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Bats in the Bear Lodge Mountains and Surrounding Areas in Northeastern Wyoming

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Abstract

Eleven species of bats are known from northeastern Wyoming. Only scant information previously was available on community structure and reproductive activities of bats from the area. Herein, we present information on a survey of bats from forested habitats in the Bear Lodge Mountains and surrounding areas in northeastern Wyoming. We captured 471 individuals representing at least 10 species. The four most common species included the Little Brown Myotis (*Myotis lucifugus*), Northern Long-eared Myotis (*Myotis septentrionalis*), Long-legged Myotis (*Myotis volans*), and Silver-haired Bat (*Lasionycteris noctivagans*), representing 70% of captures. About 92% of individuals were adults, represented by 71% males and 29% females. For most species, we captured more adult males than adult females; however, the Northern Long-eared Myotis and Long-legged Myotis had either more or equal numbers of females than males, respectively. We report the first published reproductive data in Wyoming for the Western Small-footed Myotis (*Myotis ciliolabrum*), Hoary Bat (*Aeorestes* [=*Lasiurus*] *cinereus*), Fringed Myotis/Long-eared Myotis complex (*Myotis thysanodes* / *Myotis evotis*), Silver-haired Bat, as well as the federally threatened Northern Long-eared Myotis. We present data on reproduction in Wyoming for all other species except the Eastern Red Bat (*Lasiurus borealis*). Many dates of capture extend the known published period of time species are active in Wyoming during warmer months. Researchers know little regarding community structure and natural history of bats throughout much of western North America. We encourage other researchers to publish results from surveys, as there might be a time when researchers will not have the luxury to catch and learn so much so readily about these mammals. Ultimately, such data will help to protect populations and guide management decisions, as more species likely will gain federal protection.

Key words: bats, Bear Lodge Mountains, Black Hills, community structure, *Myotis septentrionalis*, Northern Long-eared Myotis, reproduction, Wyoming

Introduction

Northeastern Wyoming is dominated by grasslands, with the Bear Lodge Mountains and Black Hills representing the largest forested habitats in the area. Eleven of 18 species of bats known from the state occur in northeastern Wyoming (Buskirk 2016). The region has a unique and diverse assemblage of bats with spe-

cies having both eastern and western affinities, along with widespread occurring species. Western species that reach some of their easternmost distributional limits in the region include the Long-eared Myotis (*Myotis evotis*), Fringed Myotis (*Myotis thysanodes*), Long-legged Myotis (*Myotis volans*), and Townsend's Big-eared Bat (*Corynorhinus townsendii*), whereas the Northern Long-eared Myotis (*Myotis septentrionalis*) and Eastern Red Bat (*Lasiurus borealis*) reach part of their westernmost limits in northeastern Wyoming (Hall 1981). Although a number of publications have reported the distribution of bats throughout the state (Long 1965; Clark and Stromberg 1987; Bogan and Cryan 2000; Buskirk 2016), only limited published information is available on community structure and reproductive activity of bats in Wyoming (e.g., Turner 1974; Bogan and Cryan 2000). In fact, "for about one-third of bat species in Wyoming, our only Wyoming-specific knowledge is that they occur in the state" (Buskirk 2016; p. 97). Understanding relative abundances of species, timing of reproductive activity, and seasonality is important for making sound management decisions to protect and monitor bats in the region. Although the fungus that causes white-nose syndrome (WNS) is not known from Wyoming, it is known to the east in eastern Nebraska (www.whitenosesyndrome.org/partner/nebraska-game-and-parks-commission) and to the west in Washington (Lorch et al. 2016). Additionally, wind-energy facilities are negatively affecting migratory bats (Arnett et al. 2008; Cryan and Barclay 2009; Grodsky et al. 2012; Frick et al. 2017). Basic natural history data will be important in the future for conservation strategies, as these two large-scale, novel threats will continue to affect more populations throughout North America.

We present this paper as a baseline study for community structure and reproduction of bats in northeastern Wyoming to compare with future data from this and other parts of the state. Forested habitats of the Bear Lodge Mountains and surrounding areas are of interest because they are the only areas in Wyoming where the Northern Long-eared Myotis occurs (Bogan and Cryan 2000; Buskirk 2016). This species recently was designated as threatened under the Endangered Species Act (USFWS 2015). We report on the first summary of reproductive activity for a community of bats in Wyoming, including some of the latest dates of reproduction for the Northern Long-eared Myotis throughout its distribution. Part of our interests in publishing this dataset is to encourage other wildlife biologists to publish their datasets in peer-reviewed outlets/publications.

METHODS

In 1997, 1998, and 2017, we captured bats with mist nets (Avinet, Inc., Portland, ME; 75 denier, 2 ply, 38 mm mesh) that ranged in size from 6 to 18 m at various localities in Crook and Weston counties of northeastern Wyoming (Appendix). Mist-netting opportunities were scattered throughout summers and represented opportunistic field efforts associated with other field projects in 1997 and 1998. In 2017, we returned to obtain GPS coordinates for most of the sites to facilitate publishing data, and again opportunistically captured bats to add to the survey results. Field efforts between the 1997–1998 period and in 2017 were different, as we accrued a total of 57 mist-net nights in 1997–1998 and only 10 mist-net nights in 2017. One mist-net night equals one mist net of any length placed at a netting site during an evening. We captured bats mainly over earthen ponds (Figs. 1–5), a metal stock tank, and the Belle Fourche River (Fig. 6). Most sites were surrounded by forests of ponderosa pine (*Pinus ponderosa*) that also contained bur oak (*Quercus macrocarpa*), quaking aspen (*Populus tremuloides*), and a variety of other species (see Hoffman and Alexander 1987). However, grasslands and patches of Rocky Mountain juniper (*Juniperus scopulorum*) surrounded one of our sites in the Thunder Basin National Grassland at an elevation of 1309 m. Our lowest site was along the Belle Fouche River in Devil's Tower National Monument at an elevation of 1170 m. Elevations in the study area ranged up to 2,024 m at Warren Peak in the Bear Lodge Mountains.

