Features used as Roosts by Bats in Montana

Prepared for:
Montana Department of Environmental Quality
Air, Energy, & Mining Division, Coal Section

Prepared by:
Dan Bachen, Alexis McEwan, Braden Burkholder, Scott Blum, and Bryce Maxell
Montana Natural Heritage Program
A cooperative program of the Montana State Library and the University of Montana
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Appendix A.

Introduction
Bats use a variety of natural and man-made features to roost such as caves, mines, trees, rock outcrops, buildings, and bridges (as reviewed in Appendix A). Roosts in the active season (May through October) are generally classified as day roosts further differentiated as maternity roosts, and night roosts. Roosts used in the winter are exclusively called hibernacula. After emerging from their hibernaculum, males and nonbreeding females may roost singly or in colonies in day roosts. Pregnant females emerge and form maternity colonies, which are commonly found between April and July in Montana when young have become flighted (Bachen et al. 2018). Female bats of most species seek warm roosts, however some species like Townsend's Big-eared Bat (*Corynorhinus townsendii*) are sensitive to high temperature (Betts 2010) and form maternity colonies in colder environments like caves and mines. Day roost are generally found in protected features such as buildings, cracks and crevices in structures or rocks, caves, mines, and within or on trees. Night roosts are roosts used during the night between foraging bouts during the active season. Since most surveys are conducted during the day, these roosts are identified by guano deposition and urine staining. During the fall bats appear to move from summering areas to hibernacula. Roosts used in September and October are sometimes described as transition roosts, however the difference, if any, between these and active season roosts is not well described Montana. Any roost used by bats during the winter (November- April) is typically called a hibernaculum.

Of the 15 species of bats in Montana, all have described roosts within the state except Eastern Red Bat (*Lasiurus borealis*). However, the amount of data for each species varies drastically. For some species like the Little Brown Bat (*Myotis lucifugus*) roosts have been well described across the active season and hibernation season. While these data are by no means comprehensive across all roost features or areas of the state, they provide a good overview of how these animals use the landscape. However, many species are poorly described, and lack survey data across some or all of the year. The Spotted Bat (*Euderma maculatum*) exemplifies this dearth of knowledge as no typical roosts have been described.

Much work has been conducted in the state to describe roosts used by bats (see Hendricks 2012, Appendix A). Some features like caves (e.g. Worthington 1991, Hendricks and Genter 1997, summarized in Hendricks 2012) and bridges (e.g. Hendricks 2005) have been the focus of intense survey efforts and should be considered well described. Rock outcrops have received some survey effort but given their diversity and the difficulty accessing roosts and assessing roost in small deep cracks or fissures, much work still needs to be done, and may not be possible without development of new survey techniques. Other roosts such as burrows and erosion cavities in soil may be used and possibly important, but few if any have been described and no structured surveys conducted. In this document we seek to describe the features used as roost in the state, the species that use them, and how they are used.

Data Collection and Aggregation
All data used for roost summaries were submitted to the Montana Natural Heritage Program. These include incidental observations bats and bat roosts, as well as data from projects targeting bats and seeking to identify roosts. We have cited the primary source if these data have been previously published. Information on specific observations are available directly from MTNHP.

ROOST FEATURES

CAVES

Caves are currently among the most studied roost features in Montana. The primary source of these data is a project to inventory and monitor bat populations in caves across the state lead by the Montana Natural Heritage Program in partnership with the Northern Rocky Mountain Grotto, Bigfork High school Cave Club, Montana Fish Wildlife and Parks, US Fish and Wildlife Service, Bureau of Land Management, and US Forest Service. Currently 328 surveys of 106 caves of the 415 described caves in Montana have been conducted by trained biologists and volunteer cavers since 2012. Caves surveys have focused on identifying hibernacula, but many caves have also been surveyed during the active season. Although only 26% of all caves have been surveyed, coverage is good within cave producing regions (Figure 1).

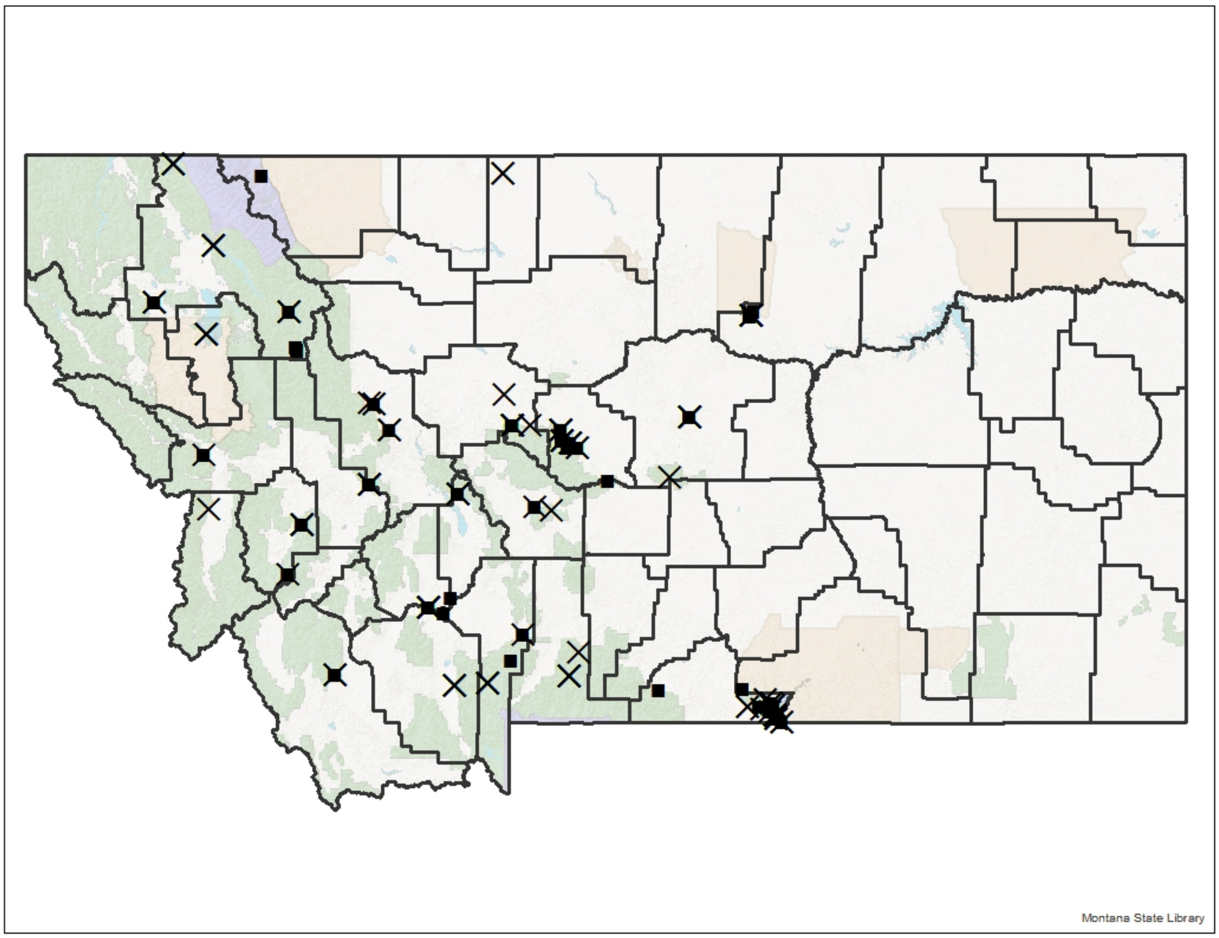

Figure 1. Cave roosts in Montana reported to the Montana Natural Heritage Program. Triangles represent night roosts, squares are day roosts, and circles are maternity colonies. Hibernacula are shown with cross symbols, which may overlay active season roosts.

Of these caves 46 are hibernacula (44% of total), 23 are used as day roosts during the active season (21%), and 37 have no evidence of use by bats (35%). Although these data are somewhat biased toward bat presence as caves with anecdotal reports of bat use are more likely to be visited, it appears that a significant portion of our caves in our state are used by bats. However, the number of individuals is generally low (Figure 2).

