Bat Roost and Habitat Use at Devils Tower National Monument Final Report

CESU Cooperative Agreement P16AC00669

<u>Prepared by:</u>

Ian Abernethy, Lead Vertebrate Zoologist
Zach Wallace, Assistant Vertebrate Zoologist
Douglas Keinath, Former Senior Zoologist

Wyoming Natural Diversity Database
University of Wyoming
1000 E. University Ave, Department 3381
Laramie, Wyoming 82071

<u>Prepared for:</u>
Rene Ohms
Chief of Resource Management
Devil's Tower National Monument
Devil's Tower, WY 82714

April, 2017

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Introduction

Bats are a key component of biodiversity and ecosystems worldwide. Globally, bats are integral in many ecosystem processes including pollination and seed-dispersal (Adams 2003, Kunz and Parsons 2009). Bats also consume large quantities of insects, some of which cause damage to agricultural resources or are vectors of diseases affecting human health (Kunz and Parsons 2009). In North America alone, bats prevent and estimated $3.7 billion in damage to crops on an annual basis (Boyles et al. 2011). Worldwide, many bat species have experienced large declines and are faced with increasing risks of extinction. In the United States alone, six bat species are currently listed as "Endangered" and one is listed as "Threatened" under the Endangered Species Act (ESA), while two others have been petitioned for ESA protections (Harvey et al. 2011, Kunz and Reichard 2011, United States Fish and Wildlife Service 2011, 2013, Center for Biological Diversity and Defenders of Wildlife 2016). Bat population declines across the globe have many causes including habitat loss and alteration, disease, and renewable energy development.

The Black Hills and Bear Lodge Mountains of northeastern Wyoming and western South Dakota represent an area of high biological diversity. The region serves as a unique biogeographic refugia for many plant and animal species typical of the Rocky Mountains, Great Basin, eastern deciduous forest, boreal forest, and southern Great Plains bioregions (Knight et al. 2014). Devils Tower National Monument (hereafter DETO) is located on the northwestern flank of the Bear Lodge Mountains. The DETO landscape is heterogeneous in topography, geology, and vegetation structure and composition. The landscape is dominated by Devils Tower itself, a tall igneous rock formation. The tower is surrounded by sandstone outcrops and steep terrain that descends to the Belle Fourche River. Much of DETO is dominated by ponderosa pine (*Pinus pondersa*) forest and mixed grass prairie (Knight et al. 2014). Bur oak (*Quercus macrocarpa*) are interspersed with ponderosa pine in forested areas and dominate low-lying areas and portions of the flood plain of the Belle Fourche River (Knight et al. 2014). Large plains cottonwood (*Populus deltoides*) are found along the Belle Fourche River. This biological diversity coupled with diverse habitat types and landscape features allows for uniquely diverse bat species assemblages, with at least 10 bat species known to occur at DETO.

While many bat species are known to occur at DETO, we primarily focused our efforts on obtaining data specific to Northern Long-eared Bat (*Myotis sepetentironalis*; hereafter NLEB). The species is a small vespertilionid bat, but is medium in size among *Myotis* species. Dorsal pelage is dull yellow-brown and ventral pelage is pale gray. Wing and tail membranes are translucent and light brown (Bogan et al. 2005). The calcar often has a slight keel. The ears are relatively long (17-19 mm) and have a distinct long, pointed tragus (Caceres and Barclay 2000). NLEB is widely distributed across central and eastern Canada and the midwestern and eastern United States. It is generally considered an eastern species and is thought to be quite rare in the western portions of its distribution. DETO is on the extreme western edge of the species range and the species has only been documented in the northeastern corner of the state in the vicinity of the Bear Lodge Mountains and Black Hills.

NLEB was petitioned for listing under the Endangered Species Act in 2010. The primary factor threating the species listed in the petition was the impact of White-Nose Syndrome (WNS) to the species throughout a large portion of its range in eastern North America. In 2011, the United States Fish and Wildlife Service (USFWS) issued a positive 90-day finding indicating substantial evidence was presented within the 2010 petition. A 12-

month status review was initiated in 2011 (United States Fish and Wildlife Service 2011). In 2013, USFWS published the results of this status review and proposed the species be listed as endangered under the ESA (United States Fish and Wildlife Service 2013). In April of 2015, USFWS determined the species warranted threatened species status. The threatened status indicates that the species in imminent danger of becoming endangered to the threat of extinction throughout a significant portion or its entire range. The USFWS also implemented a 4(d) rule for areas where WNS does not currently affect the species, which includes all areas where the species occurs in Wyoming. The 4(d) rule exempts lawful incidental take of the species in these areas and is intended to provide flexibility for activities that may affect the species in the area covered under this rule (United States Fish and Wildlife Service 2015b). As specified in the original petition, WNS is the primary threat to the persistence of NLEB in North America. The disease is caused by the fungal pathogen *Pseudogymnoacus destructans* (formerly *Geomyces destructans*) and affects hibernating bats (O'Keefe and Loeb 2017). The disease was first noted in New York in 2006. Since that time, several million bats have died from WNS (Froschauer and Coleman 2012). In affected areas, mortality rates of up to 100% have been documented (Frick et al. 2010). The disease continues to spread west from the eastern and southeastern US. Although WNS has not yet been documented in Wyoming, it has been documented in the adjacent state of Nebraska and recently made a large geographical advancement to Washington (whitenosesyndrome.org 2017). As the range of the disease continues to expand across the country, it could impact bats at DETO in the near future.

Basic knowledge of habitat use and associations of NLEB in Wyoming is limited. Across its range, NLEB is strongly associated with deciduous and coniferous forest habitats. In Wyoming, the species is only known from areas dominated by ponderosa pine forest. The species frequents a wide variety of day and night roosts during the summer with trees are most frequently used as roosts. Specifically, tall, large diameter trees are preferred across the species range though maternity colonies may also include roosts such as human-made structures and buildings (Caceres and Barclay 2000). Prior to this study, roost preference had not been evaluated in Wyoming but in the Black Hills of South Dakota, pregnant and lactating female NLEB typically roosted in the largest snags available and roost trees were generally highly decayed (Cryan et al. 2001). NLEB hibernates in caves and abandoned mines during the winter (Caceres and Barclay 2000). To date, there are no known hibernacula used by the species in Wyoming but they are known to hibernate in South Dakota. Within the hibernacula, NLEB often cluster in deep crevices. Evidence suggests that summer habit is generally fairly close to winter hibernacula (less than 56 km) (Caceres and Barclay 2000).

This report summarizes activities conducted in 2016 and 2017 to enhance our understanding of summer day roost use and selection of NLEB northern long-eared bat (*Myotis septentrionalis*; hereafter NLEB) on Devil's Tower National Monument (hereafter DETO). NLEB was listed as Threatened under the Endangered Species Act in April 2015, primarily resulting from large declines in eastern populations caused by mortalities from White Nose Syndrome (United States Fish and Wildlife Service 2015b). Evidence from the eastern U.S. suggests NLEB almost always roosts in trees during the summer (Lacki et al. 2009) and forest management practices can be used to provide favorable roosting sites for similar dwelling bats (Perry et al. 2008). Our knowledge of NLEB roost selection within the Black Hills region comes from only nine individual bats (Cryan et al. 2001). This lack of knowledge challenges land managers attempting to identify important areas and management techniques that can influence the persistence of NLEB and other bat species in the region. Ultimately, enhanced understanding of distribution and habitat associations of NLEB will help the National Park Service (NPS) in planning current management actions leading to preservation of this and other bat species, management actions that are aligned with Endangered Species Act protections and upcoming Recovery Plans, and management actions in the more distant future under possible influence of (WNS).

Methods

We captured bats using mist nets deployed in single-high arrays over water sources and double-high arrays in flight corridors. We focused capture efforts in areas that were known to be frequented by NLEB based on previous survey efforts (Griscom and Keinath 2011, Keinath and Abernethy 2016). All captured bats were measured (forearm length, ear length), weighed, sexed, aged, and identified to species. We fitted NLEB, Fringed Myotis (*Myotis thysanodes*), and Townsend's Big-eared Bats (*Corynorhinus townsendii*) with 0.25-gram Blackburn VHF radio transmitters (Philip Blackburn, 819 Logansport Street, Nacogdoches, TX 75951) or 0.27-gram Holohil LB2x VHF radio transmitters (Holohil Systems Ltd. 112 John Cavanaugh Drive, Carp, Ontario, Canada K0A 1L0) that were less than 5% of bat body mass (Aldridge and Brigham 1988). All other bat species were released at the site of capture following processing. Procedures for transmitter attachment followed those approved for Indiana Bat (United States Fish and Wildlife Service 2015a). To attach the transmitter, a small patch of hair between the scapula approximately the size of the transmitter (8 mm X 2.8 mm) was carefully trimmed to expose the skin using small sterilized scissors and cleaned using a disposable alcohol pad. A small amount of surgical adhesive (Perma-Type Surgical Cement; http://www.perma-type.com/accesil.html) was applied to the trimmed area and allowed set for 5 - 10 minutes, after which the flat side of the transmitter was placed on the adhesive with the antenna facing the posterior end of the bat. Once the adhesive was set, the bat was released at the capture location. As specified by the terms of our permit, all survey protocols followed the "2015 Range-wide Indiana Bat Survey Guidelines" (United States Fish and Wildlife Service 2015a) and equipment was decontaminated following the "National White-Nose Syndrome Decontamination Protocol Version 06.25.2012". Survey methods also conformed to recommended guidelines (e.g., Kunz and Parsons 2009, Sikes et al. 2011) and followed recommendations in Wyoming's bat conservation plan (Hester and Grenier 2005) for documentation and followed WNS protocols presented in Wyoming's WNS strategic plan (Abel and Grenier 2011).

Radio tagged bats were tracked to day roosts every day until the signal was lost or the transmitter fell off. Day roosts were located using standard VHF telemetry methods. We recorded features of roosts including structure (e.g., tree, rock crevice), location, height of bat location within the structure, diameter at breast height (DBH) of trees, total height of trees, and life stage of trees (Table 2). To assess forest features associated with occupancy by NLEB, we conducted tree density plots centered on roost trees and compared these data to data collected at plots located at random locations throughout DETO. Random plots were selected from a spatially balanced random sample generated using the Equi-probable Design option and Balanced Acceptance Sampling (BAS) algorithm (Robertson et al. 2013) within the SDraw Package (McDonald 2016) in Program R (https://www.r-project.org/). Plots were 25 m in radius and within each plot, we collected data on vegetative structure and topography within three 25-m by 2-m belt transects radiating from the plot center. The orientation of first transect was determined using a table of randomly generated compass bearings and the remaining transects were oriented 120° and 240° from the first. We counted all trees with centers within the belt and recorded their species, DBH, and total height. We divided the number of trees by the transect area to estimate tree density. We also counted, recorded species, DBH, and total height of each dead standing tree that fell within the plot. Topographic position variables of slope and aspect were calculated using a Digital Elevation Model and the Aspect and Slope tools in ArcMap 10.3. We used a Digital Elevation Model and the Geomorphometry and Gradient Metrics Toolbox in a GIS to generate a Heat Load Index (HLI) for DETO (Evans et al. 2014).

Sample sizes for Townsend's Big-eared Bat and Fringed Myotis were insufficient for statistical analyses, but descriptions of identified roost structures are presented below.

Because we had a small number of radio tagged NLEB and a small sample size of roosts, we assumed roosts were independent and pooled data across years and individuals. We assessed roost site selection at two scales: roost structures and habitat surrounding roosts. At both scales, we used logistic regression to compare used sites with random sites. Specifically, we compared trees that were used by NLEB with random trees and habitat surrounding NLEB roost structures with habitat surrounding random locations. We used the general linear model (glm) function with a logit link in Program R to conduct logistic regression analyses. For the roost structure-level analysis, we evaluated all possible subsets of additive models containing up to four variables measured at used roost trees and random trees (Table 1). Because we measured a larger number of covariates at the plot level, we used a two-stage process to develop models: first, we evaluated univariate models to select the best predictor within the categories of canopy cover, Diameter at Breast Height (DBH), height, decay class, stem density, and topographic positon (Table 2). We then evaluated all possible subsets of additive models comprising up to four covariates retained from the first stage. We used an information theoretic approach (Burnham and Anderson 2002) with the Akaike Information Criterion for small sample sizes (AICc) to select the highest ranking model with <2 ΔAICc and without uninformative parameters (Arnold 2010). Because AICc rankings mean little if the best-approximating model fits the data poorly, we assessed model fit using the Hosmer and Lemeshow goodness of fit test (Hosmer and Lemeshow 1980). We evaluated covariate point estimates and their 95% confidence intervals (CI) as indicators of the strength and direction of relationships in the best-approximating models, and interpreted lack of overlap between coefficient CI and zero as evidence of statistically significant relationships.