We deployed mist nets at dusk and monitored nets generally for a few hours after sunset. Species, time of capture, sex, age (adult or volant young), reproductive condition (pregnant, lactating, post-lactating, scrotal), and forearm length were recorded for each individual.

Figure 1. Photograph of Box Spring in the Bear Lodge Mountains on 19 June 2017 (WYOMING: Crook Co., Bear Lodge Mountains, South Fork Tent Canyon, T52N, R63W, SW1/4 Sec. 34; 44.44547°N, 104.41332°W, NAD 83).

Figure 2. Photograph of pond along Whitelaw Creek in the Bear Lodge Mountains in August 1997 (WYOMING: Crook Co., Bear Lodge Mountains, 0.8 km E US Forest Service Roads 838 and 851, along Whitelaw Creek, T52N, R63W, N1/2 Sec. 17; 44.49869°N, 104.45038°W, NAD 83).

Figure 3. Photograph of pond near Beaverdam Springs in the Bear Lodge Mountains on 20 June 2017 (WYOMING: Crook Co., Bear Lodge Mountains, 0.4 km W Beaverdam Springs, pool along road, T55N, R63W, SE1/4 Sec. 26; 44.72493°N, 104.38035°W, NAD 83).

Figure 4. Photograph of Bear Lake in the Black Hills of Wyoming on 20 June 2017 (WYOMING: Crook Co., Black Hills, 2.4 km W, 0.4 km S Bull Hill, Bear Lake, T51N, R61W, SW1/4 Sec. 25; 44.37321°N, 104.13360°W, NAD 83).

Figure 5. Photograph of earthen pond in the Elk Mountains of the Black Hills of Wyoming on 21 June 2017 (WYOMING: Weston Co., Elk Mountains, 0.6 km S intersection Forest Service Roads 123 and 118; 43.68334°N, 104.06464°W, NAD 83).

Figure 6. Photograph of the Belle Fouche River at Devil's Tower National Monument in northeastern Wyoming in August 1997 (WYOMING: Crook Co., Devil's Tower National Monument, Belle Fouche River; 44.59198°N, 104.70394°W, NAD 83).

Because of difficulties distinguishing between the Fringed Myotis and Long-eared Myotis, we lumped this species complex into a single account. Most individuals were released at capture sites, but a few vouchers of each species were taken and deposited in natural history collections at the Museum of Southwestern Biology (MSB), University of New Mexico, Albuquerque, and Sternberg Museum of Natural History (FHSM), Fort Hays State University, Hays, Kansas (Appendix). In 2017, coordinates for localities of occurrence for many sites were acquired via handheld global positioning systems (GPSs) using North American Datum 1983. Common and scientific names of bats used herein follow Bradley et al. (2014), unless otherwise noted. Subspecies were determined with distribution maps published in Hall (1981).

RESULTS

In 1997, 1998, and 2017, we captured 471 bats representing at least 10 species in the Bear Lodge Mountains and surrounding areas (Table 1; Appendix). Our field efforts spanned 7–22 August 1997, 21–24 May 1998, 18–21 June 1998, 3–5 July 1998, 2 August 1998, and 21–23 June 2017. The four most common species based on numbers of captures included the Little Brown Myotis (*Myotis lucifugus*), Northern Long-eared Myotis, Long-legged Myotis, and Silver-haired Bat (*Lasionycteris noctivagans*; Table 1). These four species represented 70% of captures. Species infrequently captured included the Eastern Red Bat, Townsend's Big-eared Bat, and Western Small-footed Myotis (*Myotis ciliolabrum*; Table 1). These three species only represented 1% of captures with a total of six individuals.

Approximately 92% of individuals were adults (n = 431) with only 8% volant young (n = 39; Table 2). Of adults, 71% were males (n = 306) and 29% were females (n = 124; Table 2). We captured more adult males than females of most species. The Northern Long-eared Myotis and Long-legged Myotis had more or equal numbers of females captured compared to males during the survey, respectively (Table 2). Comparison of relative capture rates in the late 1990s to limited data in 2017, the Big Brown Bat (*Eptesicus fuscus*) and Fringed / Long-eared Myotis complex (*Myotis thysanodes* / *Myotis evotis*) were captured less frequently in 2017 than in the past, whereas the Hoary Bat (*Aeorestes* [=*Lasiurus*] *cinereus*; Baird et al. 2015) was captured more frequently in 2017.

In Table 3, we present data on reproductive activity, and for many species, such data represented the first published accounts of reproduction in the region or for Wyoming. Although we did not capture females frequently in the area, we documented pregnant individuals for three species, lactation for at least seven species, and volant young for at least six species. Detailed information for each species is presented in the following accounts of species. Order of accounts is based on the total number of bats captured for each species (Table 1), starting with the most common species. Each account begins with brief introductory remarks about the species in the region or Wyoming, followed by information from our survey.

