal Plain physiographic province of Virginia.

61 ha, although the core area was only ~1 ha. The core roosting area was comprised of standing-dead *Pinus taeda* L. (Loblolly Pine) snags along a toe-slope ravine adjacent to a large emergent-shrub wetland, and within a larger matrix of mature, mid-Atlantic hardwood forest. All identified roost trees were Loblolly Pine snags in clusters or isolated trees. Roost trees ranged from 15.1 m to 34.2 m in height (mean = 23.8 m); dbh range = 29.7–51.3 cm (mean = 42.2 cm). Bats roosted in the mid-upper bole (mean = 16.6 m above the ground); 70% of boles had full solar exposure and exfoliating bark coverage of 30–90% (mean = 54%). Snags appeared to be insect-killed (presumably by *Dendroctonus frontalis* [Zimmerman] [Southern Pine Beetle]) and/or prescribed-fire-killed individuals. We observed fire scarring to heights of 3–4 m from the ground on most of the surrounding trees. The core roosting area was most recently burned during a late dormant-season prescribed fire in 2014. Site occupancy with this disturbance regime suggests that Indiana Bats at Fort A.P. Hill may be able to follow the shifting mosaic of insect and fire mortality in pines. Prescribed burning provides suitable but ephemeral day-roost conditions that may only persist for 2–4 seasons as observed elsewhere in the mid-Atlantic (Johnson et al. 2010).

Stand conditions, similar to those used by the colony we identified, exist throughout Fort A.P. Hill. It is noteworthy that all roost trees we located were readily identifiable from high-resolution 2014 National Agriculture Imagery Program (NAIP) aerial photography (Fig. 3a). The spectral properties of the dead trees were visible using the 1-2-3 (red-green-

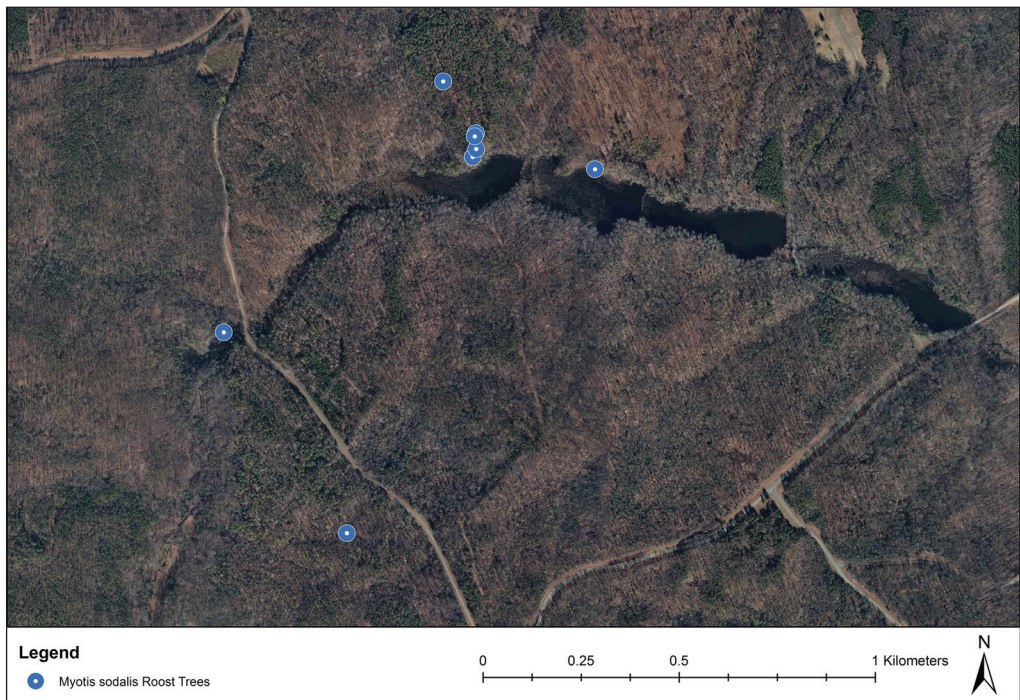


Figure 2. *Myotis sodalis* (Indiana Bat) roost locations (filled circles) at Fort A.P. Hill, VA. Two roost trees (within cluster) were <0.5 m apart and show as 1 location at this scale.

Figure 3 (following page). *Myotis sodalis* (Indiana Bat) roost locations (filled circles) at Fort A.P. Hill, Virginia, with (A) National Agriculture Imagery Program (NAIP) 2014 true-color imagery and (B). ArcGIS v10.3, 1-2-3 (red-green-blue) band combination with a histogram equalize. The spectral properties of dead vegetation show as pink with this combination and histogram stretch. Two roost trees were <1 m apart and show as 1 location at this scale.