Results and Discussion

Mist-Netting

Between 2015 and 2016, we captured a total of 166 bats representing 10 species over 21 nights of mist-netting (Table 1). In 2015, we mist-netted on 6 occasions and captured 37 bats of 8 species. Captured species included Big Brown Bat (*Eptesicus fuscus*), Silver-haired Bat (*Lasionycteris noctivagans*), Western Small-footed Myotis (*Myotis ciliolabrum*), Western Long-eared Myotis (*Myotis evotis*), Little Brown Myotis (*Myotis lucifugus*), Northern Long-eared Myotis (*Myotis septentrionalis*), Fringed Myotis, and Long-legged Myotis (*Myotis volans*). In 2016, we conducted a total of 13 nights of mist-netting and captured a total of 129 bats representing 9 species, including the first Townsend's Big-eared Bats captured at DETO (Table 3). Captured species included Big Brown Bat, Hoary Bat (*Lasiurus cinereus*), Western Small-footed Myotis, Western Long-eared Myotis, Little Brown Myotis, Northern Long-eared Myotis, Fringed Myotis, Long-legged Myotis, and Townsend's Big-eared Bat.

In both years, we observed a male sex bias, with 107 males and 59 females captured (Table 3). We captured females with evidence of reproduction including pregnant and lactating individuals for a number of species. These included Big Brown Bat, Fringed Myotis, Little Brown Myotis, and Long-legged Myotis. A total of 144 of captured individuals were determined to be adults based on evaluation of the phalangeal epiphyseal plates (Kunz and Anthony 1982). Juvenile individuals of 7 species were captured including Big Brown Bat, Fringed Myotis, Hoary Bat, Little Brown Myotis, Long-legged Myotis, Northern Long-eared Bat, and Western Small-footed Myotis. The capture of female bats with evidence of reproduction in combination with the capture of juvenile individuals suggests DETO and the surrounding area likely support maternity colonies of these species. With the exception of one female NLEB captured in 2015, all captures of NLEB at DETO were males. The capture of two juvenile individuals and one post-lactating female indicate the likely presence of a maternity colony within migration distance of NLEB. Additionally, the presence of only male NLEB at DETO runs contrary to patterns of sexual segregation driven by altitude reported for this species (Cryan et al. 2000). Specifically, Cryan et al. (2000) documented presence of males and nonreproductive females at higher elevations and the presence of pregnant and lactating females at lower elevations. Within the Black Hills, DETO is at a relatively low elevation and it is unknown why only male NLEB occupy this area.

No bats were incidentally or intentionally killed in either year and all captures were released at the site of capture in good condition. Evaluation of the tail and wing membranes revealed no evidence of WNS infection (Reichard and Kunz 2009, Reichard 2010).

Roost Structures

In 2015, we placed radio tags on 8 NLEB, 7 of which were males and 1 of which was a non-reproductive female (Figure 6; Table 4). In 2016, a total of 16 male NLEB were fitted with radio transmitters resulting in the identification of 26 unique roost sites (Figure 7; Table 4). NLEB were tracked an average of 3.3 days, although a number of bats were never relocated or roosted outside of the DETO administrative boundary following transmitter attachment. A total of 35 unique NLEB roost locations were documented (Table 4). Mean distance from capture locations to roosts was 372.56m (SD 236.18m), and most roosts were located in snags in forested drainages on the northwest side of the tower (Figures 6 and 7). NLEB roosted almost exclusively in trees that included dead and live ponderosa pine and bur oak. Characteristics of roost trees varied considerably and included moderate to large ponderosa pine snags and logs (n=14), largelive ponderosa pine (n=6), and moderate to large live bur oak (n=4) and small bur oak snags (n=10). When NLEB roosted in live trees, they chose a portion of the tree that was dead (e.g. dead portion of a split trunk ponderosa pine or dead branch of bur oak). Further, characteristics of individual roost trees varied considerably (Table 2) and included a number of downed logs (n=5), such as a highly decayed bur oak log resting on a large boulder. One individual roosted in a rock crevice for one day in 2015. To our knowledge, this is the first evidence of NLEB roosting in rock crevices. However, this only occurred on one night and it is unclear if male NLEB frequently use rock crevices. In both years, NLEB showed fidelity to roosting areas, roosting in 1 to 4 unique roosts within close proximity to one another for the duration that individual was tracked. Because transmitter retention was short, it is unknown how long individuals showed fidelity to an area. NLEB frequently switched between roosts every few days (range 1-7), but this seemed to differ by individual, with some individuals staying in the same roost for the entire tracking period. In general, NLEB roosted on slopes with southwesterly aspects (mean aspect = 224°), but a small number of roosts (n=5) were on slopes with northeast or east aspects. Most roosts were in relatively low slope positions (toeslope, footslope, or backslope).

We fitted 4 female Fringed Myotis, 2 pregnant and 2 lactating, and tracked them to 9 unique roosts at DETO in 2016 (Figure 8). These were all located in crevices in sandstone outcrops (n=6) or interstitial spaces of the boulder field (n=3). Prior to July 2, Fringed Myotis roosted in sandstone outcrops, whereas roosts located after July 2 were in the boulder field at the base of Devils Tower. Fringed Myotis fitted with radio transmitters before July 2 were all pregnant females, while those fitted with transmitters after July 2 showed evidence of lactation, suggesting the possibility that reproductive status influenced roost selection.

We fitted 2 male Townsend's Big-eared Bats and tracked them to 8 unique roosts at DETO in 2016 (Figure 9). The majority of these roosts were located in within the interstitial spaces of the boulder field at the base of the tower (n=7), while one was located within a small opening in a sandstone cliff band.

NLEB Day Roost Structure Selection

Our best approximating model for NLEB day roost structure selection included variables for the tree species and DBH. Specifically, NLEB selected bur oak over ponderosa pine based on their prevalence on the landscape ($\hat{\beta}$ = -1.30, SE: 0.43, 95% CI: -2.17 to - 0.46; Tables 5 and 7). NLEB also selected roost trees with larger diameters ($\hat{\beta}$ = 0.13, SE: 0.02, 95% CI: 0.08 to 0.18; Tables 5 and 7, Figure 10). The Hosmer and Lemeshow goodness of fit test showed no evidence of lack of fit for this model ($\chi^2 = 9.26$, df = 8, p = 0.32). Our model generally aligns with observations of roost selection across the range of NLEB (Cryan et al. 2001, Garroway and Broders 2008). Throughout their range, NLEB have been documented using a wide range of tree species based on the site-specific forest community, suggesting characteristics of the tree used as a roost may be more import than the tree species (Lacki et al. 2009, O'Keefe and Loeb 2017). It is well known that within a species, individuals of different sex and reproductive status differentially select roosts to meet energy demands and water balance needs. Specifically, males and non-reproductive females tend to select roosts with lower solar insolation that reduce energy expenditure and water loss while pregnant and lactating females select roosts with higher solar insolation that allow them to meet increased energy demands associated with fetus development and lactation (Garroway and Broders 2008, Lacki et al. 2009, O'Keefe and Loeb 2017). Our results are generally consistent with these patterns, with male NLEB selecting roosts with characteristics identified by other researchers as likely promoting reduced solar insolation (Garroway and Broders 2008, Lacki et al. 2009). Specifically, bur oak at DETO tend to be shaded by an overstory of ponderosa pine, and trees of all species with larger diameters tend to maintain lower temperatures than trees with smaller diameters. It should be noted that NLEB selected a broad array of roost structures including small bur oak snags, downed bur oak and ponderosa pine logs, and medium to large dead and live ponderosa pine. This suggests that male NLEB at DETO are able use varied roost structures, a fact that should be taken into account when considering management actions that my alter forest structure. Because we had a relatively small sample size, we choose to evaluate only additive models with a limited number of variables (Burnham and Anderson 2002). Our results, therefore, likely reflect only the strongest patterns in roost selection and may not capture more subtle relationships, like the importance of less frequently used types of roost structures and potential interactions between roost types and their location in the landscape.

NLEB Day Roost Habitat Selection

The best approximating model for NELB day roosting habitat included only the variable for the DBH of live ponderosa pine in the overstory. Specifically, NLEB selected roosts in areas with ponderosa pine of greater DBH

($\hat{\beta}$ = 0.28, SE: 0.09, 95% CI: 0.14 to 0.49; Tables 6 and 8, Figure 11). We assessed model fit using the Hosmer and Lemeshow goodness of fit test and determined model fit was good (χ^2 = 4.20, df = 8, p = 0.84). We hypothesize that forest stands with higher DBH ponderosa pine are older-aged stands that likely have a forest structure that reduces solar exposure and contain more potentially suitable roost structures. Similarly, while not statistically significant in our analysis, NLEB selected in roosts in areas with greater densities of dead trees in the overstory. Similar results have been noted in studies of NLEB and other tree-roosting bats (Lacki et al. 2009). It has been hypothesized that tree-roosting bats roost in areas with numerous potential roost structures, allowing frequent roost switching to reduce predation and ectoparasite loads (O'Keefe and Loeb 2017). As noted above, we observed roost switching by NLEB at DETO, with individuals using different roost structures within close proximity. Considering both variables included in our best approximating model suggests that forest stands comprised of large diameter ponderosa pine with a high density of dead trees are more likely to be used as roosts by NLEB at DETO.

Conclusions

Availability of suitable day roost structures is one of the key factors limiting the distribution and local abundance of bats (O'Keefe and Loeb 2017). Most studies of day roost use and selection have focused on pregnant and lactating female bats because of the importance of this demographic segment to persistence of local populations. Relatively few studies have evaluated day roost selection of male bats. Because only male NLEB appear to occupy DETO during the summer, this study presents results from an understudied demographic segment of bat populations.

Our results suggest that male NLEB at DETO use bur oak as day roost sites preferentially and that they preferred to roost in trees of larger diameters. However, a diverse array of dead, live, and even down trees were used as roosts, indicating that managers should consider the full breadth of potential roosts when planning management actions, especially where local populations have a male sex bias. At larger scales, our results suggest that NLEB selected areas with the overstory dominated by large diameter ponderosa pine and a high number of dead trees in overstory. Our results are based on observations from a relatively small number of individual male NLEB and a small geographic area. Future efforts should focus on additional demographic segments of NLEB populations and cover a larger geographic area.

Acknowledgements

This project would not have been possible without logistical support from Rene Ohms and Amy Hammesfahr. Rene was principally responsible for obtaining the necessary funding and permits, while Amy conducted most of the tracking of radio collared bats. A number of additional DETO personnel assisted in mist-netting, radio tracking, and habitat data collection.

Literature Cited

Abel, B., and M. Grenier. 2011. A strategic plan for White-nose Syndrome in Wyoming. Wyoming Game and Fish Department, Lander, Wyoming.

Adams, R. A. 2003. Bats of the Rocky Mountain West: Natural History, Ecology, and Conservation. University Press of Colorado, Boulder, Colorado.

Aldridge, H., and R. M. Brigham. 1988. Load carrying and maneuverability in an insectivorous bat - A test of the 5-percent rule of radio-telemetry. Journal of Mammalogy **69**:379-382.

Arnold, T. W. 2010. Uninformative parameters and model selection using Akaike's Information Criterion. Journal of Wildlife Management **74**:1175-1178.

Bogan, M. A., E. W. Valdez, and K. W. Navo. 2005. *Myotis septentrionalis* NORTHERN MYOTIS. Western Bat Working Group. http://www.wbwg.org.

Boyles, J. G., P. M. Cryan, G. F. McCracken, and T. H. Kunz. 2011. Economic Importance of Bats in Agriculture. Science **332**:41-42.

Burnham, K. P., and D. R. Anderson. 2002. Model Selection and Multimodel Inference: A Practical Information-Theoretic Approach. Springer, New York, NY.

Caceres, M. C., and R. M. R. Barclay. 2000. Myotis septentrionalis. Mammalian Species **634**:1-4.

Center for Biological Diversity, and Defenders of Wildlife. 2016. Petition to list the tricolored bat *Perimyotis subflavus as threatened or endangered under the Endangered Species Act*. Notice of Petition before the Secretary of the Interior.

Cryan, P. M., M. A. Bogan, and J. S. Altenbach. 2000. Effect of elevation on distribution of female bats in the Black Hills, South Dakota. Journal of Mammalogy **81**:719-725.

Cryan, P. M., M. A. Bogan, and G. M. Yanega. 2001. Roosting habits of four bat species in the Black Hills of South Dakota. Acta Chiropterologica **3**:43-52.

Evans, J. S., J. Oakleaf, S. A. Cushman, and D. Theobald. 2014. An ArcGIS Toolbox for surface gradient and geomorphometric modeling, version 2.0-0. http://evansmurphy.wix.com/evansspatial.

Frick, W. F., J. F. Pollock, A. C. Hicks, K. E. Langwig, D. S. Reynolds, G. G. Turner, C. M. Butchkoski, and T. H. Kunz. 2010. An emerging disease causes regional population collapse of a common North American bat species. Science **329**:679-682.