Myotis lucifugus (Le Conte, 1831)
Little Brown Myotis

The Little Brown Myotis (*M. lucifugus carissima*) occurs statewide in Wyoming, frequently forming maternity colonies in buildings (Bogan and Cryan 2000; Buskirk 2016). Summer habitats vary widely across the state from coniferous forests to urban and riparian habitats (Buskirk 2016). This species is known from both Crook and Weston counties in northeastern Wyoming (Bogan and Cryan 2000; Buskirk 2016). To date, relatively little information is known regarding reproduction of this species across the state (Findley 1954; Negus and Findley 1959; Turner 1974; Adams 1997).

Individuals of Little Brown Myotis were captured across the study area, with captures at a majority of netting sites (12 of 13 sites; Table 1). Most adults captured consisted of males (n = 73) compared to only 10 females (Table 2). Although adults were captured across the region, volant young (n = 11) were captured mainly from lower elevation sites such as Devil's Tower National Monument (n = 2; elev. 1,170 m), Thunder Basin National Grasslands (n = 2; elev. 1,309 m), and the town of Sundance (n = 6; elev. 1,450 m). We observed volant young from 11 to 22 August 1997 (Table 2). We

Table 1. Number of bats captured in the Bear Lodge Mountains and Black Hills of northeastern Wyoming, 1997–1998 and 2017. Percentage of sites species were documented at in the study is cumulative, with the total number of sites equal to 13. In 1997–1998, we accrued a total of 57 mist-net nights, but we only accrued 10 mist-net nights in 2017, yielding the large difference in overall numbers of captures between the two sampling periods. In 2017, we visited some of our most productive sites to attempt to capture the most bats during our limited time in the field.

Common name	Scientific name	1997–98	2017	Total	% of sites (*n*)
Little Brown Myotis	*Myotis lucifugus*	77	17	94	92% (12)
Long-legged Myotis	*Myotis volans*	60	18	78	85% (11)
Northern Long-eared Myotis	*Myotis septentrionalis*	57	21	78	54% (7)
Silver-haired Bat	*Lasionycteris noctivagans*	55	23	78	69% (9)
Hoary Bat	*Aeorestes* [=*Lasiurus*] *cinereus*	29	23	52	46% (6)
Big Brown Bat	*Eptesicus fuscus*	45	5	50	69% (9)
Fringed Myotis / Long-eared Myotis	*Myotis thysanodes* / *Myotis evotis*	34	1	35	92% (12)
Western Small-footed Myotis	*Myotis ciliolabrum*	2	1	3	15% (2)
Townsend's Big-eared Bat	*Corynorhinus townsendii*	1	1	2	15% (2)
Eastern Red Bat	*Lasiurus borealis*	1	--	1	8% (1)
Totals		361	110	471	

Table 2. Summary of adult and volant young captured for each species during our survey of bats in the Bear Lodge Mountains and Black Hills of northeastern Wyoming, 1997–1998 and 2017.

Species	Adult Female	Adult Male	Adult Unknown	Adult Totals	Young Female	Young Male	Young Totals	Grand Totals
Corynorhinus townsendii	--	2	--	2	--	--	--	2
Eptesicus fuscus	8	41	--	49	--	1	1	50
Lasionycteris noctivagans	10	67	--	77	1	--	1	78
Lasiurus borealis	1	--	--	1	--	--	--	1
Aeorestes [=*Lasiurus*] *cinereus*	14	37	1	51	--	--	--	52
Myotis ciliolabrum	1	2	--	3	--	--	--	3
Myotis lucifugus	10	73	--	83	6	5	11	94
Myotis septentrionalis	35	25	1	61	12	5	17	78
Myotis thysanodes / *evotis*	10	24	--	34	1		1	35
Myotis volans	35	35	--	70	4	4	8	78
Totals	124	306	2	431	24	15	39	471

Table 3. Dates of reproductive activity for bats in the Bear Lodge Mountains and Black Hills of northeastern Wyoming, 1997–1998 and 2017.

Species	June	July	August
Corynorhinus townsendii			
Scrotal		5	
Eptesicus fuscus			
Lactating	3, 5		
Volant young			18
Scrotal		4, 5	2, 7, 8, 12, 14, 15, 18, 20
Lasionycteris noctivagans			
Pregnant	21[1]		
Lactating		4	
Volant young			17
Scrotal		4	2, 8, 12,14
Aeorestes [=*Lasiurus*] *cinereus*			
Pregnant	20[1]		
Lactating	21, 22	3	12
Scrotal		4	12
Myotis ciliolabrum			
Lactating			12
Scrotal			2
Myotis lucifugus			
Volant young			11, 12, 13, 14, 20, 22
Scrotal		4	2, 8, 11, 12, 14, 17, 20
Myotis septentrionalis			
Pregnant	21[2], 22	4	
Lactating			7, 8, 12, 14
Volant young			12, 14, 15
Scrotal			12
Myotis thysanodes / *evotis*			
Lactating			8, 12
Volant young			18
Scrotal			8
Myotis volans			
Lactating			2, 7, 14, 17, 18, 19
Volant young			11, 14, 17, 19
Scrotal			8, 12

[1]Two fetuses
[2]One embryo

did not capture reproductively active adult females, but suspect they also reside at lower elevations. A lactating female with young was captured at a summer cottage on 1 July in Crook County (Turner 1974). In northwestern Wyoming, Findley (1954) reported that females were pregnant during the last week of June and into the first week of July. Cryan et al. (2000) also demonstrated that reproductive females tend to reside at lower elevations than both males and non-reproductive females in the nearby Black Hills of South Dakota. Males with enlarged testes and epididymides were observed from 4 July (1998) to 20 August (1997; Table 2). Although a common species in the state, our data add new seasonal dates for reproductive activities for Little Brown Myotis in Wyoming.