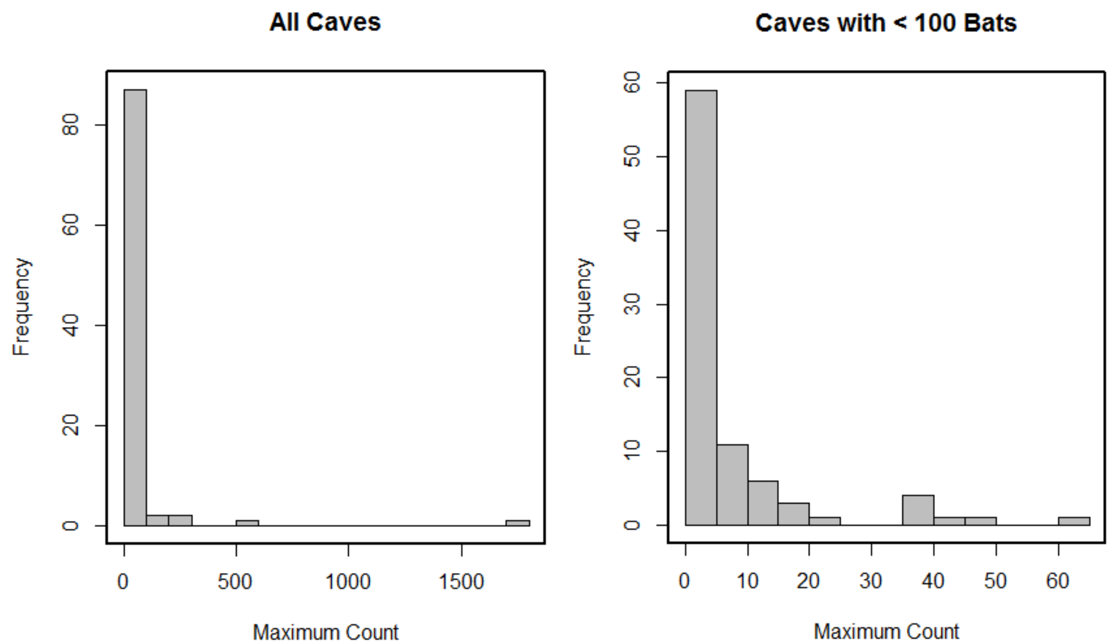

Figure 2. The maximum number of bats observed at surveyed caves across Montana. Left panel shows the distribution of all maximum counts. The right panel shows only counts of less than 100 bats. Note that caves without bats (count of 0) are included in the left-most bin on each panel.

Across all caves 7 species have been documented. Townsend's Big-eared bat was the most common species and found in 31 caves, with and average maximum count of 11.7 bats per cave. Bats in the Genus *Myotis* were the next most commonly observed group and documented at 30 caves. Myotis bats are often difficult to distinguish to species without detailed in-hand examination (Bachen et al. 2018) and identification of bats roosting in caves beyond genus is often difficult or impossible. Several Myotis bats have been identified during surveys, but these summaries are likely incomplete. Little Brown Myotis was the second most common species and found in 11 caves averaging a maximum count of 34.0 bats/cave. This species also forms large roosts, and all roost over 200 individuals are almost exclusively Little Brown Myotis. Large aggregations of this species have not been observed elsewhere in the western US and is unique to Montana (Weller et al. 2018). Western Small-footed Myotis (*Myotis ciliolabrum*) was observed in 11 caves with maximum counts averaging 2.9 bats/cave. Long-legged Myotis (*M. volans*) and Long-eared Myotis (*M. evotis*) was observed in 5 caves each with maximum counts averaging 1.4 bats/cave and 1.2 bat/ cave respectively. Big brown Bat (*Eptiscus fuscus*) was observed in 4 caves with maximum counts averaging 2.6 bats/ cave. Fringed Myotis (*M. thysanodes*) was observed in just 2 caves with maximum counts averaging 1.5 bats/ cave.

Although 65% of caves surveyed are used by bats, most are used by few individuals (Figure 2). Most caves that have overwintering bats have less than 20 individuals, and only 9 caves have had counts with more than 20 individuals of any species documented. Low use of caves likely indicates local animals are using other features to overwinter. However, some caves have relatively high use and appear to be important hibernacula for local or regional populations of bats. Caves with higher bat counts are generally longer and deeper that the average length and depth of all surveyed caves (Figure 3). Also these caves are relatively cool with an average temperature of less than 6° C and 4 of the 5 that were assessed had a relative humidity at or close to 100% (Figure 4).

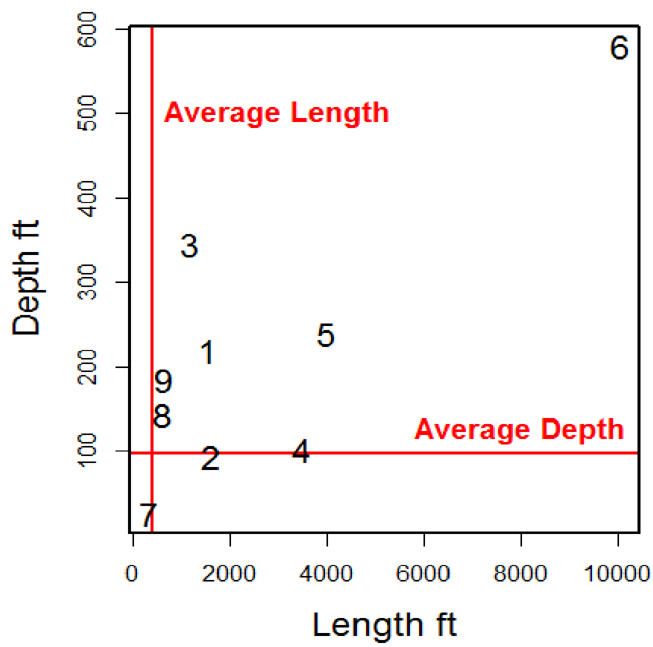

Figure 3. Length and depth of caves where more than 20 bats have been counted during the winter (numbers denote caves) compared to the average length and depth of all surveyed caves in the state (average denoted by red lines). Caves are ordered by roost size with 1 being the largest. All but one cave are close to or exceed average length and depth.

Most roosting bats are found in caves during the winter, but active season use has been observed and appears common, especially at large hibernaculum (Worthington 1991, Hendricks and Genter 1997), although counts are generally lower in the middle of summer. The exception to this trend is Townsend's Big-eared Bat, which is the only species in the state known to use caves as maternity colonies and counts are generally higher at maternity caves (Hendricks 1999b). Besides using caves for shelter, these features may also provide water. In xeric environments, bats have been observed entering caves at dusk and drinking from standing water (D. Bachen, personal obs.) similar to behavior observed in mines (Hendricks and Carlson 2001).

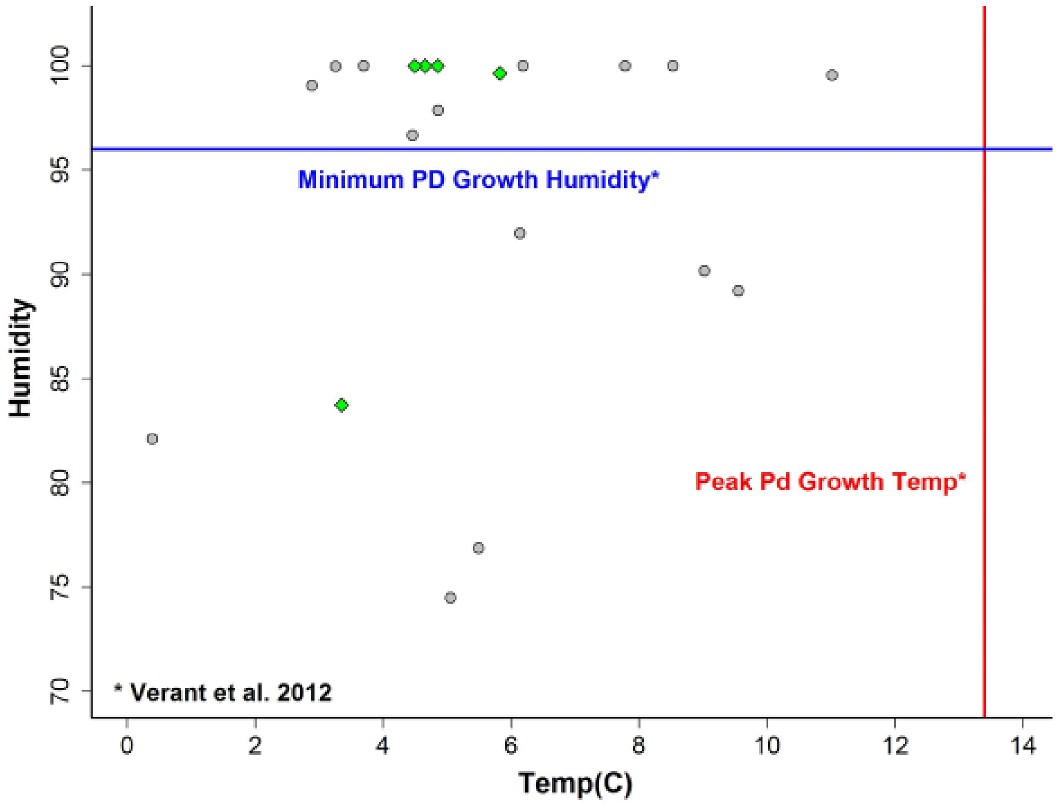

Figure 4. Average temperature and relative humidity for 21 caves across Montana. Grey circles denote caves with less than 20 bats, including caves not used as hibernacula. Green diamonds show caves with maximum winter counts exceeding 20 individuals. The minimum humidity and average temperature (Verant et al. 2012) for growth of the pathogenic fungus Pseudogymnoascus destructans (Pd) which causes White-Nose Syndrome are noted on the figure.

MINES

Although Montana lacks a state-wide inventory of bat presence in mines similar to caves, projects examining bat presence within the working of abandoned mines have been conducted across much of the state since the 1970s. Fewer mines have been surveyed than caves, likely due to the inherent dangers of entering abandoned mines which include collapse, bad air, radiation, and old explosives among other concerns (Figley et al 1998). Most surveys of mine workings have been conducted in the winter to identify hibernacula, although many have also been done in the spring and summer, which allows a more complete assessment of mine use across the year.