Froschauer, A., and J. Coleman. 2012. North American bat death toll exceeds 5.5 milliion from white-nose syndrome. United States Fish and Wildlife Service.

Garroway, C. J., and H. G. Broders. 2008. Day roost characteristics of northern long-eared bats (Myotis septentrionalis) in relation to female reproductive status. Ecoscience **15**:89-93.

Griscom, H. R., and D. A. Keinath. 2011. Inventory and status of bats at Devils Tower National Monument. Report prepared for the USDI National Park Service by the Wyoming Natural Diveristy Database - University of Wyoming, Laramie, WY.

Harvey, M. J., J. S. Altenbach, and T. L. Best. 2011. Bats of the United States and Canada. The Johns Hopkins University Press, Baltimore, Maryland.

Hester, S. G., and M. B. Grenier. 2005. A conservation plan for bats in Wyoming. Wyoming Game and Fish Department Nongame Program, Lander, WY.

Hosmer, D. W., and S. Lemeshow. 1980. GOODNESS OF FIT TESTS FOR THE MULTIPLE LOGISTIC REGRESSION-MODEL. Communications in Statistics Part a-Theory and Methods **9**:1043-1069.

Keinath, D. A., and I. M. Abernethy. 2016. Northern long-eared Myotis roost site selection in Devil's Tower National Monument. Report prepared for the Department of Interior, National Park Service by the Wyoming Natural Diversity Database, University of Wyoming, Laramie, Wyoming.

Knight, D. H., J. P. Jones, W. A. Reiners, and W. H. Romme. 2014. Mountains and plains the ecology of Wyoming landscapes. 2nd edition. Yale University Press, New Haven, CT.

Kunz, T. H., and E. L. P. Anthony. 1982. Age estimation and postnatal-growth in the bat *Myotis lucifugus*. Journal of Mammalogy **63**:23-32.

Kunz, T. H., and S. Parsons. 2009. Ecological and behavioral methods for the study of bats. Second Edition edition. The Johns Hopkins University Press, Baltimore, Maryland.

Kunz, T. H., and J. D. Reichard. 2011. Status review of the Little Brown Myotis (*Myotis lucifugus*) and determination that immediate listing under the Endangered Species Act is scientifically and legally warranted. Boston University's Center for Ecology and Conservation Biology.

Lacki, M. J., D. R. Cox, and M. B. Dickinson. 2009. Meta-analysis of Summer Roosting Characteristics of Two Species of Myotis Bats. American Midland Naturalist **162**:318-326.

McDonald, T. 2016. SDraw: Spatially balanced sample draws for spatial objects., https://CRAN.R-project.org/package=SDraw.

O'Keefe, J. M., and S. C. Loeb. 2017. Indiana bats roost in ephemeral, fire-dependent pine snags in the southern Appalachian Mountains, USA. Forest Ecology and Management **391**:264-274.

Perry, R. W., R. E. Thill, and D. M. Leslie, Jr. 2008. Scale-dependent effects of landscape structure and composition on diurnal roost selection by forest bats. Journal of Wildlife Management **72**:913-925.

Reichard, J. D. 2010. Wind-damage index used for characterizing wing condition of bats affected by white-nose syndrome.

Reichard, J. D., and T. H. Kunz. 2009. White-nose syndrome inflicts lasting injuries to the wings of little brown myotis (Myotis lucifugus). Acta Chiropterologica **11**:457-464.

Robertson, B. L., J. A. Brown, T. McDonald, and P. Jaksons. 2013. BAS: Balanced Acceptance Sampling of Natural Resources. Biometrics **69**:776-784.

Sikes, R. S., W. L. Gannon, and M. Amer Soc. 2011. Guidelines of the American Society of Mammalogists for the use of wild mammals in research. Journal of Mammalogy **92**:235-253.

United States Fish and Wildlife Service. 2011. Endangerd and Threatened Wildlife and Plants; 90-Day Finding on a Petition to List the Eastern Small-footed Bat and Northern Long-eared Bat as Threatend or Endangered. Federal Register **76**:38095 - 38106.

United States Fish and Wildlife Service. 2013. Endangered and threatened wildlife and plants; 12-month finding on a petition to list the eastern small-footed bat and the northern long-eared bat as endangered or threatened species; listing the northern long-eared bat as an endangered species. Federal Register.

United States Fish and Wildlife Service. 2015a. 2015 Range-wide Indiana Bat summer survey guidelines. United States Fish and Wildlife Service Midwest Region, http://www.fws.gov/midwest/endangered/mammals/inba/inbasummersurveyguidance.html.

United States Fish and Wildlife Service. 2015b. Endangered and Threatened wildlife and plants; Threatened Species Status for the Northern Long-Eared Bat with 4(d) Rule; Final Rule and Interim Rule. Federal Register **80**:17974-18033.

whitenosesyndrome.org. 2017. Updated white-nose syndrome map March 15, 2017. https://www.whitenosesyndrome.org/sites/default/files/resource/wns_map_20170315_1.jpg.

Figures

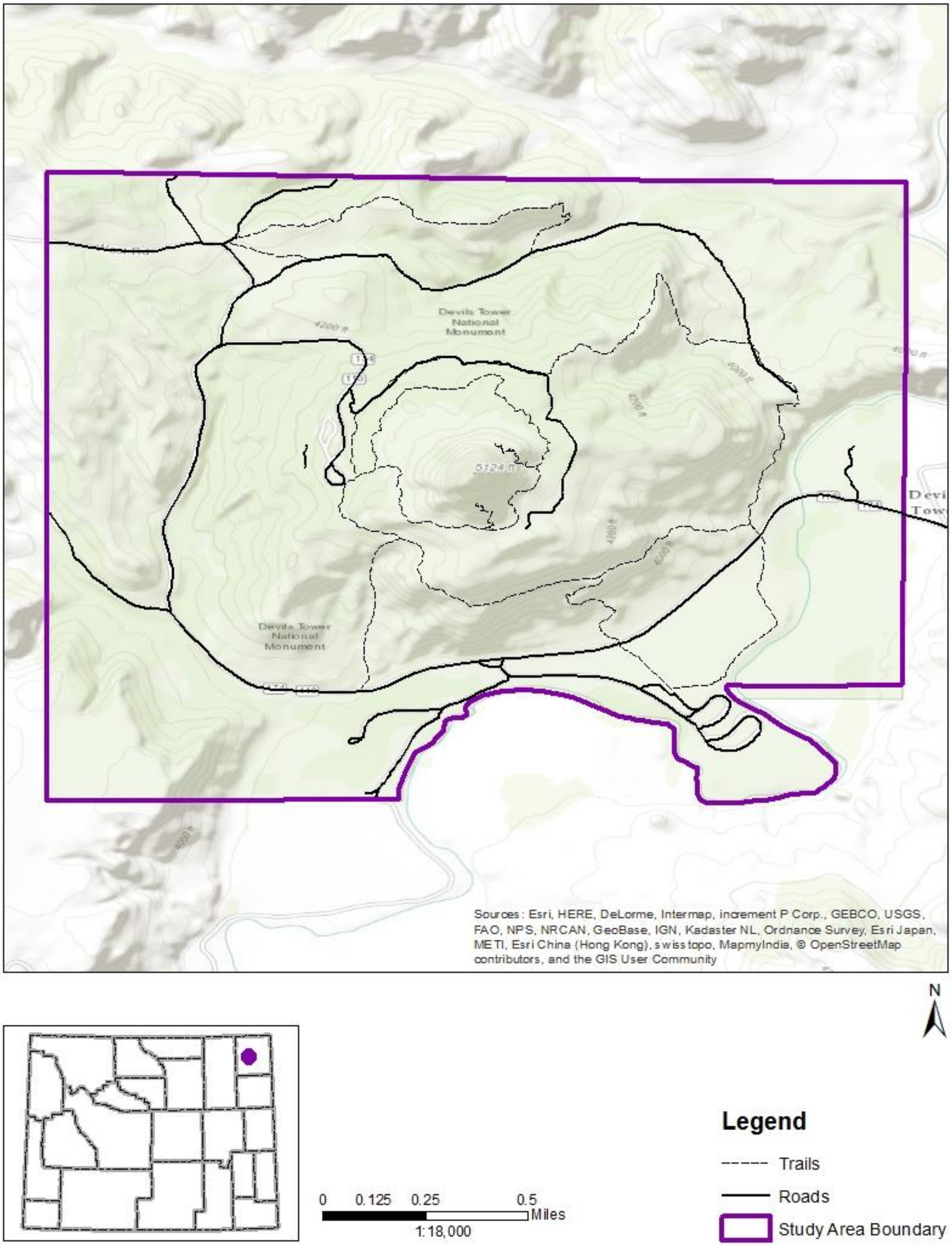

Figure 1. Study area at DETO in 2015 and 2016.

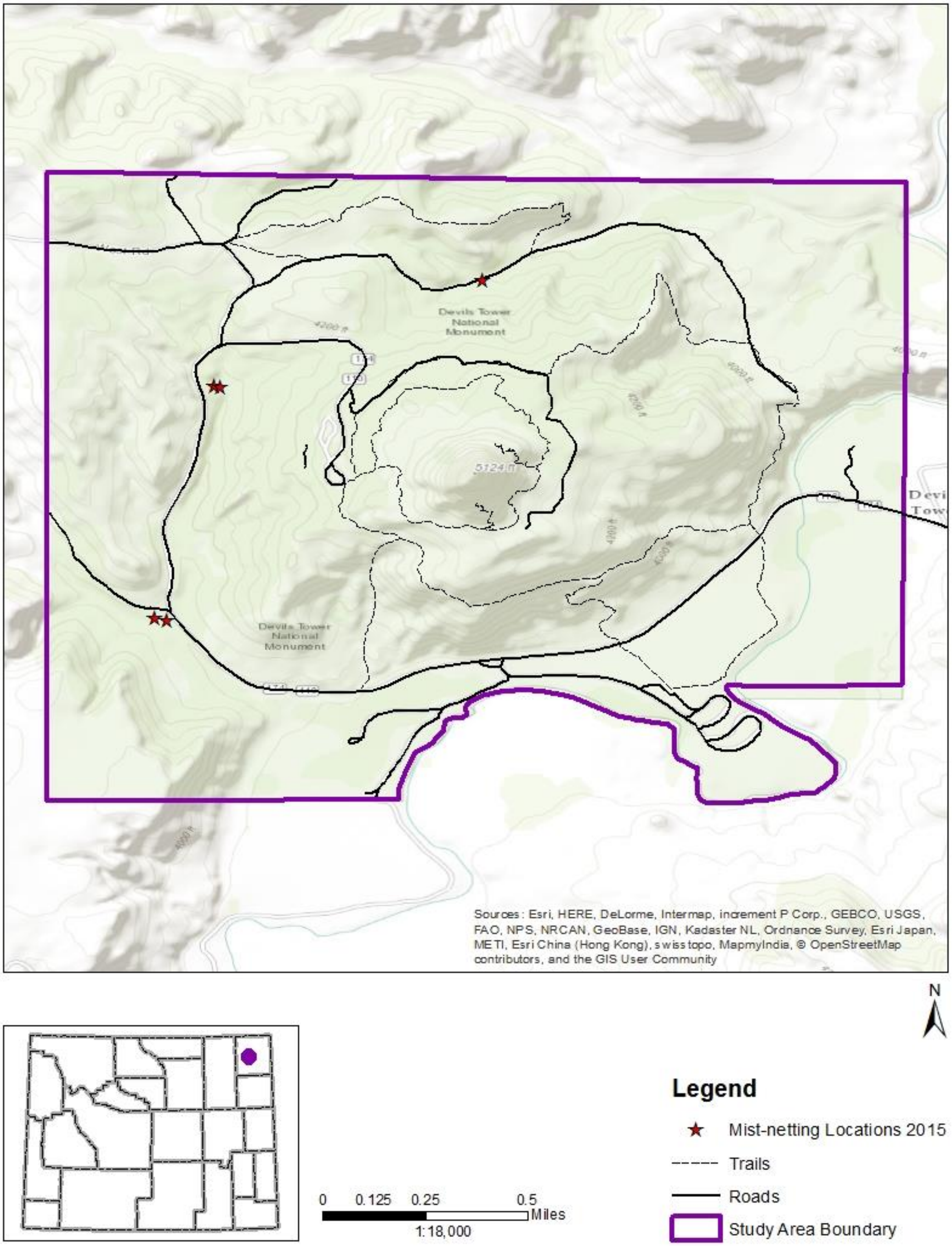

Figure 2. Map of mist-netting locations sampled at DETO in 2015.