Myotis volans (H. Allen, 1866)
Long-legged Myotis

The Long-legged Myotis (*M. volans interior*) is a common and widespread species in Wyoming, occurring in forested habitats throughout the state (Bogan and Cryan 2000; Buskirk 2016). The species is rare or absent in low-lying basins and grasslands in northeastern and extreme southeastern Wyoming (Bogan and Cryan 2000; Buskirk 2016).

The Long-legged Myotis was one of our most abundant species in terms of numbers of individuals and localities with captures (Table 1). We captured equal number of adult males and adult females (Table 2), albeit only 13 females were reproductively active or recently reproductive (i.e., lactating = 10 and post-lactating = 3). We observed lactating females from 2 August (1998) to 19 August (1997), volant young from 11 to 19 August (1997), and scrotal males from 8 to 12 August (1997; Table 3). A volant young male retained as a voucher had testes that measured 2 mm in length on 19 August 1997. Previously, the only published data on reproduction from Wyoming were observations of pregnant individuals on 11 and 13 July in Teton County (Findley 1954; Negus and Findley 1959). In the Black Hills of South Dakota, a single pregnant individual was captured on 25 July and a volant young was captured on 7 September in Custer County (Turner 1974). Cryan et al. (2001) captured lactating females in the Black Hills of South Dakota but did not provide dates of captures. Our data increase knowledge on reproduction for this species in Wyoming.

Myotis septentrionalis (Trouessart, 1897)
Northern Long-eared Myotis

The Northern Long-eared Myotis is known only from northeastern Wyoming in the Bear Lodge Mountains and Black Hills (Buskirk 2016), where the species appears to be uncommon (Turner 1974; Bogan and Cryan 2000). In the Black Hills of South Dakota, the species is common locally (Turner and Davis 1970; Cryan et al. 2000). To our knowledge, there are no published data on reproduction for this species in Wyoming.

In our survey of forested habitat in the Bear Lodge Mountains and Black Hills of Wyoming, the Northern Long-eared Myotis was one of the most common species (Table 1). Of the four most common species, however, the Northern Long-eared Myotis was captured at the fewest number of sites (54%; Table 1), suggesting it is more restrictive in its habitat use compared to the other common species. In the area, this was the only species where females outnumbered males during our survey (Table 2). About 57% of adult females were reproductive (20 of 35 individuals). We documented pregnant females on 21 June 1998, 22 June 2017, and 4 July 1998 (Table 3). One female contained an embryo with a uterine swelling of 13 mm in length on 21 June. Lactating females were captured from 7 to 14 August 1997, volant young from 11 to 15 August 1997, and a scrotal male on 12 August 1997 (Table 3). Average forearm length for adult males was 35.4 mm (range 33.5–38 mm, $n = 25$), whereas length for adult females was 36.3 mm (range 34–39 mm, $n = 35$). In the Black Hills of South Dakota, lactation data on this species is known from 26 July to 20 August and scrotal males are known from late July (Turner 1974). In northwestern Nebraska, lactating females were captured on 14 July (Geluso et al. 2015) and a volant young on 5 August in Sheridan County (Benedict 2004). In Nebraska, reproduction occurs earlier in more eastern and southern parts of the state (Benedict 2004). Currently, the USFWS (2015, p. 18024) allows the cutting of trees even in areas with known maternity roosts of this protected species after 31 July. Data presented herein and by other researchers in the region suggest that the removal date of trees in areas with the federally threatened Northern Long-eared Myotis needs to be extended beyond 31 July. In at least these western areas at higher elevations where reproduction appears

to be delayed, extension of the date to the end of August would likely protect maternity roosts in the region, including northwestern Nebraska, western South Dakota, and northeastern Wyoming.

Lasionycteris noctivagans (LeConte, 1831)
Silver-haired Bat

The Silver-haired Bat occurs statewide in Wyoming, is relatively common, and has been captured in a variety of habitats (Bogan and Cryan 2000; Buskirk 2016). This migratory species appears most common during spring (April–June) and autumn (September) in the state based on specimens recovered from the state veterinary laboratory (Bogan and Cryan 2000). No published records exist in Wyoming from midsummer. To our knowledge, there also are no published reproductive records for this species in Wyoming.

We captured Silver-haired Bats at many sites across the region (Table 1). Although most individuals were males ($n = 67$), we captured 10 adult females, some of which were reproductively active (Tables 2 and 3). We captured pregnant individuals on 21 June 2017, a lactating individual on 4 July 1998, and a volant young on 17 August 1997 (Table 3). The pregnant female contained two fetuses that had crown-rump lengths of 17 mm. Reproductively active females and volant young only were captured in the Black Hills area of Wyoming, with no documentation of reproductive females and young in the Bear Lodge Mountains. Scrotal males were captured on dates spanning 4 July (1998) to 14 August (1997) in both the Bear Lodge Mountains and Black Hills of Wyoming (Table 3). A male retained as a voucher had testes that measured 6 mm in length on 20 August 1997. These represent the first data for reproductive activity by Silver-haired Bats in Wyoming. Reproduction is known in northwestern Nebraska (Geluso et al. 2004) and the Black Hills of South Dakota, where pregnant and lactating females as well as males are known from mid-June to early-August (Turner 1974; Mattson et al. 1996). In South Dakota, both males and females commonly roost in dead ponderosa pines (*Pinus ponderosa*), with reproductively active females forming small colonies mainly in tree cavities (Mattson et al. 1996).