Across all mine survey data in the Montana Natural Heritage Program's Roost Database, Townsend's Big-eared Bat is the most commonly observed species and has been documented in 26 of the 33 mine sites where internal surveys of the workings have been conducted. Myotis bats were somewhat common, but rarely identified to species and reported at 11 mines. The most common species of Myotis was Long-legged Myotis observed at 4 sites. Big Brown Bat was observed at 2, and Long-eared Myotis, Little Brown Myotis, and Northern Myotis were all reported from one mine each. Northern Myotis, Little Brown Myotis and Long-eared Myotis have only been observed in mines during the winter although there has been insufficient survey effort during the active season to infer absence during this time. In contrast to Caves the largest aggregations of bats across all seasons are Town Townsend's Big-eared Bat send's Big-eared Bat rather than Little Brown Myotis. Townsend's Big-eared Bat is the only species with a documented maternity colony in a mine in Montana (Hendricks 1999b).

Survey coverage across the state is variable and generally favors western Montana (Figure 5). In eastern Montana few surveys have been conducted, likely this because of the risk of collapse in mines within weak sandstone. However, the few surveys conducted in this area have been productive. A survey of two mines on the Yellowstone River and Missouri River near the North Dakota border resulted in the detection of 5 species of bats overwintering Northern Myotis (*M. septentrionalis*), Little Brown Myotis, Long-eared Myotis, Long-legged Myotis, and Townsends Big eared bat (Swenson and Shanks 1979). The detection of the Northern was the first documentation of the species in the state and it was not observed again until 2016 (Bachen 2017). Other coal mine surveys in sandstone reported to MTNHP have documented Townsend's Big-eared Bat and Long-eared Evotis.

The central and western regions of the state have received the most structured survey effort, primarily in the 1990's and early 2000's. Across 8 projects (Feigley et al. 1997, Hendricks et al. 1999, Hendricks 1999a, Hendricks 1999b, Hendricks 1999c, Hendricks 2000, Hendricks and Carlson 2001, and Hendricks 2003), 5 species were detected: Western-small footed Myotis, Long-eared Myotis, Long-legged Myotis, Big Brown Bat, and Townsend's Big eared Bat. During these surveys few mines were entered, and most were surveyed using mist nets across adits, or with acoustic detectors. The proportion of mines suitable for bats varied by study. In one survey of mines in southwestern Montana, only 11 of 64 mines visited appeared open enough to be used by bats (Feigley et al. 1997). Two surveys failed to find mines that could be used by bats (Hendricks 1999c, Hendricks 2003). In contrast a survey of 73 abandoned mine workings in 88 mine sites in Beaverhead, Madison, and Silver Bow Counties in southwestern Montana found 23.1% of sites visited were collapsed and not suitable for survey and 49 mine sites (66 workings) had evidence of use by bats (Hendricks et al. 1999). Many of these surveys used mist netting or mist netting and direct surveys of the mine workings. Both appeared to be effective, but mist netting efforts resulted in more captures. Excluding Townsend's Big-eared Bat maternity colonies, bats captured at mines during the active season were reported to be to be males (Feigley et al. 1997, Hendricks et al. 1999, Hendricks 2000). This is not surprising as mines and caves are relatively cold in Montana (Campbell 1978), and are not suitable maternity sites for most species.

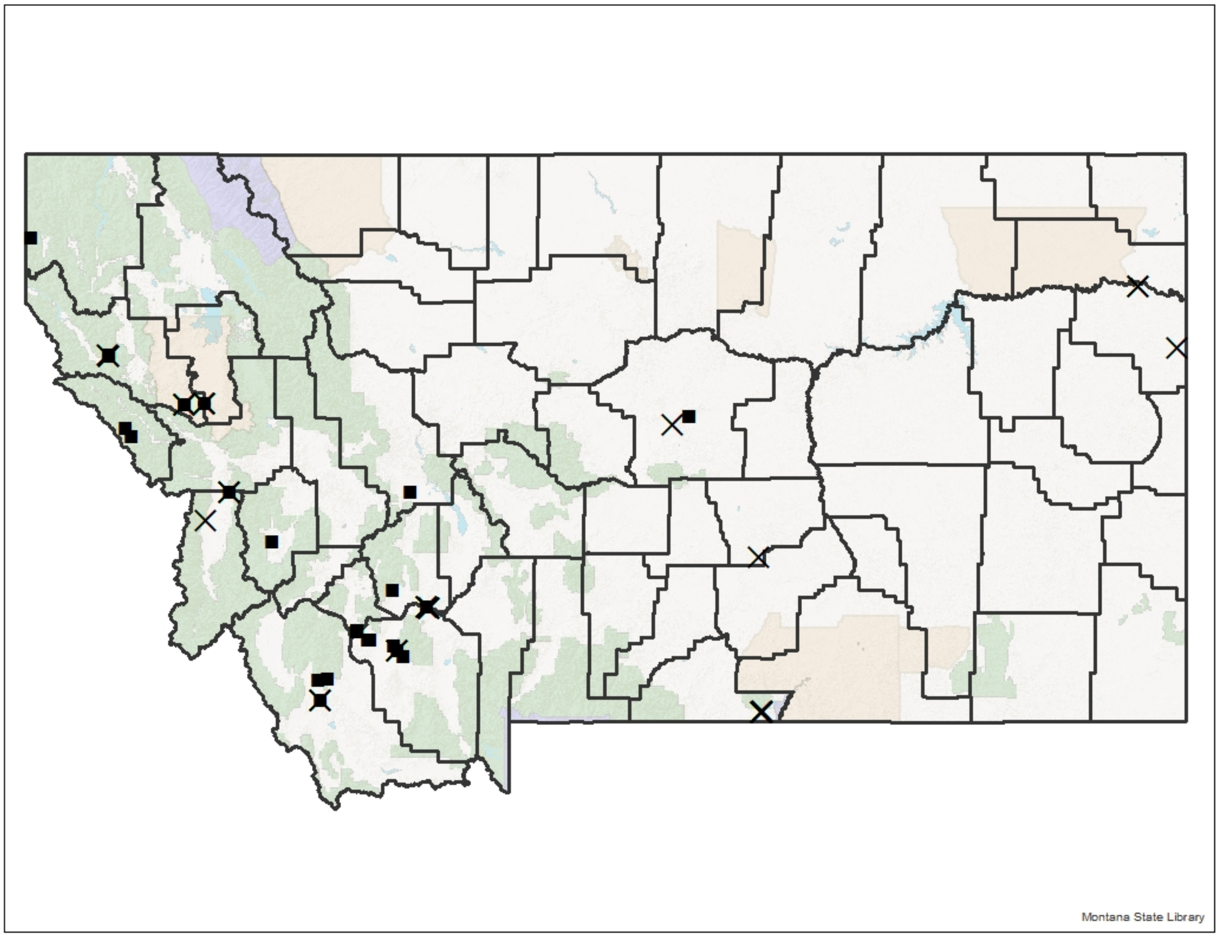

Figure 5. Mine roosts in Montana reported to the Montana Natural Heritage Program. Triangles represent night roosts, squares are day roosts, and circles are maternity colonies. Hibernacula are shown with cross symbols, which may overlay active season roosts.

Rock Outcrops

Rock outcrops such as boulders, cliffs, and talus slopes remain one of the least studied roost types but are likely among the most used roost features by bats in Montana based on observations across North America (see Appendix A). Surveys of these features are difficult as bats may not be detectable unless they roost at or near the surface of cracks and crevices and are accessible to surveyors.

In recent years MTNHP has conducted searches of rock outcrops using Visual Encounter Survey methods and by deploying Acoustic Bat detector/ recorders. Visual encounter surveys are conducted using a bright flashlight to examine cracks and crevices (e.g. McEwan and Bachen 2018). The results of these surveys are promising, but more work needs to be done to fully document the use of this roost type. Data on outcrop use are mostly derived from these surveys, but a significant portion are also from surveys of south facing rock outcrops conducted by MTNHP to detect reptiles, particularly in southeast Montana. The remainder are from incidental observations submitted to MTNHP by biologists and the general public.

Of the state's 15 bat species, all but Hoary Bat, Eastern Red Bat have been observed using rock outcrops as roosts somewhere within their range (see Appendix A for more detail). Within Montana Pallid Bat (*Antrozous pallidus*), Townsends Big-eared Bat, Big Brown Bat, Long-eared Myotis, Western Small-footed Myotis, California Myotis (*M. californicus*), and Long-legged Myotis have all been found roosting in rock outcrops. The most frequently encountered species is Long-eared Myotis which was observed at 40 of 91 rock outcrops were bats were encountered. The next most common was Western Small-footed Myotis 25 sites, followed by Big Brown Bat at 20 sites, Long-legged Myotis and Pallid Bat at 2 sites each, and Townsends Big-eared Bat and California Myotis at 1 each. Although classified as a rock outcrop the observation of the Townsend's Big Eared Bat was made in a shallow sandstone cave, and the species does not appear to utilize cracks and crevices in rock outcrops to roost.

Most detections have come from surveys of sandstone outcrops in southeastern and central Montana (Figure 6). Roosting bats are often found in cracks in cliffs, under thin slabs of rocks stacked on cliffs or boulders or behind flakes. Often these features have good solar exposure and bats appear to move to the edge to bask during cooler periods, making detection easier (McEwan and Bachen 2018). As our visual encounter survey methods are biased toward species that roost in visible cracks and toward rock types that are easily surveyed, it is difficult to say whether sandstone is a preferred roosting substrate or if it is just easily surveyed. To further confound this, areas where this sandstone is present are generally in areas of high species diversity.