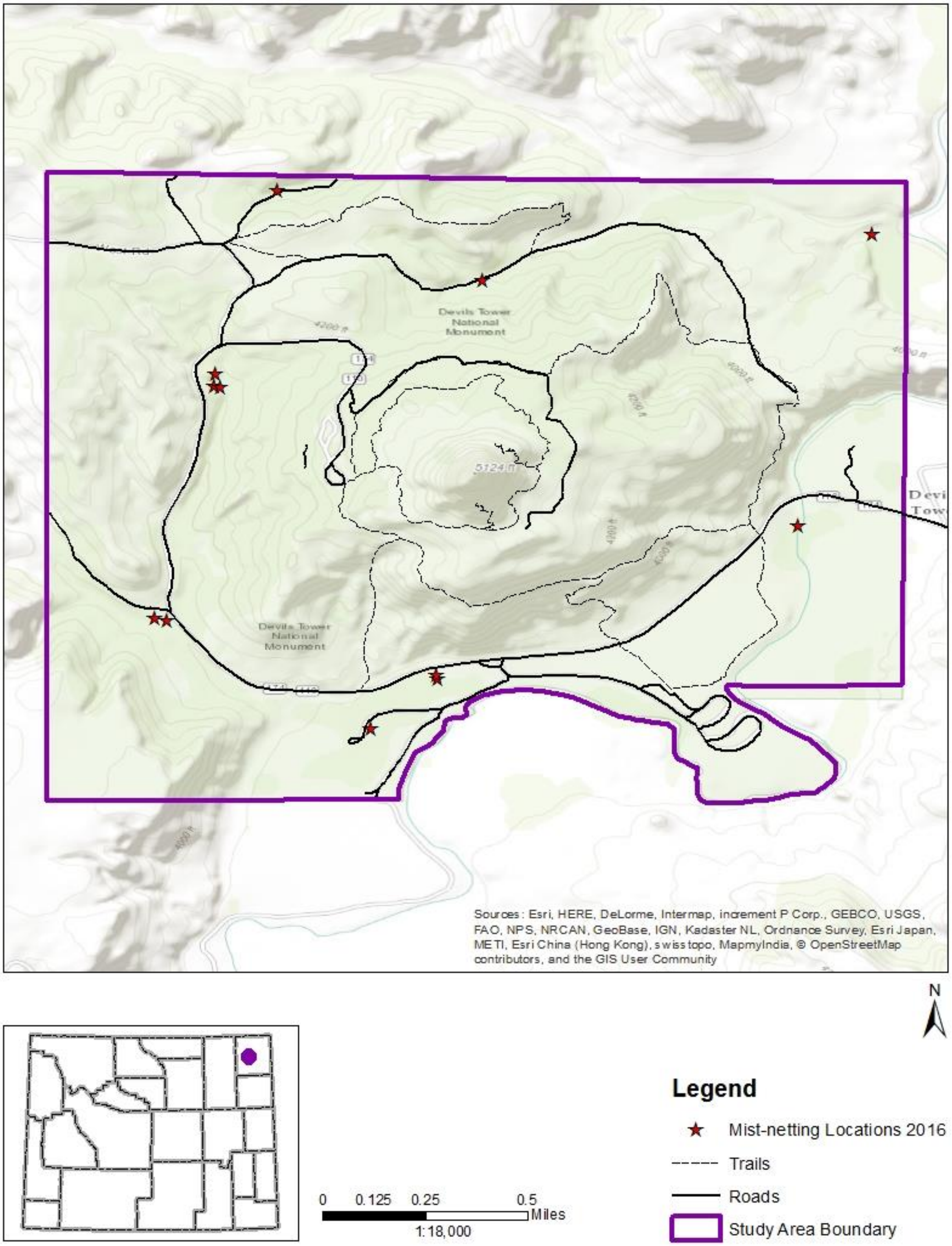

Figure 3. Map of mist-netting locations sampled at DETO in 2016.

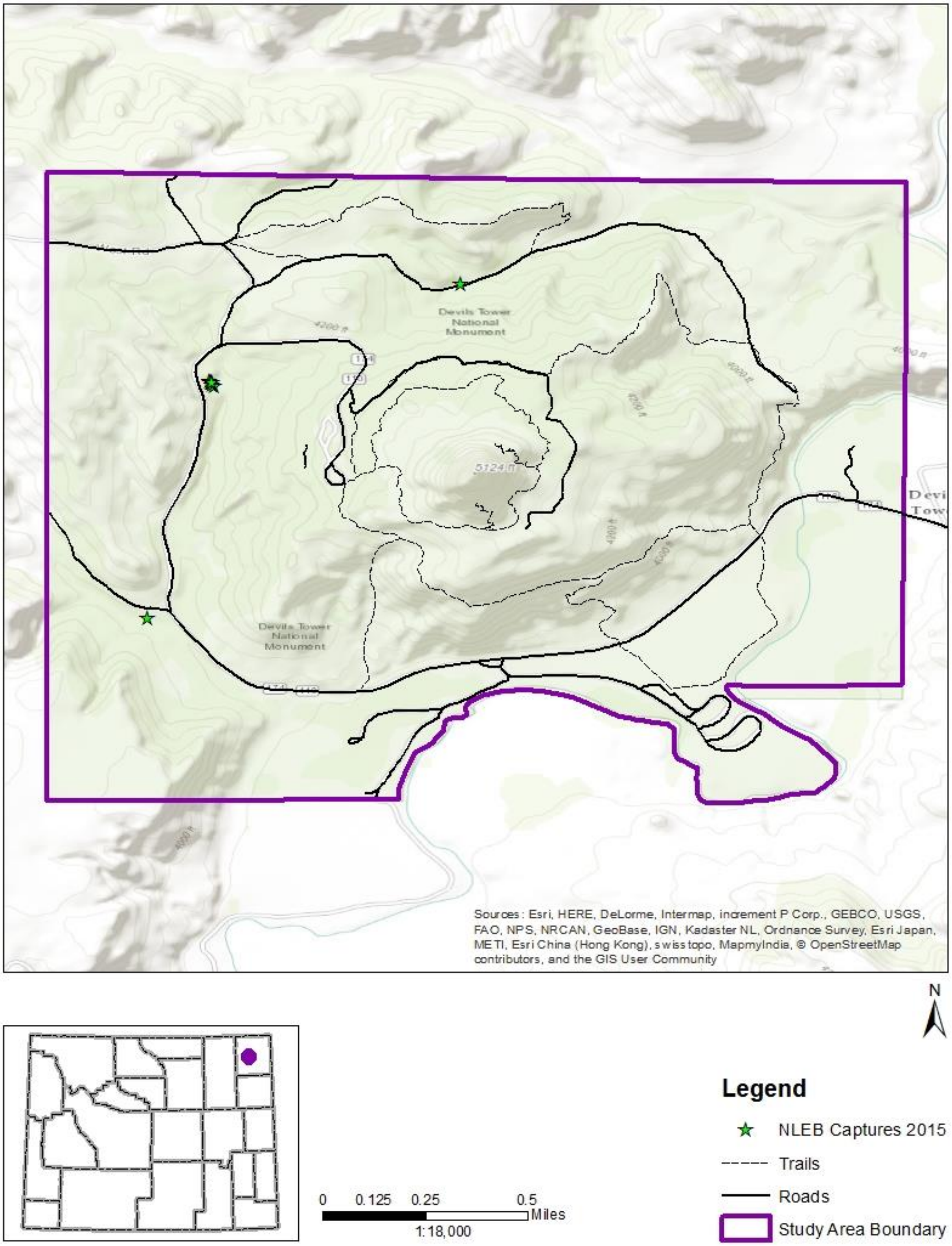

Figure 4. Map of NLEB captures at DETO in 2015.

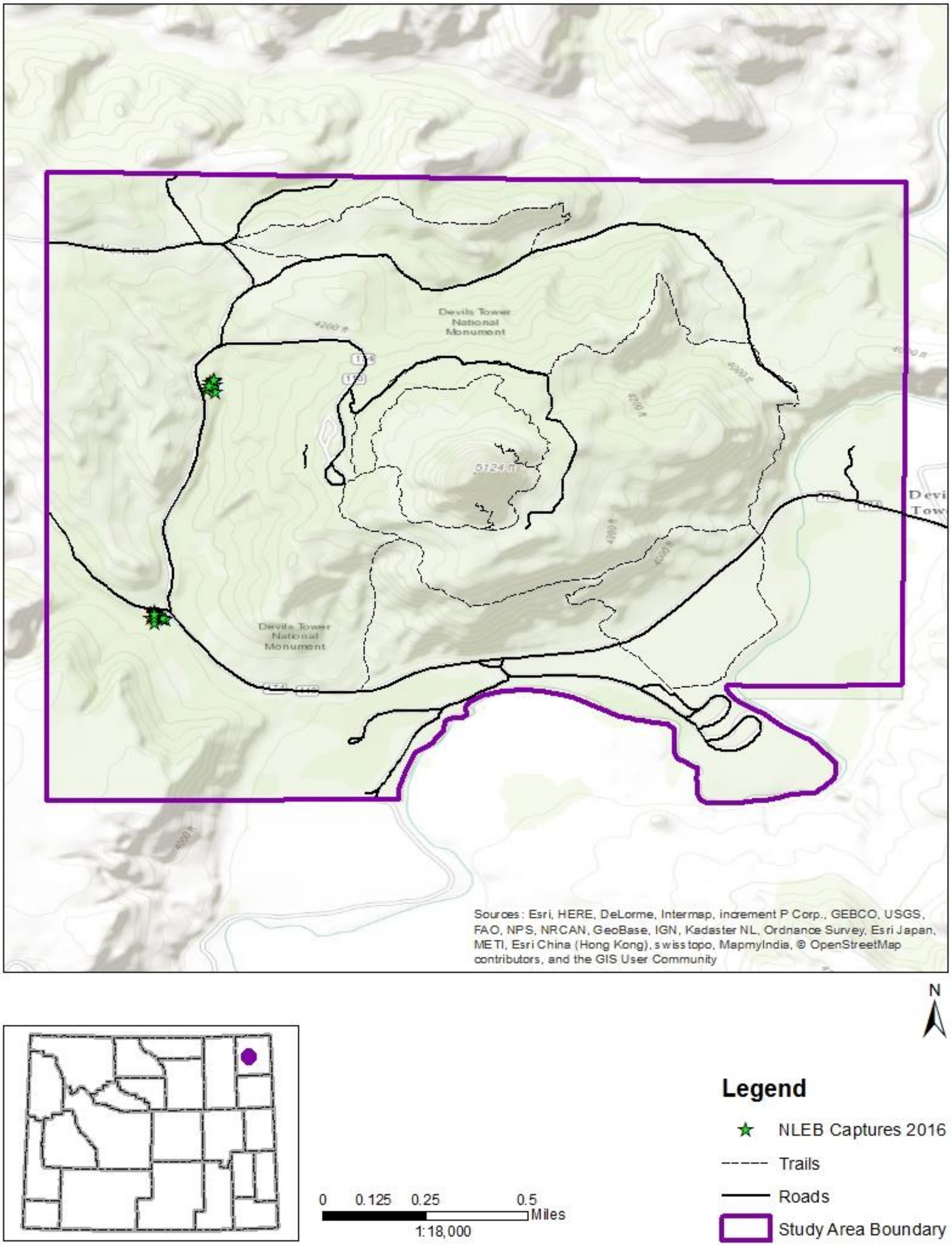

Figure 5. Map of NLEB captures at DETO in 2016.