Aeorestes [=*Lasiurus*] *cinereus* (Palisot de Beauvois, 1796)
Hoary Bat

The migratory Hoary Bat (*A. cinereus cinereus*) is widespread across the state, known from almost every county, but little is known regarding its natural history in Wyoming (Bogan and Cryan 2000; Buskirk 2016). In the adjacent Black Hills of South Dakota, both males and females occur, including reproductive females (Turner 1974).

We captured the Hoary Bat at less than half of the netting sites throughout this study. The Hoary Bat is a large, fast-flying species (Shump and Shump 1982) and likely uses mainly larger bodies of water to drink. Nearly 77% of captures were at Bear Lake that was a relatively large, unobstructed earthen pond (27 x 17 m) situated in a large grassy opening in a ponderosa pine forest (Fig. 4). In 2017, the species was tied with the Silver-haired Bat as the most numerous species captured during our brief visit (Table 1). In 1997 and 1998, the species ranked only as the seventh most common species (Table 1). More males than females were captured throughout the study (Table 2). A pregnant female was documented on 20 June 1998 with two fetuses that had crown-rump lengths of 25 and 18 mm. Lactating females were captured from 21 June (2017) to 12 August (1997; Table 3). Reproductively active females were observed in the Bear Lodge Mountains, the town of Sundance, and the Black Hills of Wyoming. Scrotal males were observed from 4 July (1998) to 12 August (1997; Table 3), with testes lengths of two males measuring 6 mm (19 June 1998 and 12 August 1997). To our knowledge, these data represent the first published accounts of reproductive activity for the Hoary Bat in Wyoming.

Eptesicus fuscus (Palisot de Beauvois, 1796)
Big Brown Bat

The Big Brown Bat (*E. fuscus pallidus*) is one of the most common bat species in Wyoming, occurring in many habitats including urban settings to high-elevation forests (Buskirk 2016). Although a hibernating species that does not move out of state, only a single published account has been documented for a maternity colony in Wyoming (see Bogan and Cryan 2000).

In the Bear Lodge Mountains and surrounding areas, the Big Brown Bat was an uncommon species but documented at over half the netting sites (Table 1). We captured many more adult males (n = 41) than adult females (n = 8; Table 2). In our brief survey of sites in 2017, we captured fewer individuals than expected based on captures in 1997 and 1998. This result might reflect that we did not mist net for bats at the Elk Mountain site in Weston County in 2017, a site where 42% of Big Brown Bats were captured in early surveys. We documented lactating females on 3 and 5 June 1998 from the town of Sundance and at our Elk Mountain site in Weston County. We captured a volant young on 18 August 1997 at the E.V.A. Ranch in Weston County. Scrotal males were captured across the region from 4 July (1998) to 20 August (1997). Our data demonstrates that the Big Brown Bat is reproductively active in northeastern Wyoming. In the Black Hills of South Dakota, Big Brown Bats are reproductively active, with many females associated with buildings (Turner 1974).

Myotis thysanodes* / *Myotis evotis
Miller, 1897 / (H. Allen, 1864)
Fringed Myotis / Long-eared Myotis

The Fringed Myotis and Long-eared Myotis are two species that have a fringe of hairs on the posterior edge of their tail membrane (i.e., uropatagium), with the Fringed Myotis having a more conspicuous fringe than the Long-eared Myotis (Hall 1981). Both species have long ears with the Long-eared Myotis tending to have longer and darker pigmented ear membranes and shorter forearms. This complex of species was difficult for us to separate in the region. We seemed to observe a continuum of traits between the two species, especially with prior experiences with these species in New Mexico. To evince the difficulty we had in identification of these two species in the region, one of us (KG) has captured a Fringed Myotis in Nebraska that has less of a fringe than specimens of Long-eared Myotis from New Mexico. At this point we lump these two species together to be conservative on identification.

Bogan and Cryan (2000) report that the Long-eared Myotis has ears that measure >21 mm. However, Manning (1993), in his in-depth analysis of the systematics of the Long-eared Myotis, reported that the subspecies residing in the region, for both males and females, averaged ear lengths of 21.1 mm (20.68–21.44 mm; 95% confidence interval; n = 40) and 21.1 mm (20.60–21.59 mm; 95% confidence interval; n = 34), respectively. Jones and Genoways (1967a) report that *M. thysanodes* in the Black Hills have ear lengths of 17–21 mm. All of our 12 specimens had ear lengths ≤21 mm. Moreover, Jones and Genoways (1967a, b) and Turner (1974) do not mention that Long-eared Myotis occur in the Black Hills of Wyoming and South Dakota, and all 30 specimens examined were considered Fringed Myotis. The subspecies of Fringed Myotis that occurs in the Black Hills is known as *M. t. pahasapensis* (Jones and Genoways 1967a). Jones and Genoways (1967a, b) point out that, in general, the Fringed Myotis has the following traits that separate it from the Long-eared Myotis: the Fringed Myotis has longer forearms, shorter ears, slightly larger cranial dimensions, and better developed sagittal crest. The confusion for us is that the subspecies in Black Hills and surrounding area, compared to *M. t. thysanodes*, tends to have traits similar to what is described for the Long-eared Myotis. That is, *M. t. pahasapensis* has longer ears, shorter forearms, more contrast in color between dorsal pelage and membranes, and a smaller skull that is relatively narrow compared to *M. t. thysanodes*. Jones and Genoways (1967a) note they had trouble separating the species and note the striking similarity between the two species, and again, state they did not capture *M. evotis* in the Black Hills. Additionally, the subspecies of Long-eared Myotis in New Mexico, that we are most familiar with, now has been described to have longer ears than the subspecies in northern Rocky Mountain (*M. e. chrysonotus*; Manning 1993).