Talus slopes also appear to be used as roosts by bats, but little work has been done to explore how bats use this type of outcrop in Montana. In 2017, 23 talus slopes were surveyed in western Montana. Guano was discovered in 35 locations indicating these roosts were used by some species of bats, and 10 occupied roost were located (McEwan and Bachen 2018). At these 10 roosts two species were represented, Long-eared Myotis at 7 roosts and Western Small-footed Myotis at 3 roosts. All animals were roosting singly. Roosts were often in boulders that had good solar exposure regardless of the orientation of the slope.

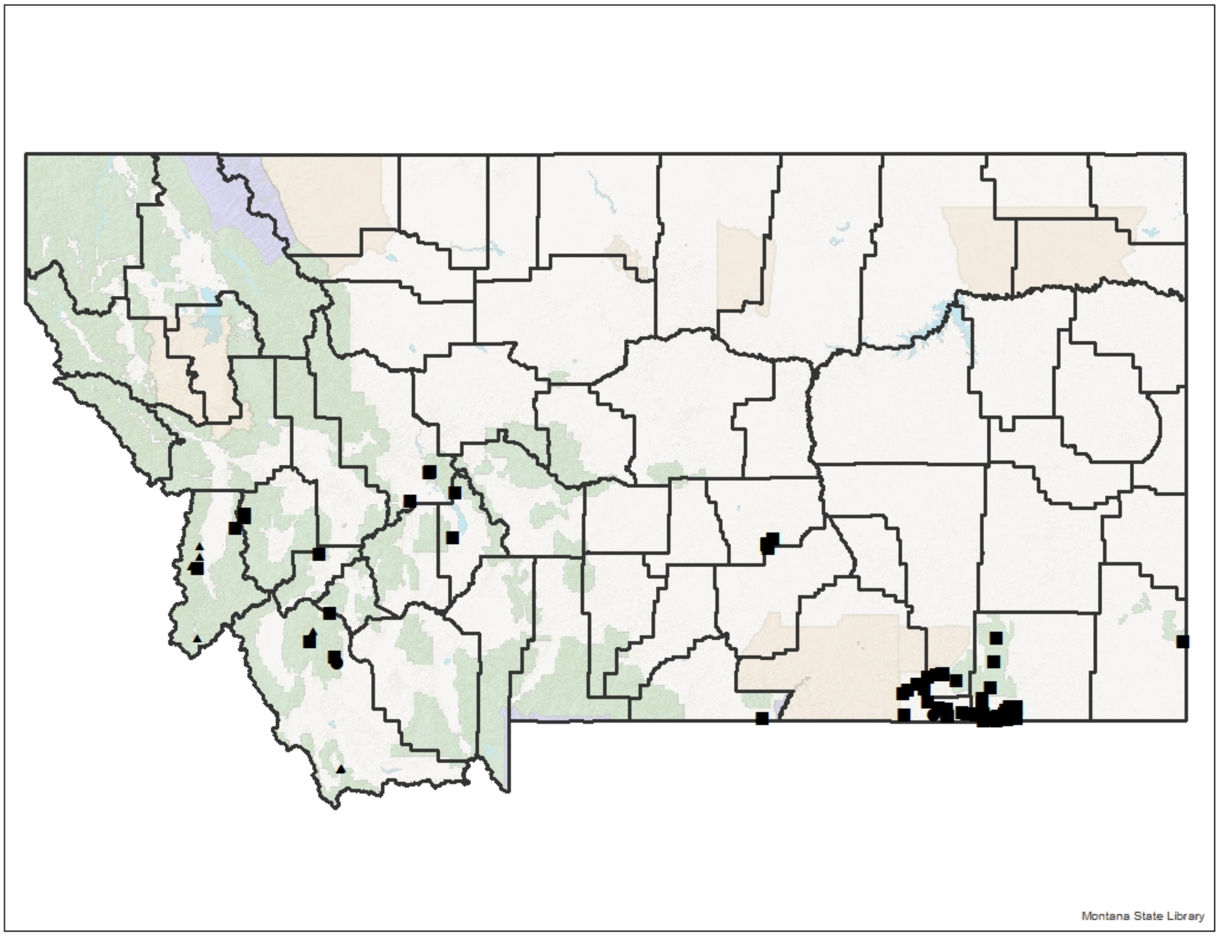

Figure 6. Rock outcrop roosts in Montana reported to the Montana Natural Heritage Program. Triangles represent night roosts, squares are day roosts, and circles are maternity colonies.

Almost nothing is known about winter use of any rock outcrop in Montana, but talus slopes may have significant interstitial space between blocks and suitability as hibernacula has been suggested based on summer presence and favorable microclimate attributes (Moosman et al. 2015). While winter use of talus has not been directly observed in Montana, winter activity associated with cliffs and talus has been documented in the Bitterroot and Sapphire Mountains of western Montana. Although the activity itself is not proof of animals hibernating in the talus, no caves or mines existed in the areas the detectors were deployed. Furthermore, talus appeared to mitigate temperature fluctuation and have high humidity similar to hibernacula in caves (Guilky 2018).

BUILDINGS

Buildings are commonly used as roosts by bats within the state, but as most of these features are privately owned observations are likely underreported. Eight of the state's species have been observed roosting on or within buildings: Townsend's Big-eared Bat, Big Brown Bat, Western Small-footed Bat, Long-eared Bat, Little Brown Bat, Long-legged Myotis, Yuma Myotis, Silver-haired Bat (*Lasionycteris noctivagans*) , Spotted Bat. Roosts on or within 57 structures have been reported to the Montana Natural Heritage Program, 12 of which are maternity colonies of either Big Brown Bat, Yuma Myotis or Little Brown Myotis. A single Townsend's Big-eared Bat maternity colony has been reported in the lower Missouri River drainage of northeastern Montana (Swenson and Shanks 1979). Overwintering within buildings by any species has not yet been reported. A California Myotis and Yuma Myotis were reported in a building in April in the Bitterroot Valley of western Montana (Hendricks 2012), however bats are increasingly active on the landscape during April (Bachen et al. 2018) and these individuals may have already emerged from hibernation. Survey coverage is well distributed across the state, but sparse (Figure 7). Some maternity roosts may be quite large, and 10 buildings in the MTNHP database have counts exceeding 100 individuals, and approximately 2,000 bats were observed exiting a building in glacier national park (Sterling et al. 2016), which is the largest active season roost known in the state. These large colonies are almost exclusively composed of Little Brown Myotis, Yuma Myotis (M. yumanensis), or Big Brown Bats.

Only one systematic survey of buildings within Montana has been conducted. In 2015 Sterling et al. (2016) surveyed 579 buildings within Glacier National Park and found 249 had evidence of use by bats. They found 88% of roosts were night roosts, 12% were day roost of which 5 were maternity colonies. Bats appeared to favor buildings with masonry and avoid those with metal siding for night roosts. They also performed limited emergence counts of day roosts and found that their initial survey estimates severely underestimated the total number of bats within the roost.

Figure 7. Building roosts in Montana reported to the Montana Natural Heritage Program. Triangles represent night roosts, squares are day roosts, and circles are maternity colonies. Surveys conducted by Sterling (2015) in glacier national park have not been included as the survey density prevents clear visualization of these data at this scale.

BRIDGES

Bridges are the most well surveyed feature used by bats in Montana. Since 2004, 2,076 bridges maintained by the Montana Department of Transportation and US Forest Service have been surveyed for bat presence across the state. As a result of these efforts bridge roosts have been identified in all but 4 counties within the state (Figure 8).