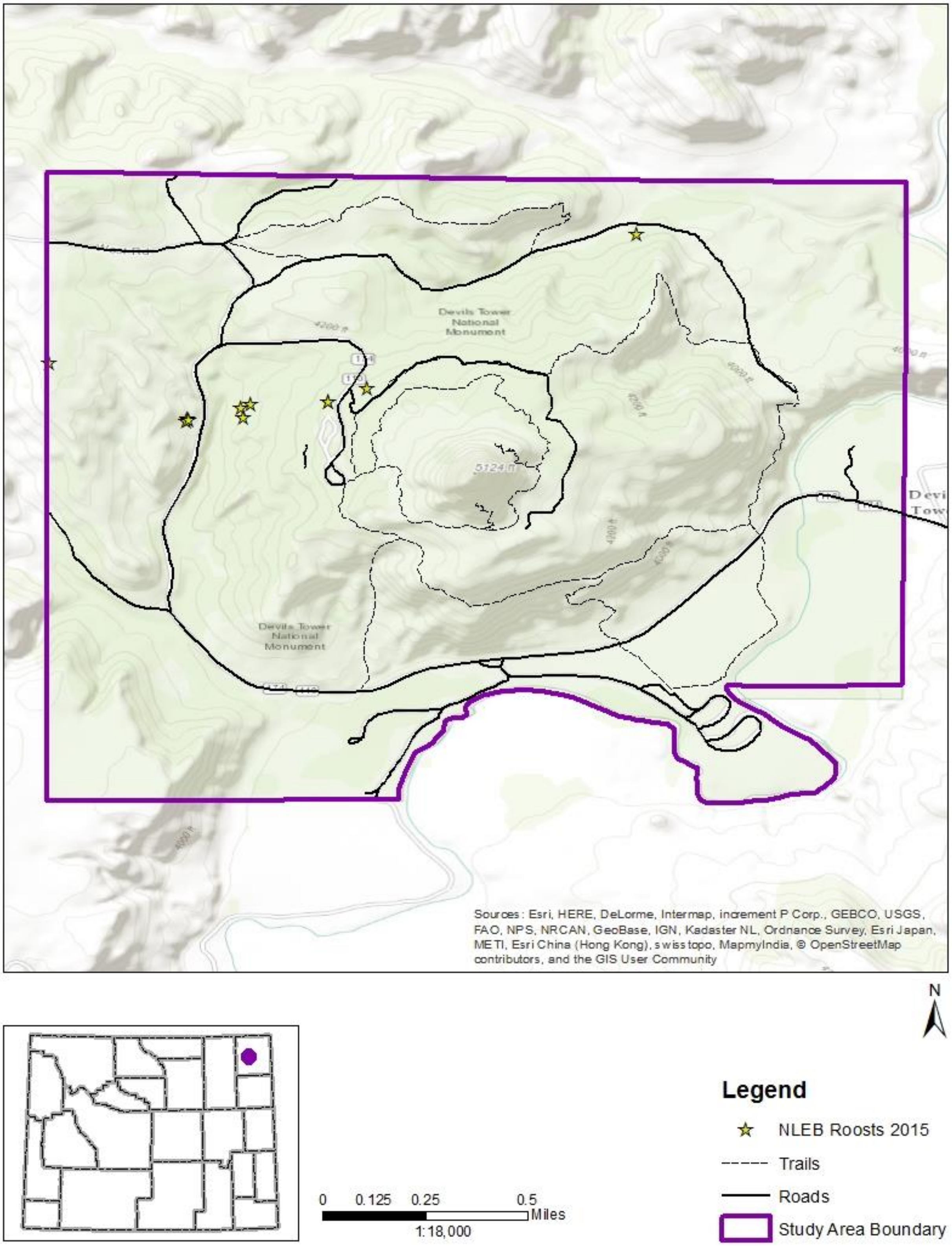

Figure 6. Map of NLEB day roosts located by tracking radio tagged bats at DETO 2015.

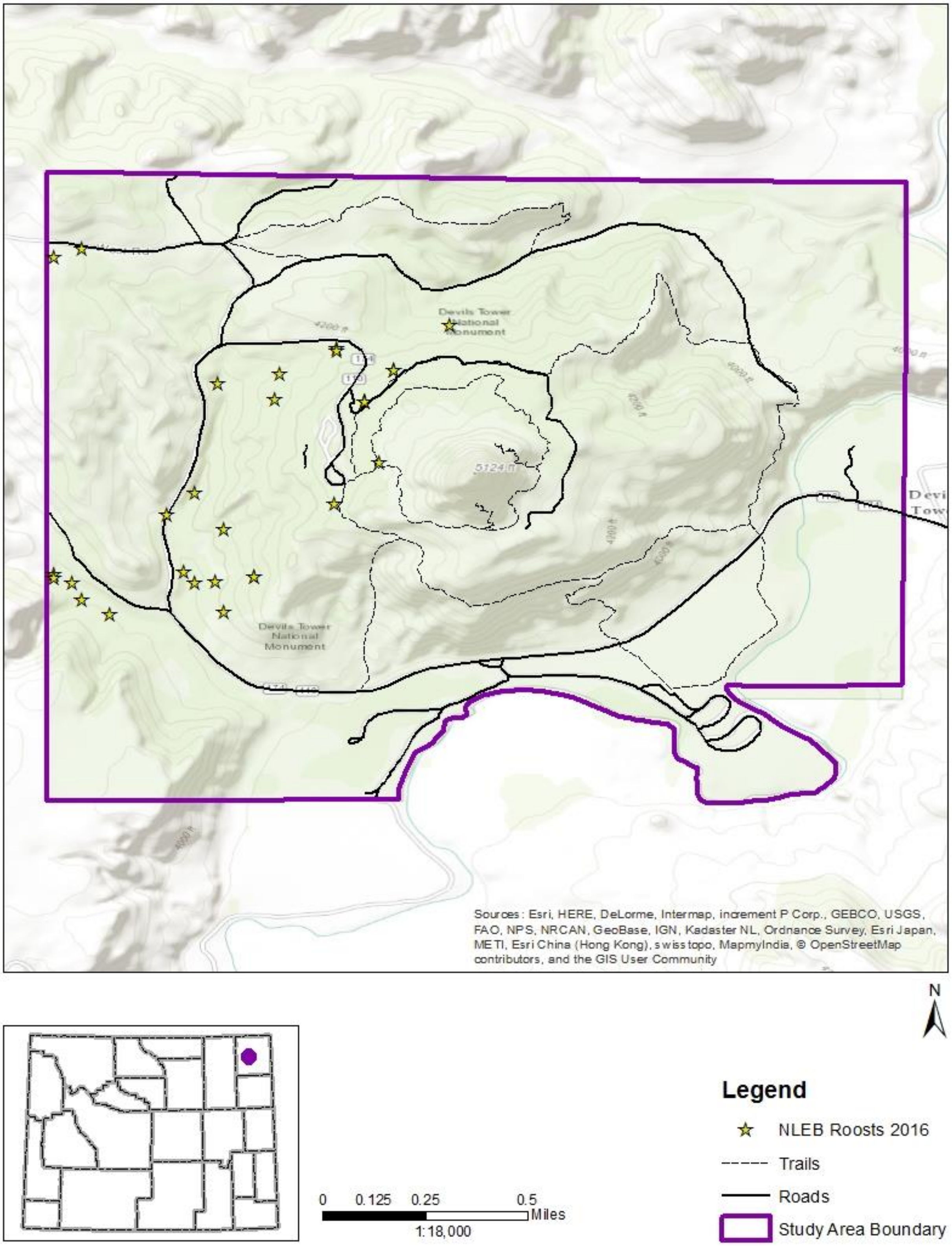

Figure 7. Map of NLEB day roosts located by tracking radio tagged bats at DETO 2016.

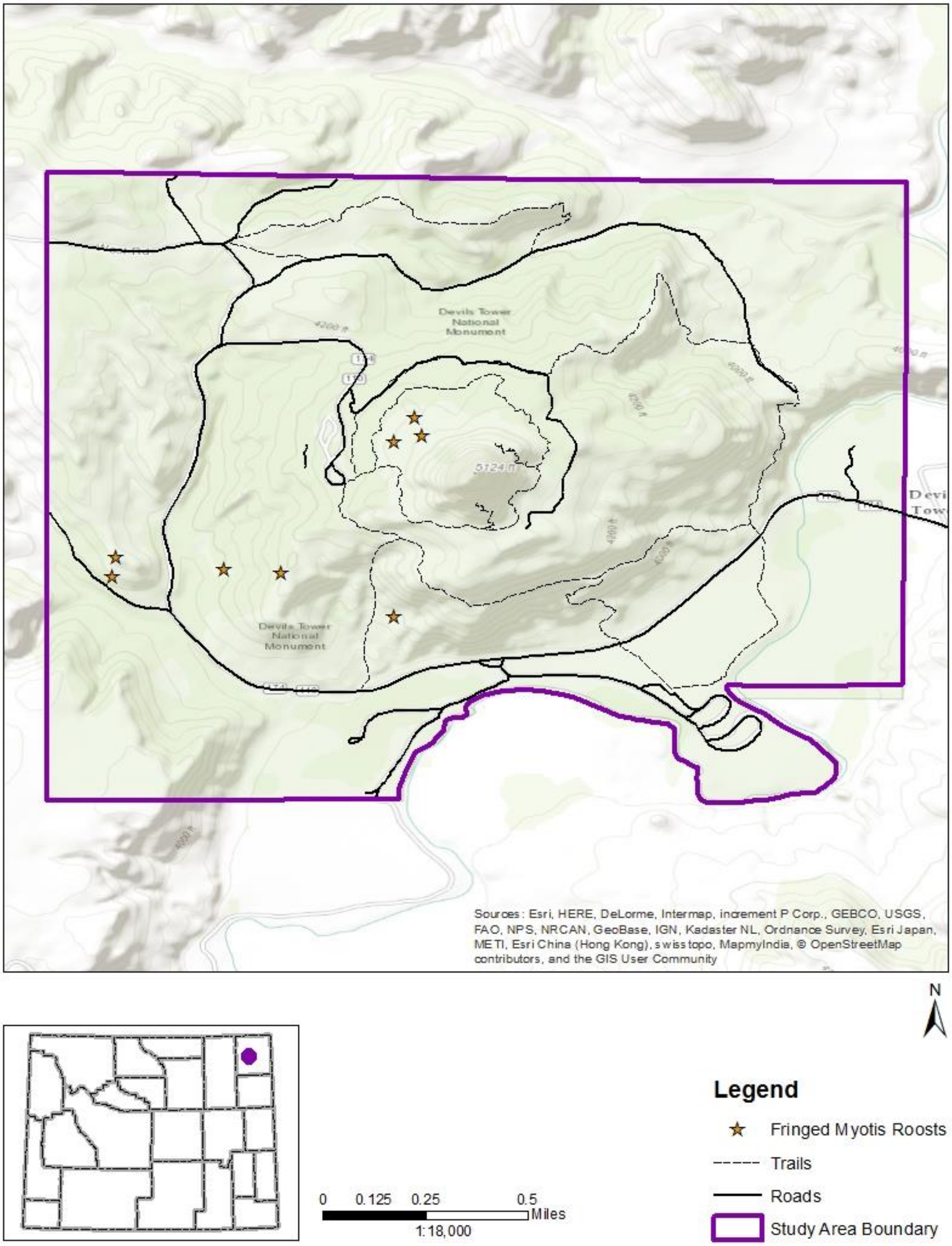

Figure 8. Map of Fringed Myotis day roosts located by tracking radio tagged bats at DETO 2016.

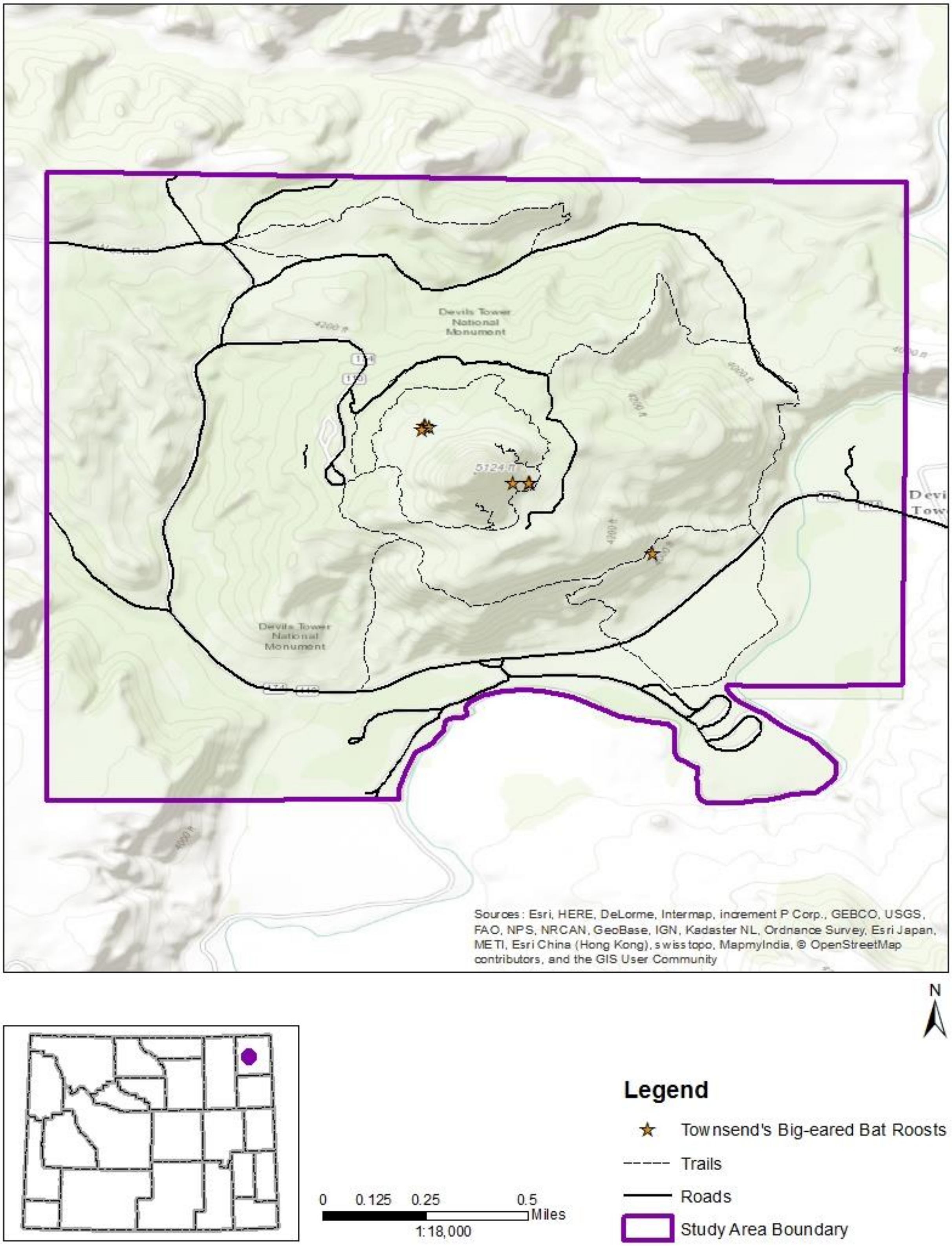

Figure 9. Map of Townsend's Big-eared Bat day roosts located by tracking radio tagged bats at DETO 2016.