Due to identification issues in our early surveys in 1997 and 1998, we collected a few more voucher specimens of this complex than other species. In December 2017, one of us (KG) compared our specimens from northeastern Wyoming to other specimens housed at MSB of both species from the region. In short, KG observed that all of our specimens were most similar to other *M. evotis* from Wyoming and different from *M. thysanodes* from the Wildcat Hills in western Nebraska and two specimens of *M. thysanodes* from near Cheyenne, Wyoming. Fringed Myotis from those two sites had larger skull characters and generally a more dense uropatagial fringe. Our specimens, based on skull morphology, appeared to all be similar, but length and density of fringe was variable. At first, we suspected that all individuals we captured during this survey likely

represented mainly Fringed Myotis, but after our recent examination of many specimens from multiple states, we now suspect that all might represent Long-eared Myotis. We find that a genetic study would be useful to clarify the relationship of these two species in the area as well as the overall distribution of each species.

Both the Fringed Myotis and Long-eared Myotis are uncommon in Wyoming and have widespread distributions (Bogan and Cryan 2000; Buskirk 2016). Both species appear to mainly reside in coniferous forests across the state (Bogan and Cryan 2000; Buskirk 2016). Little is known about the natural history of both species, with no information given for reproduction in the state (Bogan and Cryan 2000; Buskirk 2016). Reproductive activity is known from the adjacent Black Hills of South Dakota for the Fringed Myotis (Turner 1974).

We captured a total of 35 individuals across the study area, with this species complex being captured across most sites during our survey (92%; Table 1). However, in our brief survey in 2017, we only captured a single individual, many fewer based on relative abundances from surveys in 1997 and 1998. As with most species in the area, we captured more adult males (n = 24) compared to adult females (n = 10; Table 2). We captured lactating females on 8 and 12 August 1997, a volant young on 18 August 1997, and a scrotal male on 8 August 1997. Males taken as vouchers had testes lengths as follows: 3 mm (19 June 1998, 20 June 1998, 20 June 1998), 4 mm (15 August 1997), 6 mm (7 August 1997, 12 August 1997, 15 August 1997), and 7 mm (14 August 1997). To our knowledge, these data represent the first published accounts of reproductive activity for either species in Wyoming.

Myotis ciliolabrum (Merriam, 1886)
Western Small-footed Myotis

The Western Small-footed Myotis is known from throughout Wyoming, except in the northwestern mountains (Buskirk 2016). Buskirk (2016) reported this species as a habitat generalist, whereas Bogan and Cryan (2000) reported this species generally occurs in ponderosa pine and mixed coniferous forests. Little information is known about this uncommon species in the state, with nothing known regarding reproduction (Turner 1974; Bogan and Cryan 2000; Buskirk 2016).

We captured three individuals, one in the Thunder Basin National Grasslands in Weston County (12 August 1997) and two in the northern part of the Bear Lodge Mountains near Beaverdam Spring in Crook County (22 June 2017 and 2 August 1998). The individual from Thunder Basin was captured in an area dominated by junipers, whereas the individuals from the Bear Lodge were in an area dominated by ponderosa pine and bur oak. Our capture of a lactating female on 12 August 1997 represents the first documented reproductively active female in Wyoming. Reproduction in Western Small-footed Myotis is known from nearby South Dakota and western Nebraska (Tuttle and Heaney 1974; Czaplewski et al. 1979; Bogan and Cryan 2000; Geluso et al. 2013). Lactation in western Nebraska for this species spans from 7 July to 13 August (Geluso et al. 2013). Although only a single datum, this late date of lactation possibly suggests reproduction might occur later in northeastern Wyoming than other nearby populations. A male captured on 2 August 1998 had enlarged testes and epididymides.

Corynorhinus townsendii (Cooper, 1837)
Townsend's Big-eared Bat

Townsend's Big-eared Bat (*C. townsendii pallescens*) is widespread in Wyoming (Buskirk 2016). This hibernating species is known from a variety of habitats, including from shrub-steppe to coniferous forests in the state (Buskirk 2016). Large numbers of individuals hibernate in caves in the Black Hills of South Dakota, with the species known from throughout all counties in the area (Turner 1974). We captured two adult male individuals, one on 5 July 1998 in Weston County and one on 22 June 2017 in Crook County. The scrotal male from Weston County had testes that measured 7 mm in length.

Lasiurus borealis (Müller, 1776)
Eastern Red Bat

The Eastern Red Bat (*L. borealis borealis*) occurs throughout eastern North America, reaching part of its westernmost distributional limit in eastern Wyoming (Buskirk 2016). The distribution of this migratory tree-roosting bat appears to have shifted westward in recent decades, or at least the species has increased in abundance along its western margin of its range (Benedict et al. 2000; Geluso et al. 2013; Geluso and Geluso 2016).

Recent surveys in western Nebraska demonstrate Eastern Red Bats generally are migratory throughout the region, commencing movements through western Nebraska in late July by non-reproductive individuals (Geluso et al. 2013; Geluso and Geluso 2016). Only a limited number of captures are reported from eastern Wyoming (Bogan and Cryan 2000; Buskirk 2016).