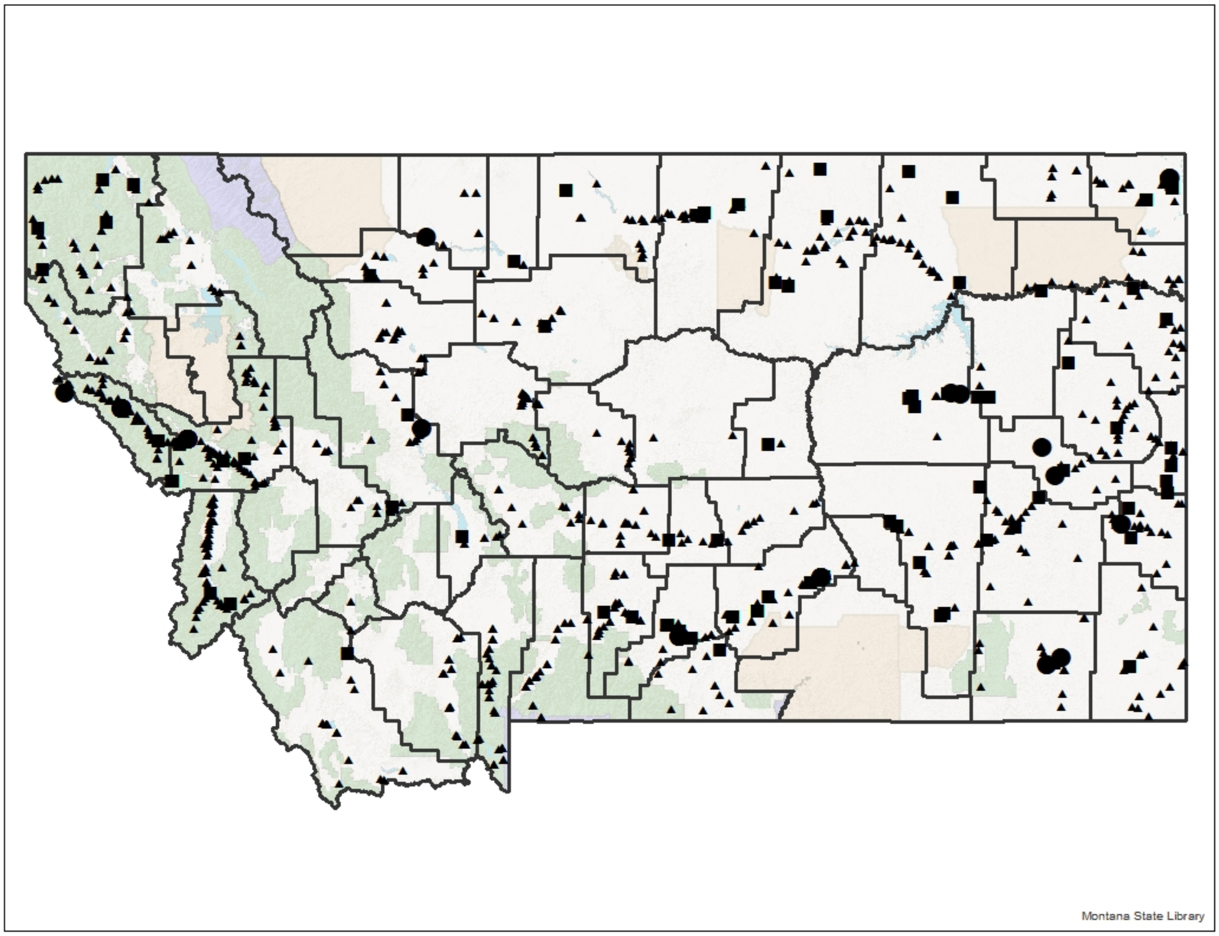

Figure 8. Bridge roosts in Montana reported to the Montana Natural Heritage Program. Triangles represent night roosts, squares are day roosts, and circles are maternity colonies..

Seven separate projects have focused on surveying bridges in Montana. In 2003 and 2004 Hendricks (2005) surveyed 130 bridges across southcentral Montana and found 78 had evidence of bat use including 12 day roosts. Species encountered were Big Brown Bat, Western Small-footed Myotis and Little Brown Myotis. Surprisingly an adult female Hoary Bat (*Lasiurus cinereus*) with two pups was also observed roosting under a bridge, which is the first documented use of bridges by this species. One Big Brown Bat and one Little Brown Myotis maternity colony were found during these surveys, containing a maximum of 15 and 125 bats respectively. In 2014, 412 bridges were surveyed in Mineral, Missoula, and Ravalli counties between May and October. Of these 180 (46%) were used as night roosts, at 11 day roosting bats were detected (3%) and 3 of these had maternity colonies. Concrete bridges were used disproportionately to their availability (Whittle 2015). In 2015 a student surveyed 407 bridges in Beaverhead, Deerlodge, and SilverBow Counties of southwestern Montana. He found that 44% of structures had evidence of night roosting bats, and just 4 bridges (0.5%) were day roosts. Also in 2015, 73 bridged were surveyed on the Flathead Reservation of in the Flathead Valley of northwestern Montana. Little evidence of roosting bats was observed and only 5 bridges were used as night roosts and no day roosting bats were found. In 2017, 383 bridges were surveyed across the counties bordering the North and South Dakota border. Of these 56% had evidence of use by bats, 45% were used as night roosts, 0.5% were day roosts including 5 maternity colonies. As in other areas of the state concrete decking material seemed to be preferred for roosts and its use was disproportionate to its availability.

In 2019, 671 bridges were surveyed across the northern region of the state as well as underserved areas of eastern, central and western Montana. This effort completed the statewide inventory of bridges. Of these bridges 264 had evidence of use by bats, 225 were used as night roosts (34%), 31 had day roosting bats (0.5%). Due to the timing of surveys, no maternity colonies could be confirmed, but 8 roosts were large enough and established early enough in the year to suspect that these were maternity colonies. Four species were confirmed at day roosts: Big Brown Bat, Townsend's Big-eared Bat, Little Brown Myotis, and Long-eared Myotis. Roost size ranges from approximately 200 in a bridge over the Missouri River to single roosting individuals.

Across these surveys, bats are often identified to genus rather than species as surveyors are either not trained in handling and vaccinated for rabies and unable to confirm species in hand, bats cannot be reached or captured. Occasionally species are confirmable, particularly for distinctive species like Hoary Bat, Silver-haired Bat, Townsend's big-eared Bat, and Big Brown Bat. Myotis bats remain the most difficult to confirm. One project collected guano samples from bridges and genetic methods were used to identify species using the bridges. Although these methods did not detect all species using a given bridge, the entire data set is useful for determining what species use bridges. Across the state 7 species have been found using bridge roosts: Townsend's Big-eared Bat, Big Brown Bat, Hoary Bat, Silver-haired Bat, Western Small-footed Myotis, Northern Myotis, Long-eared Myotis, Little Brown Myotis have been detected. Long-legged Myotis, California Myotis, Fringed Myotis, and Yuma Myotis may use bridges but have not been confirmed in hand or with genetic methods.

Bridge use seems to be relatively constant sate-wide and between 35% and 50% of structures are used as night roosts by bats with around 0.5% - 10% as day roosts (Figure 9). The proportion of night roosts is comparable to many states surveyed by Keeley and Tuttle (1999). Day roosting proportions were lower than many other states although proportions for Wyoming, Idaho, and Utah were all less than 10% in the same study. Within Montana bridges in the southcentral region (Hendricks 2005) had a slightly higher proportion of day roosts than the other surveys, while all the other survey rates were similar. Although the proportion of bridges with day roosting bats across the northern region of the state comparable to other areas, the proportion of night roosts lower than other areas.

Across all surveys, concrete decked bridges appear to be favored by bats as night and day roosts. Many maternity colonies observed were in expansion joints where the initial foam had fallen out or degraded allowing bats to enter. In areas with wooden bridges, day roosts were often found between boards that are placed in such a way as to create deep vertical crevices.

Surveys of bridges have been limited to the spring through early fall. Although no bridges have been surveyed in the winter these features are unlikely to be used as hibernacula as they provide little shelter from cold temperatures or maintain high humidity.

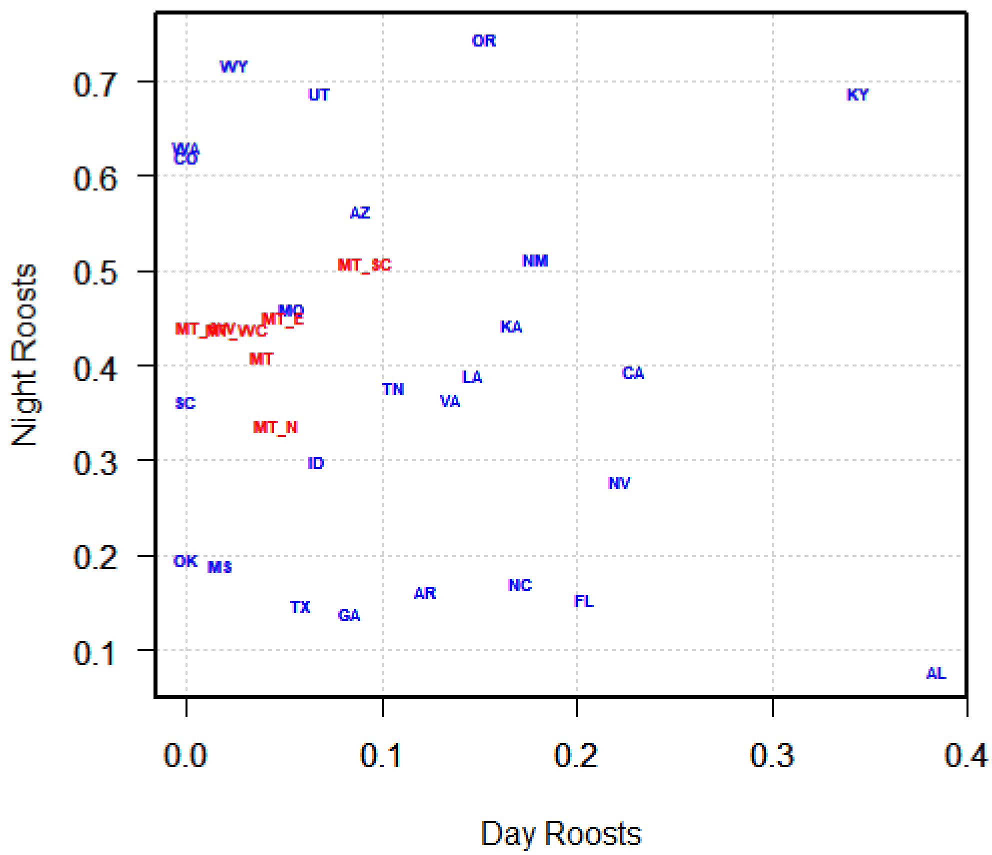

Figure 9. a comparison of the proportion of bridges used as day and night roosts across 26 states, other states in blue and Montana in red. Individual Montana projects are noted as MT_geographic region (e.g. MT_SW for southwest). The aggregated proportions are shown under MT. Proportions for other states is derived from Appendix V in Keely and Tuttle 1999.