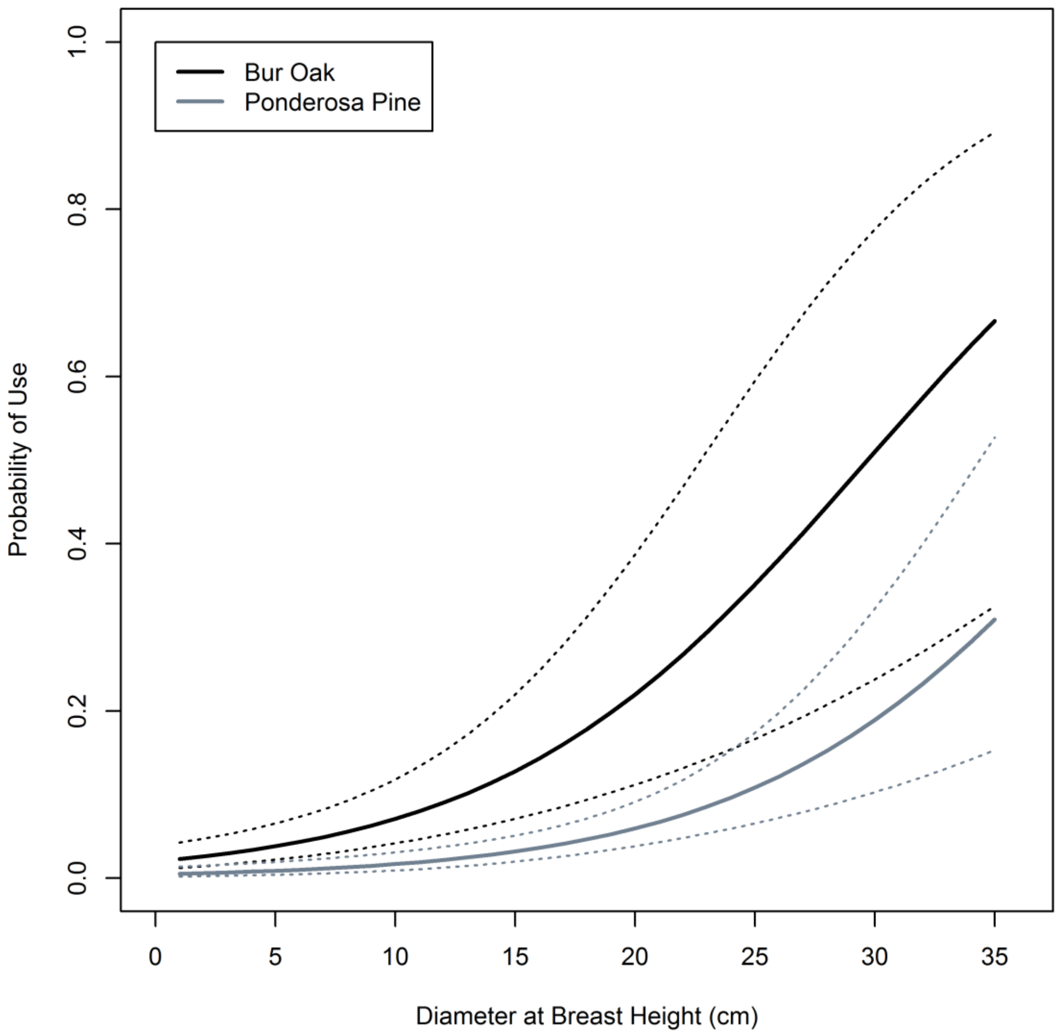

Figure 10. Probability that trees were used as day roosts by NLEB as a function of diameter at breast height for live bur oak (dark solid line) and ponderosa pine (light solid line) at DETO in 2015–2016, with upper and lower 95% confidence intervals (dotted lines). Probability of trees being used as day roosts by NLEB had a significant positive relationship with DBH ($\hat{\beta}$ = 0.13, SE: 0.02 , 95% CI: 0.08 to 0.18) and was significantly lower for ponderosa pine compared to bur oak ($\hat{\beta}$ = -1.30, SE: 0.43, 95% CI: -2.17 to -0.46).

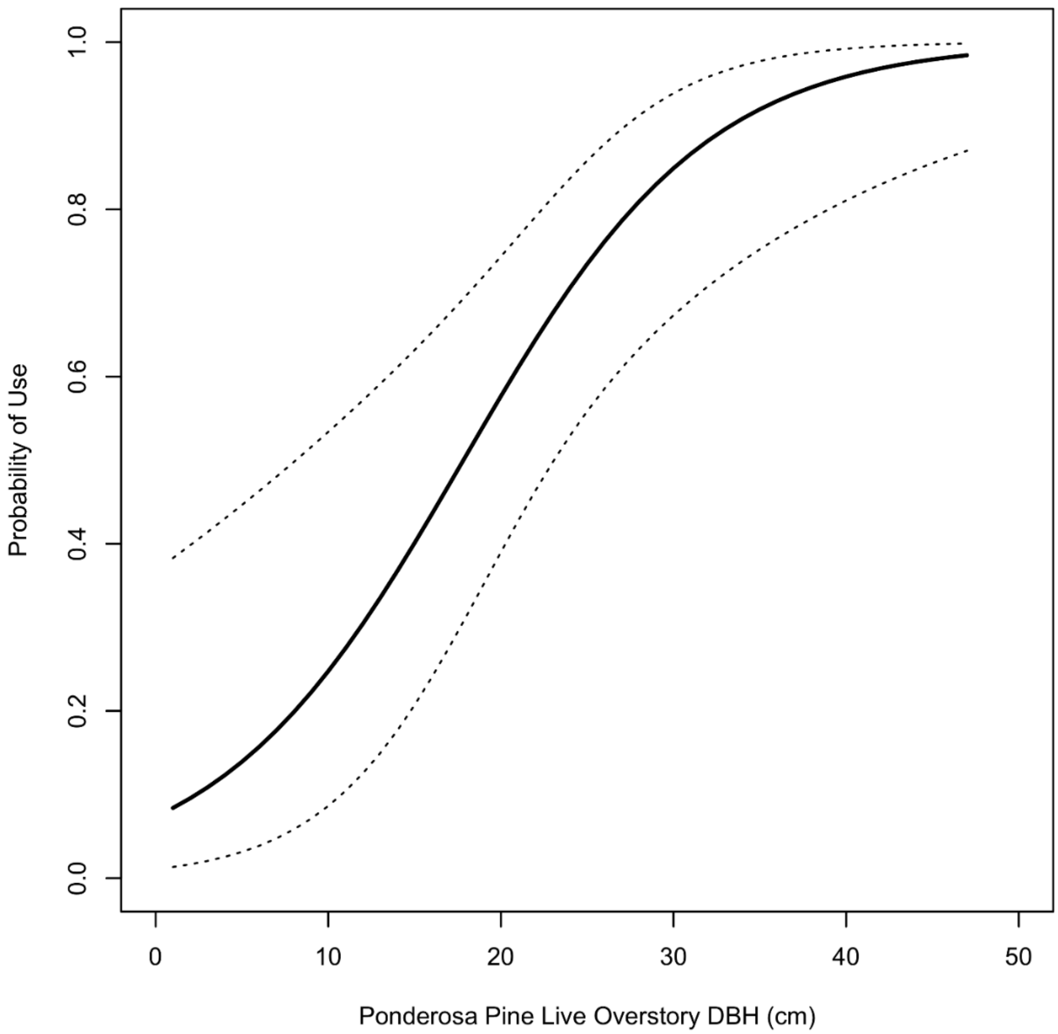

Figure 11. Probability that trees were used as day roosts by NLEB as a function of the average diameter at breast height of live ponderosa pine greater than 3m in height within a 25 m radius around the roost site (solid line) at DETO in 2015– 2016, with upper and lower 95% confidence intervals (dotted lines). Probability that trees were used as roosts had had a significant positive relationship with the DBH of live ponderosa pine in the surrounding area ($\hat{\beta}$ = 0.28, SE: 0.09, 95% CI: 0.14 to 0.49).

Tables

Table 1. Variables measured at NLEB roosts and random trees at DETO in 2015 and 2016.

Code	Definition
Used	1=bat roost 0=random plot
TreeSpecies	Species of random or roost tree
TreeStatus	Status, dead or live, of random or roost tree
DecayClass	Decay class of random or roost tree
DBH_inches	Diameter at Breast Height of random or roost tree
ThreeHeight	Height of random or roost tree

Table 2. Variables measured at plots centered on NLEB roosts and at random plots at DETO in 2015 and 2016. Category represents habitat variable groupings used to identify the best predictor. The best predictor of NLEB roost use are denoted by an asterisk in the Code column and were included in our all-subsets modeling process.

Category	Code	Definition
	Used	1=bat roost 0=random plot
Canopy Cover	PCR*	Percent canopy cover at the roost or random plot center
	PCP	Percent canopy cover for the entire plot
DBH	LSO_DBH	DBH of live trees over 3m
	DSO_DBH	DBH of dead trees over 3m
	DSU_DBH	DBH of dead trees less than 3m
	PP_LSO_DBH*	DBH of live Ponderosa Pine over 3m
	BO_LSO_DBH	DBH of live Bur Oak over 3m
	PP_DSO_DBH	DBH of dead Ponderosa over 3m
	BO_DSO_DBH	DBH of dead Bur Oak over 3m
	Snag_DBH	DBH of dead trees over 2m
Tree Heights	LSO_Rheight	Average height of live trees over 3m proximate to roost
	LSO_Pheight	Average Height of live trees over 3m for entire plot
	DSO_Height	Average height of dead trees over 3m for entire plot
	DSU_Height*	Average height of dead trees under 3m for entire plot
	SnagHeight	Average height of dead trees over 3m for entire plot
Decay Classes	DSO_Decay*	Average decay class of dead trees over 3m for entire plot
	DSU_Decay	Average decay class of dead trees under 3m for entire plot
	SnagDecay	Average decay class of all dead trees for entire plot
Stem Density	D_LSO	Density of live trees greater than 3m in height
	D_DSO*	Density of dead trees greater than 3m in height
	D_DSU	Density of dead trees less than 3m in height
	D_Snags	Density of dead trees of any height
Topographic	Slope	Slope in degrees
	Aspect	Aspect of slope in degrees
	HLI*	Heat Load Index

Table 3. Bats captured at Devils Tower National Monument in 2015 and 2016.