We captured a single individual during field efforts, an adult female on 18 August 1997. The individual was non-reproductive. Only a single reproductive Eastern Red Bat is known from Wyoming. Stromberg (1982) reported on a female with four embryos. Reproductive females have been reported to the east in western parts of South Dakota and Nebraska. In the Black Hills of South Dakota, a lactating female and volant young were captured in 1968 in Pennington County (Turner 1974). In western Nebraska, only two Eastern Red Bats were observed to be reproductively active. In Morrill County, a female with four young was documented on 4 June (Benedict et al. 2000; Geluso et al. 2013), and in Sioux County, a lactating female was documented on 15 July (Czaplewski et al. 1979). We expect that with a number of recent captures of multiple individuals in western Nebraska adjacent to Wyoming, Eastern Red Bats are more common than currently perceived in eastern parts of Wyoming, especially in late July and throughout August, when non-reproductive individuals appear to be migrating through the region (Geluso et al. 2013; Geluso and Geluso 2016).

Conclusions

We regret we did not make these data available in a more timely fashion. For example, data on lactation well into mid-August for the Northern Long-eared Myotis clearly is novel information that might have been useful in the federal listing of the species in 2015 (USFWS 2015). Ideally, the USFWS could have used these data and extended the date (now 31 July) when tree cutting and clearing is prohibited. In the late stages of lactation, however, young bats can be volant (Kurta et al. 1989). Our "late data" is a good example that it is unclear/unknown which data may be important in the future for management decisions to help protect species. Unfortunately, even common species, such as the once abundant Little Brown Myotis in eastern parts of North America (Turner et al. 2011; Moosman et al. 2013), might become a species of conservation need, as populations will continue to fluctuate and change due to human-mediated changes to the environment. In short, researchers have an obligation to publish their findings, in part, to allow data to be available to others (Nesbitt 2005). Wilson (1998, p. 64) points out that "One of the strictures of the scientific ethos is that a discovery does not exist until it is safely reviewed and in print." In conducting research on organisms and the associated costs, "It is our ultimate obligation to make sure the knowledge gained is used to benefit of the species" (Nesbitt 2005, p. 1).

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APPENDIX

Locations visited in 1997, 1998, and 2017 to survey for bats in the Bear Lodge Mountains and surrounding areas in northeastern Wyoming. We report on the dates of capture for each locality followed by parentheses that contain the number of males and females of each species captured as well as age and reproductive condition. "unk" represents individuals of unknown sex that escaped from mist nets without determining sex, "lact" represents lactating females, "preg" represents pregnant females, "post lact" represents post-lactating females, "scr" represents scrotal males, and "FYOY" represents volant young-of-year. Abbreviations for species are as follows and are in the order on the basis of the frequency captured from greatest to least: *Myotis lucifugus* (MYLU), *Myotis volans* (MYVO), *Myotis septentrionalis* (MYSE), *Lasionycteris noctivagans* (LANO), *Aeorestes* [=*Lasiurus*] *cinereus* (AECI), *Eptesicus fuscus* (EPFU), *Myotis thysanodes* / *Myotis evotis* (MYTH/MYEV), *Myotis ciliolabrum* (MYCI), *Corynorhinus townsendii* (COTO), and *Lasiurus borealis* (LABO). Specimens deposited in museums include specimen numbers (Museum of Southwestern Biology, University of New Mexico, Albuquerque (MSB), Sternberg Museum, Hays, Kansas (FHSM)).

CROOK COUNTY:

(1) Bear Lodge Mountains, 0.8 km E US Forest Service Roads 838 and 851, along Whitelaw Creek, T52N, R63W, N1/2 Sec. 17, 44.49869°N, 104.45038°W; 7 August 1997 (MYTH/MYEV 9♂ (MSB122259); MYSE 2♂, 1♀ lact (MSB122257), 1♀ post lact; LANO 1♂; MYLU 2♂, EPFU 1♂ scr, MYVO 1♀ lact (MSB122258)); 8 August 1997 (LANO 2♂; MYTH/MYEV 1♀ (MSB122260)).

(2) Bear Lodge Mountains, South Fork Tent Canyon, Box Spring, T52N, R63W, SW1/4 Sec. 34; 44.44547°N, 104.41332°W; 8 August 1997 (LANO 4♂, 6♂ scr; MYVO 7♂, 2♂ scr; EPFU 1♂, 5♂ scr, 1♀; MYLU 2♂, 2♂ scr; MYSE 1♀, 1♀ lact; MYTH/MYEV 1♂ scr, 1♀ lact); 21 May 1998 (MYSE 2♀, EPFU 1♂, MYVO 1♂); 20 June 1998 (MYTH/MYEV 5♂ (MSB123244, 123245); AECI 1♂, 1♀ preg; MYVO 3♂); 21 June 1998 (AECI 1♂, MYSE 1♀ preg (MSB123243)).

(3) Black Hills, Cranberry Springs, T51N, R61W, SE1/4 Sec. 11; 44.41853°N, 104.14551°W; 10 August 1997 (MYTH/MYEV 1♀); 17 August 1997 (MYVO 3♂, 2♂ FYOY, 2♀, 3♀ lact, 2♀ FYOY; MYSE 3♂; MYLU 1♂ scr; LANO 1♀ FYOY).

(4) Black Hills, 2.4 km W, 0.4 km S Bull Hill, Bear Lake, T51N, R61W, SW1/4 Sec. 25; 44.37321°N, 104.13360°W; 12 August 1997 (MYSE 4♂, 1♂ scr, 2♂ FYOY 2♀, 5♀ lact, 2♀ post lact, 6♀ FYOY; LANO 5♂, 4♂ scr, 2♀; MYLU 6♂, 2♂ scr, 1♀; MYVO 1♂, 3♂ scr, 1♀, 1♀ post lact; AECI 1♂ scr (MSB122269), 2♀ (MSB122270, 122271), 2♀ lact (MSB122267, 122268); MYTH/MYEV 1♂ (MSB122272), 1♀ lact; EPFU 1♂ scr); 24 May 1998 (AECI 3♂; MYVO 3♀; MYSE 2♀; LANO 1♀; EPFU 1♂); 4 July 1998 (LANO 18♂, 1♂ scr, 1♀ lact; AECI 11♂, 1♂ scr; MYLU 7♂, 1♂ scr; EPFU 2♂, 1♂ scr; MYSE 1♂, 1♀ preg; MYVO 1♂); 21 June 2017 (LANO 17♂, 1♀, 4♀ preg (FHSM43083); AECI 15♂, 5♀ lact; MYLU 10♂; EPFU 1♂; MYSE 1♂; MYVO 1♀).