Trees

Like rock outcrops, trees are likely among the most used roosts by almost all species in Montana but are also the most poorly documented roost type. Importance of trees as roost features is well documented for all but two species in Montana: Townsend's Big-eared Bat and Spotted Bat (see Appendix A). In Montana data on tree roost location or attributes is sparse. The few data that exist are either from incidental observations or telemetry-based studies. All observations are within the active season. Future work is needed to confirm that trees are used as roosts in similar ways as in other states and describe the attributes of roost trees by each species.

The single published study of tree roosts in Montana are limited to work conducted in burned conifer forests in western Montana (Schwab 2006). Little Brown Myotis and Long-eared Myotis were tracked using radio-telemetry to roosts in Engelmann Spruce (*Picea engelmannii*), Lodgepole Pine (*Pinus contorta*), and Subalpine Fir (*Abies lasiocarpa*). Engelmann Spruce appeared to be preferred as a roost relative to its availability, as are larger trees and those that are prominent within the surrounding forest. In addition to roosts in trees female Long-eared Myotis were occasionally roosting in stumps (Schwab 2006).

Five roosts used by two species have been reported to the Montana Natural Heritage Program. Two Hoary Bat day roosts have been reported, both observations were of single individuals in the foliage of deciduous trees in central and eastern Montana. In one case an animal was flushed from a Green Ash (*Fraxinus pennsylvanica*) approximately 1.5 m above ground level along the little Missouri River. The other observation was of an individual roosting in the foliage of a tree 8 m off the ground along Highwood Creek, the species of tree was unreported. One Silver-haired Bat roost in a tree has been found in a tree along Beaver Creek South of Lewistown in the foot hills of the Big Snowy Mountains. The tree was a mature Ponderosa Pine (*Pinus ponderosa*) and was used as a maternity colony although the details of the number of bats was unreported. The colony was found when the tree was felled by the property owner. Another maternity colony was documented in a Ponderosa Pine in the Gold Creek drainage of Western Montana. A singe Long-eared Myotis roost was reported in a Western Larch (*Larix occidentalis*) in the same drainage.

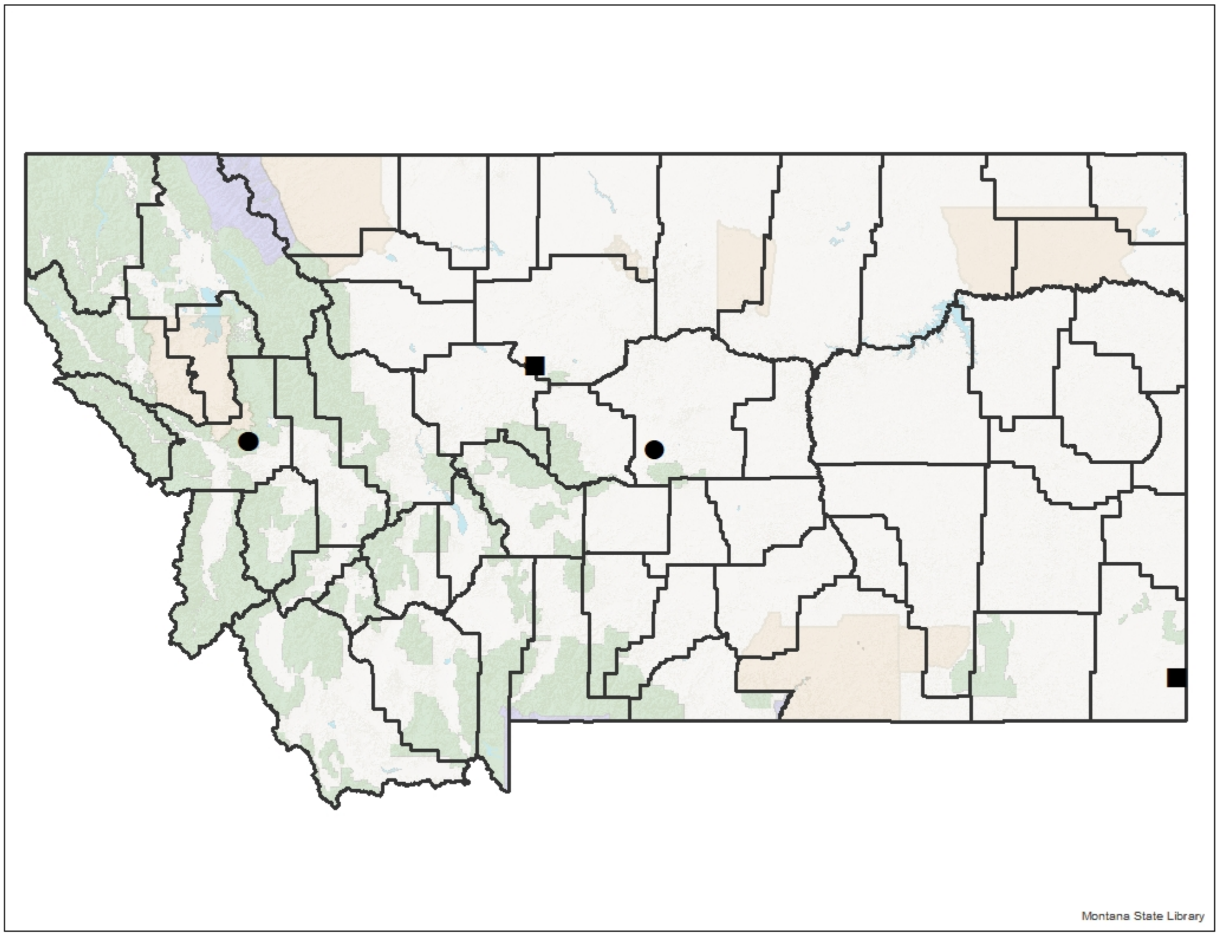

Figure 10. Tree roosts in Montana reported to the Montana Natural Heritage Program. Triangles represent night roosts, squares are day roosts, and circles are maternity colonies.

Atypical Roosts

Bats have also been reported roosting in atypical roost locations that are not easily classified into the previous categories. Whether these objects have attributes similar to natural roosts or were used out of necessity or incidentally is unknown. Pallid Bat has been documented roosting on two atypical features. One individual was observed roosting on a cement and stone sign post during a thunder storm in southeast Montana. This is likely an atypical night roost used out of necessity during inclement weather. Another Pallid Bat was found roosting on a tractor in the Clark's Fork drainage in southcentral Montana. This observation was made in early October during the fall transition period, when the animal may have been moving to an overwintering location. The animal may have used this vehicle out of convenience or necessity. One Spotted-bat was observed roosting behind a meter box on a power pole during mid-summer in north of the lower Yellowstone River in eastern Montana. The species has been observed infrequently in association with river breaks and badlands in this general area (NHP Point Observation Database), but the immediate area near the observation was reported as shortgrass prairie. As spotted bats are known to travel 10's of kilometers between roosting and foraging sites each evening (Rabe et al. 1998), this individual may have been foraging somewhere in the general area and was unable to return to its usual roost, so used this atypical feature out of necessity.

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Appendix A

Overview of Roosting Habitat and Home Range / Foraging Distance Documented for Montana Bats

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The table, figures, and images below summarize and provide examples of what is known about winter, maternity, and day/night roost habitat use for Montana bat species in the state and/or elsewhere across their ranges. Protection of these cave, mine, cliff, rock outcrop, ground crevice, large tree, bridge, and building habitats with cracks and crevices ranging from $^{1}/_{3}$ to 1 inch in width and associated temperature and humidity regimes, is essential for protection and conservation of Montana's bats. Artificial bat roosts that provide summer maternity, night, and day roosts, can be deployed to serve as a surrogate for large diameter tree and other roosts that have been lost and/or to encourage roosting away from buildings where bats would be in close proximity to sleeping humans. Artificial winter roost habitat is not a viable management option at the present time.

Table 1. Summary of roosting habitat and home range for Montana's bat species including known roost features used within the winter and active seasons and observed home range sizes and foraging distances from the literatures. Sources are cited in this section below the table.