Date	Common Name	Sex	Age	Reproductive Status
7/8/2015	Western Long-eared Myotis	Female	Adult	Non-reproductive
7/8/2015	Big Brown Bat	Female	Adult	Pregnant
7/8/2015	Northern Long-eared Bat	Male	Adult	Non-reproductive
7/8/2015	Big Brown Bat	Male	Adult	Non-reproductive
7/9/2015	Long-legged Myotis	Female	Adult	Pregnant
7/9/2015	Big Brown Bat	Female	Adult	Lactating
7/9/2015	Western Long-eared Myotis	Male	Adult	Non-reproductive
7/9/2015	Fringed Myotis	Male	Adult	Non-reproductive
7/9/2015	Fringed Myotis	Female	Adult	Non-reproductive
7/9/2015	Fringed Myotis	Female	Adult	Lactating
7/9/2015	Little Brown Myotis	Male	Adult	Non-reproductive
7/9/2015	Western Long-eared Myotis	Female	Adult	Non-reproductive
7/9/2015	Fringed Myotis	Female	Adult	Lactating
7/9/2015	Fringed Myotis	Female	Adult	Lactating
7/9/2015	Fringed Myotis	Female	Adult	Lactating
7/9/2015	Northern Long-eared Bat	Male	Adult	Non-reproductive
7/9/2015	Fringed Myotis	Female	Adult	Pregnant
7/9/2015	Northern Long-eared Bat	Male	Adult	Non-reproductive
7/9/2015	Northern Long-eared Bat	Male	Adult	Non-reproductive
7/9/2015	Northern Long-eared Bat	Male	Adult	Non-reproductive
7/9/2015	Fringed Myotis	Female	Adult	Lactating
8/10/2015	Silver-haired Bat	Female	Adult	Non-reproductive
8/11/2015	Northern Long-eared Bat	Female	Adult	Non-reproductive
8/11/2015	Little Brown Myotis	Male	Juvenile	Non-reproductive
8/11/2015	Western Small-footed Myotis	Male	Adult	Non-reproductive
8/11/2015	Fringed Myotis	Male	Juvenile	Non-reproductive
8/11/2015	Little Brown Myotis	Male	Adult	Non-reproductive
8/11/2015	Fringed Myotis	Male	Adult	Non-reproductive
8/11/2015	Northern Long-eared Bat	Male	Adult	Non-reproductive
8/11/2015	Northern Long-eared Bat	Male	Adult	Non-reproductive
8/11/2015	Long-legged Myotis	Female	Adult	Lactating
8/11/2015	Fringed Myotis	Male	Adult	Non-reproductive
8/11/2015	Northern Long-eared Bat	Male	Adult	Non-reproductive
8/12/2015	Northern Long-eared Bat	Male	Adult	Non-reproductive
8/12/2015	Northern Long-eared Bat	Male	Adult	Non-reproductive
8/27/2015	Long-legged Myotis	Female	Adult	Non-reproductive
8/27/2015	Western Small-footed Myotis	Male	Adult	Non-reproductive
6/16/2016	Fringed Myotis	Female	Adult	Pregnant
6/16/2016	Little Brown Myotis	Male	Adult	Non-reproductive

Date	Common Name	Sex	Age	Reproductive Status
6/16/2016	Little Brown Myotis	Male	Adult	Non-reproductive
6/16/2016	Long-legged Myotis	Female	Adult	Pregnant
6/16/2016	Long-legged Myotis	Female	Adult	Pregnant
6/16/2016	Little Brown Myotis	Male	Adult	Non-reproductive
6/16/2016	Little Brown Myotis	Male	Adult	Non-reproductive
6/16/2016	Long-legged Myotis	Female	Adult	Pregnant
6/16/2016	Little Brown Myotis	Male	Adult	Non-reproductive
6/16/2016	Northern Long-eared Bat	Male	Adult	Non-reproductive
6/16/2016	Little Brown Myotis	Male	Adult	Non-reproductive
6/16/2016	Long-legged Myotis	Female	Adult	Non-reproductive
6/16/2016	Fringed Myotis	Male	Adult	Non-reproductive
6/16/2016	Little Brown Myotis	Male	Adult	Non-reproductive
6/16/2016	Long-legged Myotis	Male	Adult	Non-reproductive
6/16/2016	Big Brown Bat	Male	Adult	Non-reproductive
6/16/2016	Northern Long-eared Bat	Male	Adult	Non-reproductive
6/16/2016	Northern Long-eared Bat	Male	Adult	Non-reproductive
6/17/2016	Fringed Myotis	Male	Adult	Non-reproductive
6/17/2016	Little Brown Myotis	Male	Adult	Non-reproductive
6/18/2016	Long-legged Myotis	Male	Adult	Non-reproductive
6/18/2016	Fringed Myotis	Male	Adult	Non-reproductive
6/18/2016	Fringed Myotis	Male	Adult	Non-reproductive
6/18/2016	Fringed Myotis	Female	Adult	Pregnant
6/18/2016	Fringed Myotis	Female	Adult	Pregnant
6/18/2016	Fringed Myotis	Male	Adult	Non-reproductive
6/18/2016	Western Small-footed Myotis	Male	Adult	Non-reproductive
6/18/2016	Little Brown Myotis	Male	Adult	Non-reproductive
6/18/2016	Northern Long-eared Bat	Male	Adult	Non-reproductive
7/13/2016	Long-legged Myotis	Male	Adult	Non-reproductive
7/13/2016	Little Brown Myotis	Male	Adult	Descended Testis
7/13/2016	Fringed Myotis	Female	Adult	Lactating
7/13/2016	Fringed Myotis	Male	Adult	Descended Testis
7/13/2016	Western Small-footed Myotis	Male	Adult	Descended Testis
7/13/2016	Long-legged Myotis	Female	Adult	Lactating
7/13/2016	Northern Long-eared Bat	Male	Adult	Non-reproductive
7/21/2016	Northern Long-eared Bat	Male	Adult	Non-reproductive
7/21/2016	Fringed Myotis	Female	Adult	Lactating
7/21/2016	Fringed Myotis	Female	Adult	Lactating
7/21/2016	Long-legged Myotis	Female	Juvenile	Non-reproductive
7/21/2016	Fringed Myotis	Male	Adult	
7/21/2016	Fringed Myotis	Male	Adult	Non-reproductive

Date	Common Name	Sex	Age	Reproductive Status
7/21/2016	Fringed Myotis	Male	Adult	Non-reproductive
7/21/2016	Northern Long-eared Bat	Male	Adult	Non-reproductive
7/21/2016	Long-legged Myotis	Female	Adult	Non-reproductive
7/21/2016	Long-legged Myotis	Male	Juvenile	Non-reproductive
7/21/2016	Fringed Myotis	Female	Juvenile	Non-reproductive
7/21/2016	Fringed Myotis	Female	Juvenile	Non-reproductive
7/21/2016	Fringed Myotis	Male	Juvenile	Non-reproductive
7/21/2016	Northern Long-eared Bat	Male	Adult	Non-reproductive
7/21/2016	Fringed Myotis	Female	Adult	Lactating
7/22/2016	Little Brown Myotis	Male	Adult	Non-reproductive
7/22/2016	Little Brown Myotis	Male	Juvenile	Non-reproductive
7/22/2016	Big Brown Bat	Male	Juvenile	Descended Testis
7/22/2016	Hoary Bat	Male	Juvenile	Non-reproductive
7/22/2016	Big Brown Bat	Male	Adult	Non-reproductive
7/22/2016	Hoary Bat	Male	Adult	Non-reproductive
7/22/2016	Big Brown Bat	Male	Adult	Non-reproductive
7/22/2016	Big Brown Bat	Male	Adult	Descended Testis
7/22/2016	Little Brown Myotis	Male	Juvenile	Non-reproductive
7/22/2016	Little Brown Myotis	Male	Adult	Non-reproductive
7/22/2016	Little Brown Myotis	Female	Adult	Non-reproductive
7/23/2016	Fringed Myotis	Female	Adult	Non-reproductive
7/23/2016	Northern Long-eared Bat	Male	Adult	Non-reproductive
7/23/2016	Northern Long-eared Bat	Male	Juvenile	Non-reproductive
6/30/2016	Western Long-eared Myotis	Male	Adult	Non-reproductive
6/30/2016	Fringed Myotis	Female	Adult	Pregnant
6/30/2016	Fringed Myotis	Female	Adult	Pregnant
6/30/2016	Little Brown Myotis	Male	Adult	Non-reproductive
7/1/2016	Fringed Myotis	Female	Adult	Non-reproductive
7/1/2016	Fringed Myotis	Male	Adult	Non-reproductive
7/1/2016	Fringed Myotis	Male	Adult	Non-reproductive
7/1/2016	Northern Long-eared Bat	Male	Adult	Non-reproductive
7/1/2016	Fringed Myotis	Female	Adult	Lactating
7/1/2016	Little Brown Myotis	Male	Adult	Non-reproductive
7/1/2016	Fringed Myotis	Female	Adult	Pregnant
7/1/2016	Fringed Myotis	Female	Adult	Pregnant
7/2/2016	Little Brown Myotis	Male	Adult	Non-reproductive
7/2/2016	Long-legged Myotis	Male	Adult	Non-reproductive
7/13/2016	Long-legged Myotis	Male	Adult	Non-reproductive
7/13/2016	Long-legged Myotis	Male	Adult	Non-reproductive
7/13/2016	Fringed Myotis	Male	Adult	Non-reproductive

Date	Common Name	Sex	Age	Reproductive Status
7/13/2016	Fringed Myotis	Male	Adult	Non-reproductive
7/13/2016	Northern Long-eared Bat	Male	Adult	Non-reproductive
7/13/2016	Big Brown Bat	Male	Adult	Descended Testis
7/13/2016	Fringed Myotis	Male	Adult	Non-reproductive
7/13/2016	Fringed Myotis	Male	Adult	Non-reproductive
7/13/2016	Big Brown Bat	Male	Adult	Descended Testis
7/13/2016	Fringed Myotis	Female	Adult	Lactating
7/14/2016	Fringed Myotis	Female	Adult	Non-reproductive
7/21/2016	Long-legged Myotis	Female	Juvenile	Non-reproductive
7/21/2016	Northern Long-eared Bat	Male	Adult	Non-reproductive
7/21/2016	Fringed Myotis	Female	Adult	Lactating
7/21/2016	Fringed Myotis	Female	Adult	Lactating
7/21/2016	Townsend's Big-eared Bat	Male	Adult	Non-reproductive
7/21/2016	Townsend's Big-eared Bat	Male	Adult	Non-reproductive
7/21/2016	Fringed Myotis	Male	Adult	Non-reproductive
7/21/2016	Little Brown Myotis	Female	Adult	Non-reproductive
7/21/2016	Fringed Myotis	Female	Adult	Post Lactating
7/21/2016	Long-legged Myotis	Female	Adult	Lactating
7/21/2016	Fringed Myotis	Male	Juvenile	Non-reproductive
7/21/2016	Fringed Myotis	Male	Juvenile	Non-reproductive
7/22/2016	Little Brown Myotis	Female	Adult	Lactating
7/22/2016	Little Brown Myotis	Female	Juvenile	Non-reproductive
7/22/2016	Little Brown Myotis	Female	Adult	Lactating
7/22/2016	Little Brown Myotis	Male	Adult	Non-reproductive
7/23/2016	Fringed Myotis	Female	Adult	Lactating
7/23/2016	Fringed Myotis	Male	Juvenile	Non-reproductive
7/22/2016	Little Brown Myotis	Female	Juvenile	Non-reproductive
7/23/2016	Western Small-footed Myotis	Male	Juvenile	Non-reproductive
7/23/2016	Fringed Myotis	Male	Adult	Non-reproductive
7/23/2016	Fringed Myotis	Female	Adult	Lactating
7/23/2016	Fringed Myotis	Male	Adult	Non-reproductive
7/23/2016	Townsend's Big-eared Bat	Male	Adult	Non-reproductive
7/23/2016	Fringed Myotis	Male	Adult	Non-reproductive
7/30/2016	Long-legged Myotis	Female	Adult	Non-reproductive
7/30/2016	Northern Long-eared Bat	Male	Adult	Non-reproductive
7/29/2016	Northern Long-eared Bat	Male	Juvenile	Non-reproductive
7/29/2016	Townsend's Big-eared Bat	Male	Adult	Non-reproductive
7/29/2016	Townsend's Big-eared Bat	Male	Adult	Descended Testis
7/29/2016	Little Brown Myotis	Female	Adult	Lactating
7/30/2016	Fringed Myotis	Female	Adult	Lactating

Date	Common Name	Sex	Age	Reproductive Status
7/30/2016	Fringed Myotis	Female	Adult	Lactating
7/30/2016	Fringed Myotis	Male	Juvenile	Non-reproductive
7/30/2016	Long-legged Myotis	Female	Adult	Lactating
7/30/2016	Fringed Myotis	Male	Adult	Non-reproductive
7/30/2016	Northern Long-eared Bat	Male	Adult	Non-reproductive
7/30/2016	Northern Long-eared Bat	Male	Adult	Non-reproductive
7/30/2016	Northern Long-eared Bat	Male	Juvenile	Non-reproductive

Table 4. Day roost sites and roost characteristics observed at DETO in 2015 and 2016.