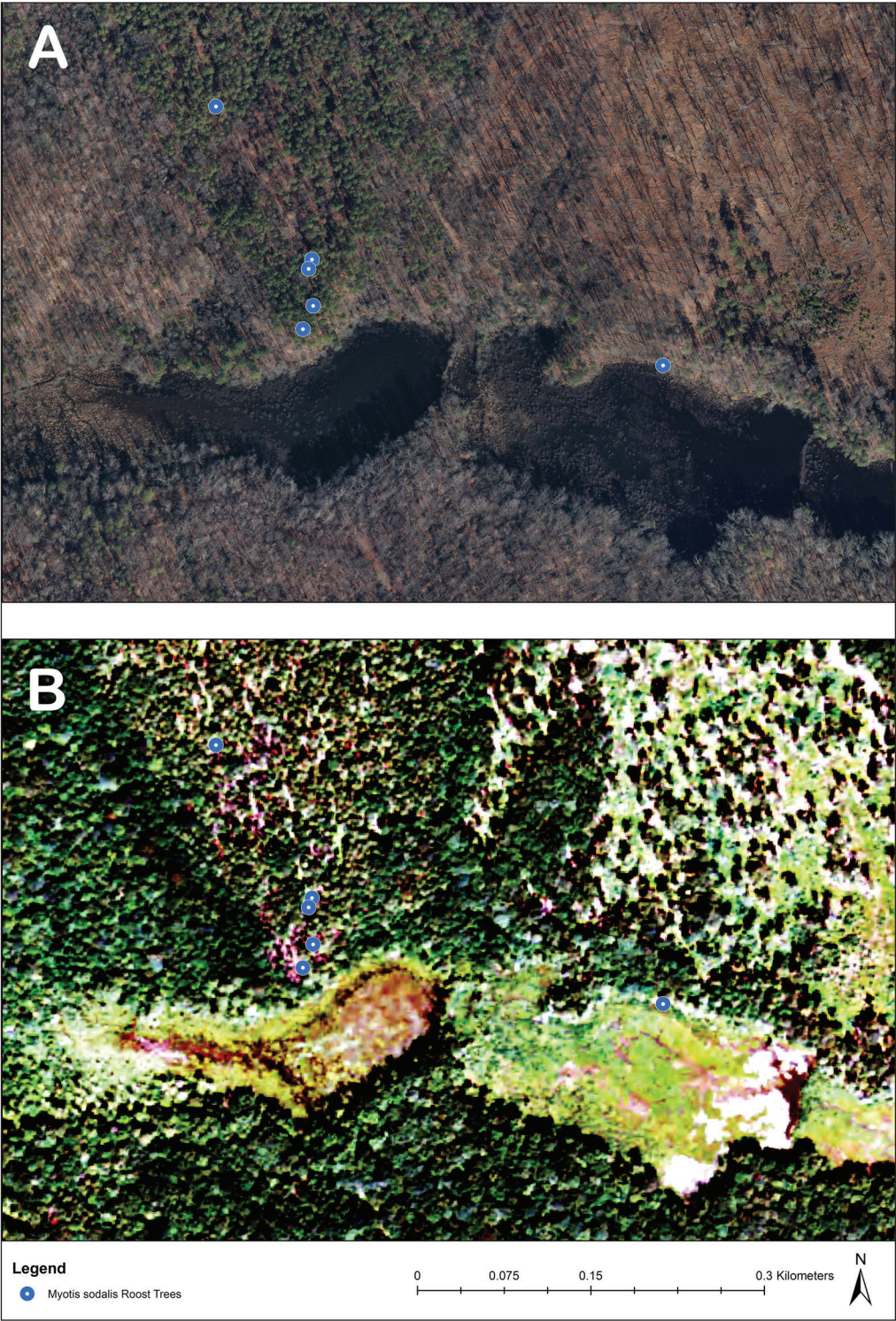


Figure 3.[Caption located on previous page.]

blue) band combination with a histogram-equalize stretch within ArcGIS 10.3 (Fig. 3b). The change-detection analysis we performed between 2012 and 2014 suggests 1% annual Loblolly Pine mortality as potential roost recruitment.

Our finding represents the first confirmed Indiana Bat maternity colony in Virginia and is relatively novel for its occurrence in the Coastal Plain. Although this colony appears small compared to other sites studied prior to the advent of White-nose Syndrome (Menzel et al. 2001, Silvis et al. 2014), it represents a significant expansion in the known range of the species' summer distribution. Additional acoustic surveys along the Fall Line in Virginia conducted during 2014–2015 detected the probable presence of Indiana Bats at numerous other locations (A. Silvis, unpubl. data), suggesting the species may be more widely distributed than previously believed. The Coastal Plain of Virginia, and more broadly, much of the Coastal Plain of the mid-Atlantic, was previously considered to be outside the known range; thus, surveys for targeting Indiana Bats in the area have been lacking. Therefore, it is unclear whether the colony we documented has a long-term history in the region, or if it represents a shift in range in concert with land-use change, ongoing climate change, the White-nose Syndrome disease dynamic, or a combination of those factors. Accordingly, we suggest that increased monitoring and surveys in the mid-Atlantic Coastal Plain physiographic province are warranted.

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