Species / Comments	Winter Roost	Summer Maternity Roost	Summer Day/Night Roost	Home Range/Foraging Distance
Pallid Bat **(*Antrozous pallidus*)** Low roost site fidelity with 90% of inter-night movements of 50-600 meters.[3] Highly social, often using day and night roosts in groups of 20 or more guided by social vocalizations and odors.[2,4] Yearling females typically give birth to a single pup, but older females typically give birth to 2 pups.[4,43]	Not documented in Montana, but likely occurs in deep rock crevices if the species is present.[1,4]	Not documented in Montana. Elsewhere in vertical and horizontal rock crevices, under rock slabs, in buildings, and on taller and larger diameter live trees and tree snags with loose bark in mature stands with southerly aspects and lower percentages of overstory.[4,37,38,41,42,44]	Under rock slabs, in horizontal and vertical rock crevices, and on farm equipment in Montana.[1] Elsewhere occasionally on buildings, bridges, caves, mines, vertical and horizontal rock crevices that are typically on east or southeast aspects, and taller and larger diameter live trees and tree snags with loose bark in mature stands with southerly aspects and lower percentages of overstory.[2,4,21,22,23,30,37,38,39,40,41,44]	Lactating females moved an average of 2,450 meters +/- 845 from roost to foraging areas and had an average foraging area size of 1.56 square km +/- 0.88 SE. Post-lactating females moved an average of 210 meters from roost to foraging areas and had an average foraging area size of 5.97 square km +/- 2.69 SE in northern California.[37] Individuals commuted 1 to 4 km between day roosting and foraging areas, 0.5 to 1.5 km between day roosts and night roosts, and switched day roosts often, usually moving <200 meters between roosts (range 25 to 3,660 meters) in eastern Oregon.[38,39] Individuals typically commuted 1-2 km from day roosts to foraging areas, but one male often used different day roosts separated by 10 km in California.[42]

Townsend's Big-eared Bat (***Corynorhinus townsendii***) High fidelity to maternity and hibernacula roosts, lower interseasonal roost site fidelity, and travel up to 24 km from hibernacula to summer foraging areas.[73] Forage and commute adjacent to vegetation.[72]	Twilight areas of caves, mines, and unused tunnels in Montana.[1, 31, 32, 75, 84] Limestone or lava tube caves and mines are known to be used elsewhere with arousal and movement within or between sites, possibly responding to changing temperature.[5, 73, 74, 82]	Caves and mines, often in twilight areas in Montana.[1, 75] Reported in caves, mines, buildings, and basal tree hollows elsewhere.[2, 5, 72, 73, 81, 82, 83] Females prefer cooler maternity roosts than other vespertilionid bat species.[2]	In Montana, usually in caves and mines, often in twilight areas, but more rarely building attics, root cellars, and pocket/daylight caves.[1, 21, 31, 32, 75] Reported in caves, mines, buildings and large diameter basal tree hollows elsewhere.[2, 5, 72, 81, 82, 83]	Average one-way travel distances between day roosts and foraging areas was 3.2 km +/- 0.5 SD for males and 1.3 km +/- 0.2 SD for females in coastal California; maximum distance traveled from the day roost was 10.5 km.[72]
Species / Comments	**Winter Roost**	**Summer Maternity Roost**	**Summer Day/Night Roost**	**Home Range/Foraging Distance**
Big Brown Bat (***Eptesicus fuscus***) Males often roost solitarily during summer. Rarely move more than 80 km between summer and winter roosts. [2, 6] Roost switching is common at natural roosts, but show high fidelity to man-made roosts.[64, 65, 71]	Caves, mines, and some evidence for rock crevices which are probably the most widespread winter roost in Montana.[1, 31, 84] Known to use narrow deep rock crevices or erosion holes in steep valley walls on the Canadian prairie and buildings in Ohio.[6, 62]	Buildings, bridges, large diameter trees snags with hollows or loose bark in Montana.[1, 75] Primarily large diameter tree snag hollows and crevices, but also live aspen hollows, in more sparsely spaced stands, deep rock crevices, and older human structures are known to be used elsewhere. [6, 29, 59, 64, 65, 66, 67, 68, 71]	Rock crevices, buildings, bridges, and caves in Montana.[1, 22, 31] Larger diameter tree snags with hollows and crevices and preferential selection for older more sparsely spaced stands, older buildings, and rock crevices with good solar exposure are known to be used elsewhere. [27, 29, 30, 64, 65, 66, 67, 68, 69, 71] Caves and mines known to be used as night roosts elsewhere.[70,]	Average of 1.5 km +/- 0.9 SD (range 0.4 to 1.8 km) from roosts to capture locations with average movement between successive roosts of 1.1 km +/- 0.7 SD (range 0.4 to 2.0 km) in the Black Hills of South Dakota.[29] Average one-way travel distances between day roosts and foraging areas of 1.8 km +/- 0.1 SE) range (0.3 to 4.4 km) in southern British Columbia.[64]
Spotted Bat (***Euderma maculatum***) High roost site fidelity with multiple individuals following the same nightly commuting routes up side canyons to foraging areas at speeds of up to 53 km/hr. [8, 49]	Not documented in Montana. Deep rock cracks and crevices are commonly used elsewhere and caves and human structures are rarely used elswhere.[1, 2, 7, 51]	Not documented in Montana. Rock cracks and crevices in upper portions of tall remote south facing cliffs near perennial waters are used elsewhere. [1, 2, 7, 8, 50]	Buildings and other human structures in Montana. [1, 47] Rock cracks and crevices in upper portions of tall remote cliffs near perennial waters, and, apparently more rarely, cave entrances and buildings elsewhere. [2, 7, 8, 45, 46, 47, 48, 49, 50, 51]	50-60 km round trip flight distances nightly with average home range size of 297 +/- 25 SE (range = 242.5 to 363.8) square km in northern Arizona. [8] Nightly round trip commutes of >77 km between day roosts, foraging areas, and night roosts that differed in elevation by ca. 2,000 meters in northern Arizona.[49] Nightly round trip

Forage over clearings and along cliff rims. [49, 50, 51]				foraging flights of 12 to 20 km in British Columbia. [50]
Silver-haired Bat **(*Lasionycteris noctivagans*)**	Not documented in Montana. Known to use loose bark, basal tree cavities, cavities under tree roots, and rock crevices on more southerly aspects and in older stands of trees, elsewhere with retreat to more underground sites at lower temperatures. [93] Use of mines is also known. [94]	Large diameter tree snags with loose bark or cavities in Montana. [1, 9, 26] Hollows and crevices in live aspen and large diameter and taller trees or tree snags in older lower canopy closure stands known to be used elsewhere. [9, 59, 86, 90, 91, 92, 95, 96]	Large diameter tree snags with loose bark or cavities and a building in Montana. [1, 26, 78] Large diameter trees or tree snags in older stands with hollows and crevices are predominant summer roost elsewhere, but rock crevices, buildings, bridges, and other human structures also used.[9, 22, 86, 90, 91, 96]	Distance between capture locations and roost snags ranged from 0.1 to 3.4 km (averages for juvenile males, juvenile females, adult males, and adult females were 1.3, 1.5, 1.8, and 0.5 km, respectively) in northeastern Washington. [96]

Species / Comments	Winter Roost	Summer Maternity Roost	Summer Day/Night Roost	Home Range/Foraging Distance
Eastern Red Bat **(*Lasiurus borealis*)** Species is a solitary rooster at heights of 1 to 6 meters from the ground, but forage and migrate in groups. [10]	Not documented in Montana and thought to migrate far to the south where they use tree roosts on warmer days and nights and retreat below leaf litter when temperatures dip below freezing. [10, 54]	Maternity roosts or lactating individuals have not been detected in Montana. Elsewhere, known to roost mostly in dense foliage that provides shade and protection from the wind, but also on trunks, of larger diameter mature deciduous and conifer trees, often in riparian areas. [10, 52, 53, 55, 56, 57]	Not documented in Montana. Elsewhere, known to roost mostly in denser foliage, but also on trunks, of larger diameter mature deciduous and conifer trees, often in riparian areas. Also more rarely in shrubs, under leaf litter, and on human structures. [10, 52, 53, 55, 56, 57]	Maximum distances traveled to foraging areas averaged 1.24 km (range 0.19 to 3.28) and foraging areas averaged 94.4 Ha +/- 20.2 SE with no significant differences between sex and age classes in Mississippi. [52] Maximum distances traveled from diurnal roosts to foraging areas ranged from 1.2 to 5.5 km for females and 1.4 to 7.4 km for males with average foraging area size of 334 Ha in Kentucky [53]
Hoary Bat **(*Lasiurus cinereus*)** Species is a solitary rooster at heights of 3 to 5 meters from the ground, but forage and migrate in groups. [11]	Not documented and thought to migrate far to the south of Montana in the winter. [11]	Only a bridge roost documented in Montana.[1] Known to be a solitary rooster in deciduous and conifer tree foliage that offers shelter from the wind and more southern exposure to the sun elsewhere. [11, 85, 86, 87, 88, 89]	A bridge, and cottonwood and green ash foliage in Montana.[1] Known to roost in deciduous and conifer tree foliage elsewhere. [1, 11, 85, 86, 87]	Females traveled one-way distances up to 20 km from day roosts while on first of up to five nightly foraging bouts in Manitoba Canada.[85]
California Myotis **(*Myotis californicus*)** Roosts alone or in groups. [12]	Recent acoustic and telemetry data indicates species likely overwinters in rock crevices in Montana.[1, Nate Schwab, personal communication] Rock crevices, caves, mines, tunnels, and buildings are used elsewhere. [2, 12, 25, 61]	Not documented in Montana. Elsewhere known to roost under loose bark or in holes or cracks in more isolated larger diameter tree snags in areas with lower canopy closure.[58, 59] More rarely, known to use buildings elsewhere. [60]	A house and a cellar in Montana. [32] Elsewhere known to roost under loose bark or in holes or cracks in more isolated larger diameter tree snags in areas with lower canopy closure.[58, 59] Also known to use rock crevices, bridges, buildings, and other human structures elsewhere. [12, 21, 22, 30, 60]	*No documentation found.