Roost ID	Common Name	Survey Date	Tree Species	Tree Status	Decay Class	DBH (IN)	Tree Height	Sloughing Bark	Cavities Present
BR01	Northern Long-eared Bat	7/9/2015	Burr Oak	Dead	3	5	1.3	Much	Yes
BR02	Northern Long-eared Bat	7/10/2015	Ponderosa Pine	Dead	3	-		Much	No
BR03	Northern Long-eared Bat	7/10/2015	Ponderosa Pine	Dead	1	20	23.4	Much	Yes
BR04	Northern Long-eared Bat	7/11/2015	Burr Oak	Dead	2	5.9	7.7	Much	Yes
BR05	Northern Long-eared Bat	7/11/2015	Ponderosa Pine	Live	NA	34	28	Much	No
BR06	Northern Long-eared Bat	7/12/2015	Ponderosa Pine	Dead	1	24	17	Much	Yes
BR07	Northern Long-eared Bat	8/12/2015	Ponderosa Pine	Dead	4	13.9	2	Much	Yes
BR08	Northern Long-eared Bat	8/12/2015	Rock Crevice	NA	NA	NA	NA	NA	NA
BR09	Northern Long-eared Bat	8/13/2015	Ponderosa Pine	Live	NA	19.4	14.1	None	No
BR10	Northern Long-eared Bat	8/14/2015	Ponderosa Pine	Live	NA	11.1	18.4	None	No
BR11	Fringed Myotis	6/16/2016	Rock Crevice	NA	NA	NA	NA	NA	NA
BR12	Northern Long-eared Bat	6/16/2016	Ponderosa Pine	Dead	4	14	14	Much	Yes
BR13	Fringed Myotis	6/17/2016	Rock Crevice	NA	NA	NA	NA	NA	NA
BR14	Fringed Myotis	6/18/2016	Rock Crevice	NA	NA	NA	NA	NA	NA
BR15	Northern Long-eared Bat	6/18/2016	Ponderosa Log	Dead	4	-	1.5	Much	Yes
BR16	Northern Long-eared Bat	6/19/2016	Ponderosa Pine	Dead	3	22	2.2	Much	Yes
BR17	Fringed Myotis	6/19/2016	Rock Crevice	NA	NA	NA	NA	NA	NA
BR18	Fringed Myotis	6/21/2016	Rock Crevice	NA	NA	NA	NA	NA	NA
BR19	Fringed Myotis	6/22/2016	Rock Crevice	NA	NA	NA	NA	NA	NA
BR21	Fringed Myotis	7/2/2016	Rock Crevice	NA	NA	NA	NA	NA	NA
BR22	Townsend's Big-eared Bat	7/2/2016	Rock Crevice	NA	NA	NA	NA	NA	NA
BR23	Townsend's Big-eared Bat	7/3/2016	Rock Crevice	NA	NA	NA	NA	NA	NA
BR24	Townsend's Big-eared Bat	7/4/2016	Rock Crevice	NA	NA	NA	NA	NA	NA
BR25	Townsend's Big-eared Bat	7/4/2016	Rock Crevice	NA	NA	NA	NA	NA	NA
BR26	Townsend's Big-eared Bat	7/6/2016	Rock Crevice	NA	NA	NA	NA	NA	NA
BR27	Townsend's Big-eared Bat	7/6/2016	Rock Crevice	NA	NA	NA	NA	NA	NA
BR28	Townsend's Big-eared Bat	7/7/2016	Rock Crevice	NA	NA	NA	NA	NA	NA
BR29	Northern Long-eared Bat	7/14/2016	Burr Oak	Dead	4	6	1	Much	Yes
BR30	Northern Long-eared Bat	7/15/2016	Burr Oak	Dead	3	5	0.5	Much	Yes

Roost ID	Common Name	Survey Date	Tree Species	Tree Status	Decay Class	DBH (IN)	Tree Height	Sloughing Bark	Cavities Present
BR31	Northern Long-eared Bat	7/21/2016	Ponderosa Pine	Live	NA	17	16.2	Much	No
BR32	Townsend’s Big-eared Bat	7/21/2016	Rock Crevice	NA	NA	NA	NA	NA	NA
BR33	Northern Long-eared Bat	7/21/2016	Ponderosa Pine	Live	NA	13	17	None	Yes
BR34	Northern Long-eared Bat	7/22/2016	Burr Oak	Dead	3	7.5	7.5	Much	Yes
BR35	Townsend's Big-eared Bat	7/22/2016	Rock Crevice	Rock Crevice	NA	NA	NA	NA	NA
BR36	Northern Long-eared Bat	7/23/2016	Burr Oak	Live	NA	9	6	None	Yes
BR37	Northern Long-eared Bat	7/23/2016	Burr Oak	Dead	1	8.9	22.3	Some	Yes
BR38	Fringed Myotis	7/24/2016	Rock Crevice	NA	NA	NA	NA	NA	NA
BR39	Northern Long-eared Bat	7/24/2016	Burr Oak	Live	NA	8.9	17.3	Much	Yes
BR40	Fringed Myotis	7/26/2016	Rock Crevice	NA	NA	NA	NA	NA	NA
BR41	Northern Long-eared Bat	7/30/2016	Burr Oak	Dead	3	10	6	Some	No
BR42	Northern Long-eared Bat	7/30/2016	Ponderosa Pine	Dead	4	15	8	Much	Yes
BR43	Northern Long-eared Bat	7/30/2016	Burr Oak	Dead	2	9	5	Much	Yes
BR44	Northern Long-eared Bat	7/31/2016	Burr Oak	Dead	1	8.5	1.4	Much	Yes
BR45	Northern Long-eared Bat	7/31/2015	Ponderosa Pine	Live	1	17.5	21	Some	Yes
BR46	Northern Long-eared Bat	7/31/2016	Burr Oak	Live	NA	8.4	10.1	Some	Yes
BR47	Northern Long-eared Bat	8/1/2016	Ponderosa Pine	Dead	3	14.8	0	Some	Yes
BR48	Northern Long-eared Bat	8/1/2016	Burr Oak	Live	NA	6.7	8.6	Much	Yes
BR49	Northern Long-eared Bat	8/1/2016	Ponderosa Pine	Dead		14.3	13.4	Much	Yes
BR50	Northern Long-eared Bat	8/2/2016	Ponderosa Pine	Dead	3	20	1	Some	Yes
BR51	Northern Long-eared Bat	8/2/2016	Burr Oak	Dead	1	6	3.2	Some	Yes
BR52	Northern Long-eared Bat	8/3/2016	Ponderosa Pine	Dead	4	18	2.8	Some	Yes
BR53	Northern Long-eared Bat	8/3/2016	Ponderosa Pine	Dead	2	15	5	Some	Yes
BR54	Northern Long-eared Bat	8/4/2016	Ponderosa Pine	Dead	2	13	18	Some	Yes

Table 5. Candidate models and associated AICc statistics investigating the selection of day roost structures by NLEB at DETO in 2015 and 2016. The model in bold font indicates the best approximating model.

Model Form	K	AICc	ΔAICc	AICc Weight	Cumulative Weight
TreeSpecies + TreeStatus + DecayClass + DBH_Inches	7	265.67	0	0.52	0.52
TreeSpecies + TreeStatus + DHB_inches	6	267.36	1.69	0.22	0.74
TreeSpecies + DBH_inches	**3**	**268.06**	**2.38**	**0.16**	**0.9**
TreeSpecies + DecayClass + DBH_inches	4	269.18	3.50	0.09	0.99
DBH_inches	2	275.09	9.41	0	0.99
DecayClass + DBH_inches	3	275.54	9.86	0	1
TreeStatus + DecayClass + DBH_inches	6	276.69	11.02	0	1
TreeStatus + DBH_inches	5	277.33	11.66	0	1
TreeSpecies + TreeStatus + DecayClass	6	292.39	26.71	0	1
DecayClass	2	292.58	26.91	0	1
TreeSpecies	2	293.7	28.03	0	1
TreeSpecies + DecayClass	3	293.84	28.16	0	1
TreeStatus + DecayClass	5	294.14	28.46	0	1
TreeSpecies + Tree Status	5	295.41	29.73	0	1
TreeStatus	4	296.46	30.78	0	1

Table 6. Candidate models and associated AICc statistics investigating the selection of habitat surrounding day roost sites used by NLEB at DETO in 2015 and 2016. The model in bold font indicates the best approximating model.

Model Form	K	AICc	ΔAICc	AICc Weight	Cumulative Weight
PP_LSO_DBH + D_DSO	3	47.39	0.00	0.12	0.12
PP_LSO_DBH	**2**	**47.94**	**0.55**	**0.09**	**0.21**
PP_LSO_DBH + D_DSO + HLI	4	48.40	1.02	0.07	0.28
PCR + PP_LSO_DBH	3	49.00	1.61	0.05	0.33
PP_LSO_DBH + HLI	3	49.12	1.74	0.05	0.38
PCR + PP_LSO_DBH + HLI	4	49.22	1.83	0.05	0.43
PCR + PP_LSO_DBH + D_DSO	4	49.41	2.02	0.04	0.47
PCR + PP_LSO_DBH + D_DSO + HLI	5	49.73	2.35	0.04	0.51
PP_LSO_DBH + DSU_Height + D_DSO	4	49.74	2.35	0.04	0.55
PP_LSO_DBH + DSO_Decay + D_DSO	4	49.77	2.38	0.04	0.58
PP_LSO_DBH + DSU_Height	3	50.10	2.71	0.03	0.62
PP_LSO_DBH + DSO_Decay	3	50.11	2.72	0.03	0.65
PP_LSO_DBH + DSO_Decay + D_DSO + HLI	5	50.48	3.10	0.03	0.67
PCR + D_DSO + HLI	4	50.74	3.36	0.02	0.69
PP_LSO_DBH + DSU_Height + D_DSO + HLI	5	50.85	3.46	0.02	0.71
PCR + PP_LSO_DBH + DSO_Decay + HLI	5	51.18	3.79	0.02	0.73
PCR + PP_LSO_DBH + DSU_Height	4	51.35	3.96	0.02	0.75

PCR + PP_LSO_DBH + DSO_Decay	4	51.37	3.99	0.02	0.76
PP_LSO_DBH + DSU_Height + HLI	4	51.40	4.01	0.02	0.78
PCR + DSO_Decay + D_DSO + HLI	5	51.42	4.03	0.02	0.80
PP_LSO_DBH + DSO_Decay + HLI	4	51.50	4.11	0.02	0.81
PCR + PP_LSO_DBH + DSU_Height + HLI	5	51.68	4.30	0.01	0.83
PCR + DSU_Height + D_DSO + HLI	5	51.72	4.34	0.01	0.84
PCR + HLI	3	51.81	4.42	0.01	0.85
PCR + D_DSO	3	51.85	4.46	0.01	0.87
PCR + PP_LSO_DBH + DSU_Height + D_DSO	5	51.88	4.50	0.01	0.88
PCR + PP_LSO_DBH + DSO_Decay + D_DSO	5	51.89	4.51	0.01	0.89
PCR + DSU_Height + HLI	4	52.13	4.74	0.01	0.90
PP_LSO_DBH + DSU_Height + DSO_Decay + D_DSO	5	52.24	4.85	0.01	0.91
PP_LSO_DBH + DSU_Height + DSO_Decay	4	52.37	4.99	0.01	0.92
DSU_Height + D_DSO	3	52.77	5.39	0.01	0.93
PCR + DSU_Height + D_DSO	4	52.82	5.44	0.01	0.94
DSU_Height + D_DSO + HLI	4	53.36	5.97	0.01	0.94
PCR	2	53.38	6.00	0.01	0.95
PCR + DSU_Height	3	53.49	6.11	0.01	0.96
PCR + DSO_Decay + HLI	4	53.74	6.36	0.00	0.96
PCR + PP_LSO_DBH + DSU_Height + DSO_Decay	5	53.83	6.44	0.00	0.97
PP_LSO_DBH + DSU_Height + DSO_Decay + HLI	5	53.89	6.50	0.00	0.97
D_DSO	2	54.10	6.72	0.00	0.97
PCR + DSO_Decay + D_DSO	4	54.23	6.84	0.00	0.98
PCR + DSU_Height + DSO_Decay + HLI	5	54.33	6.94	0.00	0.98
D_DSO + HLI	3	54.95	7.56	0.00	0.98
DSU_Height + DSO_Decay + D_DSO	4	55.08	7.69	0.00	0.99
PCR + DSU_Height + DSO_Decay + D_DSO	5	55.32	7.93	0.00	0.99
PCR + DSO_Decay	3	55.48	8.09	0.00	0.99
PCR + DSU_Height + DSO_Decay	4	55.65	8.26	0.00	0.99
DSU_Height + DSO_Decay + D_DSO + HLI	5	55.71	8.32	0.00	0.99
DSO_Decay + D_DSO	3	56.32	8.93	0.00	1.00
DSU_Height	2	56.80	9.41	0.00	1.00
DSO_Decay + D_DSO + HLI	4	57.13	9.74	0.00	1.00
DSU_Height + HLI	3	57.41	10.02	0.00	1.00
DSU_Height + DSO_Decay	3	57.83	10.44	0.00	1.00
DSU_Height + DSO_Decay + HLI	4	59.37	11.99	0.00	1.00
DSO_Decay	2	64.20	16.82	0.00	1.00
DSO_Decay + HLI	3	66.36	18.98	0.00	1.00
HLI	2	66.71	19.33	0.00	1.00

Table 7. Model coefficients from the best approximating model for selection of day roost structures by NELB at DETO in 2015 and 2016.

Variable	Estimate	SE	z-value	Pr(>|z|)	LCL	UCL
(Intercept)	-3.97	0.35	-11.40	>0.001	-4.70	-3.33
Ponderosa Pine	-1.30	0.43	-3.00	0.003	-2.17	-0.46
DBH	0.13	0.02	5.21	>0.001	0.08	0.18

Table 8. Model coefficients from the best approximating model for habitat surrounding day roosts by NELB at DETO in 2015 and 2016.

Variable	Estimate	SE	z-value	Pr(>|z|)	LCL	UCL
(Intercept)	-2.39	0.98	-2.45	0.014	-4.73	-0.77
PP_LSO_DBH	0.28	0.09	3.30	>0.001	0.14	0.49