(5) Sundance, 5th and Warren Street; 44.40346°N, 104.37599°W; 13 August 1997 (MYLU 1♂, 2♂ FYOY, 4♀, 4♀ FYOY); 3 July 1998 (EPFU 2♀ lact; AECI 1♀ lact).

(6) Bear Lodge Mountains, 0.4 km W Beaverdam Springs, pool along road, T55N, R63W, SE1/4 Sec. 26; 44.72493°N, 104.38035°W; 14 August 1997 (MYSE 1♂, 1♂ FYOY, 1♀, 3♀ lact, 1♀ post lact, 5♀ FYOY; MYVO 1♀, 3♀ lact, 1♀ post lact, 2♀ FYOY; MYLU 4♂, 1♂ scr; EPFU 1♂ scr; MYTH/MYEV 1♂ (MSB122261); LANO 1♂ scr); 15 August 1997 (MYLU 1♂; EPFU 1♂ scr); 22 May 1998 (MYTH/MYEV 2♀; EPFU 1♀); 2 August 1998 (MYLU 4♂ scr; EPFU 1♂ scr; LANO 1♂ scr; MYCI 1♂ scr; MYVO 1♀ lact); 22 June 2017 (MYSE 6♂, 1♀, 2♀ preg, 1 unk; MYVO 2♂, 8♀; MYLU 6♂; EPFU 4♂; AECI 2♂, 1♀ lact; COTO 1♂; LANO 1♂; MYCI

1♂; MYTH/MYEV 1♀ (FHSM)); 23 June 2017 (MYSE 1♀, MYVO 1♂, MYLU 1♂).

(7) Bear Lodge Mountains, 2.3 km NW (by road) Forest Service Roads 847 and 854, near Lytle Creek, T52N, R64W, SE1/4 Sec. 11; 44.49854°N, 104.49431°W; 15 August 1997 (MYSE 1♂, 2♂ FYOY, 1♀, 2♀ post lact, 1♀ FYOY; MYTH/MYEV 2♂ (MSB122263, 122264), 1♀ post lact; MYLU 2♂; LANO 1♀; MYVO 1♂); 16 August 1997 (LANO 1♂); 23 June 2017 (MYSE 5♂, 4♀; MYVO 1♂, 5♀).

(8) EVA Great Spirit Ranch, 1262 Beaver Creek Road, T46N, R60W, NE1/4 Sec. 8; 18 August 1997 (EPFU 2♂ scr, 1♂ FYOY; AECI 1♂; LANO 2♂; MYVO 1♂, 1♀ lact; LABO 1♀ (MSB122274); MYLU 1♀; MYTH/MYEV 1♀ FYOY (MSB122273)); 19 August 1997 (AECI 1 unk).

(9) Devil's Tower National Monument, pool below Spring #3, T53N, R66W, NE1/4 Sec. 13; 44.58536°N, 104.72684°W; 19 August 1997 (MYVO 1♂, 1♂ FYOY (MSB122275), 1♀, 1♀ lact, 1♀ post lact; MYTH/MYEV 1♂).

(10) Devil's Tower National Monument, Belle Fouche River; 44.59198°N, 104.70394°W; 20 August 1997 (MYLU 7♂, 4♂ scr, 1♂ FYOY (MSB122279), 2♀, 1♀ post lact, 1♀ FYOY; EPFU 3♂ scr (MSB122276); LANO 1♂ (MSB122277); MYTH/MYEV 1♀ (MSB122278)).

(11) Bear Lodge Mountains, Cub Creek, T54N, R63W Sec. 26 or 27; 22 August 1997 (LANO 2♂; MYLU 1♂ FYOY, 1♀).

WESTON COUNTY:

(12) Thunder Basin National Grasslands 9.7 km E, 3.2 km S Upton, T47N, R64W, NW1/4 Sec. 11; 44.07092°N, 104.50923°W; 11 August 1997 (MYLU 2♂, 1♂ scr, 1♀ post-lact, 1♀ FYOY; MYVO 1♂ FYOY); 12 August 1997 (MYLU 1♂ FYOY; MYCI 1♀ lact (MSB122266); MYTH/MYEV 1♀ lact (MSB122265)).

(13) Elk Mountains, 0.6 km S intersection Forest Service Roads 123 and 118; 43.68334°N, 104.06464°W; 19 June 1998 (EPFU 4♂; AECI 1♀ (MSB123240), 1♀ preg (MSB123239); MYLU 3♂; MYVO 3♂; MYTH/MYEV 2♂); 20 June 1998 (EPFU 2♂; AECI 1♂ (MSB123241)); 5 July 1998 (EPFU 3♂, 6♂ scr, 4♀ lact; MYVO 4♂; MYLU 2♂; MYTH/MYEV 2♂; COTO 1♂ scr).

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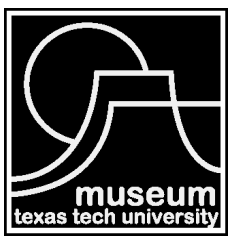

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