Western Small-footed Myotis (*Myotis ciliolabrum*) Mostly a solitary rooster, but sometimes aggregates in small groups. Fidelity to roost areas is shown, but roost switching within those areas is frequent [13, 63] Also show a high fidelity to commuting corridors.[63]	Caves and mines documented in Montana.[1, 76, 84] Known to use lava tube caves, deep cracks in ground, deep rock crevices, tunnels, and drill holes in rock elsewhere. [2, 13, 77]	Rock outcrop crevices with good solar exposure in Montana. [1] Known to rely mostly on vertical and horizontal crevices in cliffs and rock outcrops, but also documented using buildings elsewhere. [13, 63]	Rock outcrop crevices, bridges, caves, mines, and buildings in Montana. [1, 31, 32] Known to use rock outcrops, cracks in ground, tree hollows, and trees with loose bark elsewhere. [13, 63] No bats were detected using night roosts in a north central Oregon study.[63]	6 to 24 km round trip travel distances from roosts to foraging areas in north central Oregon. [63]

Species / Comments	Winter Roost	Summer Maternity Roost	Summer Day/Night Roost	Home Range/Foraging Distance
Long-eared Myotis **(*Myotis evotis*)** Suspected of only traveling short distances between summer and winter roosts. [14] Have low fidelity to individual roosts, but high fidelity to roost areas.[97, 98, 99]	Caves and mines.[1, 75, 84] May also use deeper rock crevices. [14]	Caves, cliff and rock outcrop crevices, and large diameter trees in Montana.[1, 26, 76] Known to use sheltered erosion cavities on stream banks, crevices in basalt, conifer stumps, conifer snags, buildings, and mine tunnels elsewhere. [14, 97, 98, 99]	Large diameter trees, rock outcrops, buildings, and caves in Montana. [1, 26, 31, 79] Known to use buildings, trees/snags with loose bark, trestle bridges, mines, rock crevices, stream bank cavities, and sink holes elsewhere. [14, 21, 27, 97, 98, 99]	Traveled an average of 970 meters (range 35-5,154 meters) between roosts in western Montana.[26] Moved 1 to 812 meters between day roosts and had roosting home ranges that ranged from 0.08 to 1.93 ha in Alberta.[97] Traveled 620 meters from capture sites to day roosts in western Oregon .[98] Traveled an average distance between day roosts of 148.9 m in northeastern Washington.[99]
Little Brown Myotis **(*Myotis lucifugus*)** Show high fidelity to summer colonies and hibernacula across years, but some individuals relocated between years a median distance of 315 km between hibernacula (range 6 to 563 km) and 431 km between summer roosts (range 25 to 464 km).[100] Males and nonreproductive females occupy cooler roosts than pregnant or lactating females.[15]	Caves and mines with high humidities and temperatures above freezing in Montana and elswhere. [1, 31, 36, 75, 84] May also use deeper rock crevices. [15] Predominantly documented using caves elsewhere. [100]	Attics and roofs of buildings, bridges, and bat houses in Montana. [1] Known to use cracks or hollows in larger diameter tree snags in older stands, rock crevices, and buildings elsewhere. [2, 15, 35, 90, 101, 102, 103]	Large diameter tree, rock crevices, buildings, bridges, caves, and bat houses in Montana. [1, 26, 31, 80] Known to use cracks or hollows in larger diameter tree snags in older stands, wood piles, and rock crevices elsewhere.[15, 35, 90] Caves and mines known to be used as night roosts elsewhere.[70]	Average 970 meters (range 35-5,154 meters) between roosts in western Montana.[26] Traveled 10 to 647 km from hibernacula to summer colonies in Manitoba and northwestern Ontario, Canada.[100] Female home range averaged 30.1 ha +/- 15.0 SD during pregnancy and 17.6 ha +/-9.1 SD during lactation in Quebec, Canada.[101] Males moved and average of 275 m +/- 406 SD between successive roosts, had mean minimum roosting areas of 3.9 ha +/- 7.9 SD, mean minimum foraging areas of 52.0 ha +/- 57.4 SD, mean distance between roosting and foraging areas of 254 m +/- 254.2 SD, and mean distances between capture sites and first roosts of 761 m +/- 623 SD in New Brunswick.[102] Mean home range area was 143 ha +/- 71.0 SE in New York.[103]

Species / Comments	Winter Roost	Summer Maternity Roost	Summer Day/Night Roost	Home Range/Foraging Distance
Northern Myotis **(*Myotis septentrionalis*)** Low roost site fidelity, but often stay in same general area within a season. May travel up to 56 km between summer and winter roosts. [16]	Only known from a single abandoned coal mine in Montana.[1, 75] Known from caves, with a preference to cluster in deep crevices and possibly move between caves within a winter elsewhere. [16]	Not documented in Montana. Known to use bark and hollows of larger diameter trees, usually in decay, and building crevices and bat houses elsewhere. [16, 29, 35, 69, 102]	Not documented in Montana. Known to use bark and hollows of larger diameter trees, usually in decay, and building crevices and bat houses elsewhere.[16, 29, 35, 69] Caves and mines known to be used as night roosts elsewhere.[70,]	Average of 2.2 km +/- 1.4 SD (range 0.1 to 5.9 km) from roosts to capture locations with average movement between successive roosts of 0.6 km +/- 0.5 SD (range 0.1 to 1.5 km) in the Black Hills of South Dakota.[29] Females/males moved and average of 457/158 m +/- 329/127 SD between successive roosts, had mean minimum roosting areas of 8.6/1.4 ha +/- 9.2/1.4 SD, mean minimum foraging areas of 46.2/13.5 ha +/- 44.4/8.3 SD, mean distance between roosting and foraging areas of 584.6/293.0 m +/- 405.8/282.8 SD, and mean distances between capture sites and first roosts of 1001/402 m +/- 693/452 SD in New Brunswick.[102]
Fringed Myotis **(*Myotis thysanodes*)** Very sensitive to roost site disturbance. [17] Maintain at least some level of group integrity when switching roosts. [29]	Caves in Montana. Some individuals may migrate south of Montana. [1]	Caves. [1] Known to use cracks and hollows of larger diameter trees, usually in decay, rock crevices on south-facing slopes, and buildings elsewhere. [17, 29]	Caves in Montana. [1, 32] Known to use cracks and hollows of larger diameter trees, usually in decay, rock crevices on south-facing slopes, mines, buildings, and bridges elsewhere. [17, 21, 22, 29]	Average of 1.0 km +/- 0.6 SD (range 0.1 to 2.0 km) from roosts to capture locations with average movement between successive roosts of 0.5 km +/- 0.6 SD (range 0.1 to 2.0 km) in the Black Hills of South Dakota.[29]
Long-legged Myotis **(*Myotis volans*)**	Caves and mines in Montana and elsewhere. [1, 19, 31, 36, 75, 84]	Large diameter trees in Montana. [1, 26] Elsewhere in taller, but random to normal diameter tree snags with loose bark or cracks, especially in areas with less habitat fragmentation, greater snag density but with greater tree spacing. [28, 33, 34, 35] Also in rock	Buildings, mines, caves and large diameter trees in Montana. [1, 26, 31, 32, 78, 79] Elsewhere in taller but random to larger diameter tree snags with loose bark or cracks, especially in areas with less habitat fragmentation, greater snag density but with greater tree spacing, are known to be	Average of 2.0 km +/- 0.1 SE from roosts to capture locations with average movement between successive roosts of 1.4 km +/- 0.1 SE across four study areas in Washington and Oregon.[28] Average of 1.9 km +/- 1.6 SD (range 0.4 to 3.7 km) from roosts to capture locations with average movement between

		crevices, cracks in the ground, and buildings are known to be used elsewhere with south-facing roosts preferred. [2, 29]	used elsewhere with south-facing roosts preferred. [27, 28, 29, 30, 33, 34, 35] Also in buildings, cracks in the ground, rock crevices, and caves. [19, 36]	successive roosts of 0.7 km +/- 0.5 SD (range 0.2 to 1.6 km) in the Black Hills of South Dakota.[29] Average home range size of 647 ha +/- 354 SE (range 16.5 to 3,029 ha) for males, 448 ha +/- 78.7 SE for pregnant females, and 304 ha +/- 53.8 SE for lactating females in Idaho.[33]

Species / Comments	Winter Roost	Summer Maternity Roost	Summer Day/Night Roost	Home Range/Foraging Distance
Yuma Myotis **(*Myotis yumanensis*)** Sensitive to roost site disturbance. [2]	Not documented in Montana, but acoustic evidence indicates overwintering in rock crevices in cliffs. [1]	Building, bridges, and bat houses in Montana.[1] Buildings, bridges, caves, mines, and abandoned cliff swallow nests are known elsewhere. [2, 20, 21, 22, 25]	Buildings, bridges, and bat houses in Montana.[1, 79] Large diameter trees, buildings, rock/cliff crevices and abandoned cliff swallow nests elsewhere. [2, 21, 22, 23, 24, 25, 30]	Average of 2 km (range 0.59-3.5 km) from roosts to capture locations in California.[24] 4 km from maternity roost to foraging areas in British Columbia.[25]

[1] supported by observations in Montana's statewide point observation database.

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