YEAR-ROUND BRIDGE COLONY OF MEXICAN FREE-TAILED BATS (*TADARIDA BRASILIENSIS MEXICANA*) IN TRANS-PECOS TEXAS

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Abstract.–Mexican Free-tailed Bats (*Tadarida brasiliensis mexicana*) from a bridge colony in Big Bend Ranch State Park, Presidio County, Texas were followed over two natal seasons and two winters. For the period of this study, the bridge was being utilized as a maternity roost with a number of the young of the summer overwintering in each of the two winters examined. The site also was used by non-reproductive adult males during spring and summer. Adult bats left the bridge roost by mid-to-late summer, leaving only young of the summer at the bridge to exploit roost and local resources through the fall and winter. Young of the summer being left at the maternity roost to overwinter is a novel behavior for *T. b. mexicana.* Sex- and age-specific segregation of bats is inferred within the bridge roost.

Keywords: *Tadarida brasiliensis mexicana*, bridge colony, free-tailed bat, Texas

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Two subspecies of the Brazilian Free-tailed Bat (*Tadarida brasiliensis*) occur in Texas. The Mexican Free-tailed Bat (*T. b. mexicana*) is considered migratory and is distributed in the western three-quarters of Texas, whereas in the more temperate, higher humidity of the eastern one-quarter of the state, LeConte's Free-tailed Bat (*T. b. cynocephala*) is a non-migratory subspecies that resides in the state year-round (Ammerman et al. 2012). Some individuals of the migratory subspecies *T. b. mexicana* have been documented to remain at a summer roost in Texas in small numbers throughout the winter (Spenrath & LaVal 1974; Scales & Wilkins 2007). Recently researchers have found that the subspecies has begun to establish new and larger overwintering year-round populations in central Texas (Mink 2012; Weaver et al. 2015). In the Trans-Pecos region of Texas, Schmidly (1977) considered that almost the entire population of *T. b. mexicana* migrates southward in the fall and spends the winter in Mexico. At Carlsbad Cavern in southeastern New Mexico, *T. b. mexicana* recently was documented in limited numbers actively feeding on insects based on netting research and roosting during the winter months (defined as November-March) within the cavern (Geluso 2007; 2008).

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Mexican Free-tailed Bats have evolved to utilize natural roosting sites such as caves and rock crevices, but in the last hundred years this species has exploited man-made structures that include culverts, tunnels, abandoned mines, and buildings (Barbour & Davis 1969; Cockrum 1969; Wilkins 1989; Fraze & Wilkins 1990). During the past several decades, some populations have been reported to roost in highway bridges and overpasses of suitable design and construction materials (Keeley & Tuttle 1999; Bogan et al. 2003; Geluso & Mink 2009). Specifically, *T. b. mexicana* and other species of bats utilize the unique open slot spaces formed beneath pre-cast concrete bridges as locations for both roosting and raising offspring (Allen et al. 2010). Bridges also can be used as mating sites in spring and stopover sites during spring (Keeley & Keeley 2004) and fall migration (Ammerman et al. 2012).

During a baseline mammal survey of Big Bend Ranch State Park (BBRSP), Yancey (1997) documented a large colony of *T. b. mexicana* roosting under the two-lane east-west Fresno Creek Bridge on Texas State Hwy. 170 where it crosses Fresno Creek as it drains south into the Rio Grande. Bats were considered to be potential year-round residents of BBRSP based on their presence at the bridge during winter (Yancey 1997). Since the bridge was not within BBRSP when that survey was completed, no direct research was conducted at the bridge; however, today the bridge is within the park's boundaries. The following 19 month funded study is an intermittent seasonal examination of the colony of Mexican Free-tailed Bats using the Fresno Creek Bridge, BBRSP, Presidio Co., Texas.

MATERIALS & METHODS

Study area.–The Fresno Creek Bridge is one of five bridges along Texas State Hwy. 170 between Lajitas and Redford, within or adjacent to the southern boundary of BBRSP. The other four bridges, which cross Topado Canyon and Contrabando, Panther, and Madera creeks, are not structurally conducive for *T. b. mexicana* roosting, and no sign of *T. b. mexicana* was observed at those four bridges during preliminary examination of these structures.

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The Fresno Creek Bridge (29.297033 N, 103.848182 W; 734 m) was originally built in 1982 and has a total length of 50.3 m, with the only vertical supports located at the center of the bridge. For each half of the bridge, eight abutted pre-cast concrete box beam girders traverse from each ledge of Fresno Canyon to the center vertical supports. Among the eight concrete girders, seven open vertical slots created during construction cross the bridge span and are used as roosting sites by bats (Fig. 1). Based on 14 random measurements, slots varied from 1.9 to 2.2 cm wide, with the outer two slots being the narrowest at 1.9 cm. Depths varied at arbitrary points from 14.6 to 27.3 cm due to flowed concrete poured during construction, although the majority of measurements ranged from 23.0 to 27.3 cm. Space between the bridge bottom and guano covered canyon ledges was *ca*. 1 m in height. Because the shear canyon walls have a *ca.* 20 m drop to the creek bed, safe access was restricted to only *ca.* 5-7.5 m at each end of the bridge. Habitat at the level of the bridge is typical Chihuahuan Desert scrub dominated by creosote-bush (*Larrea tridentata*) with a mosaic of other plants including mesquite (*Prosopis glandulosa*), ocotillo (*Fouquieria splendens*), acaia (*Acaia* sp.), agarito (*Berberis trifoliolata*), and *Opuntia* cacti (Yancey 1997) with sparse patches of seepwillow (*Baccharis* sp.) in the desert riparian environment in the creek bed near the bridge (Fig. 2). The intermittent spring fed drainage flows southward into the nearby Rio Grande, *ca.* 1.8 km south of the bridge.

Bat capture and observations.–Investigation of *T. b. mexicana* roosting in the bridge included a general visual and auditory assessment of bat activity during each visit (e.g., flight activity, bats moving in slots versus torpidity, presence of vocalizations, etc.). For 10 dates examined, bats were always present however there was no sampling on two dates because bats were not safely accessible. Search for individuals from slots under the bridge was accomplished by supine visual examination. Bats were removed from vertical slots using two soft-wood paddles to persuade each individual bat to crawl down to the slot opening where bats were captured by hand. No mist netting was done because bats left the roost at the inaccessible center of the bridge. Individual bats were examined for age, sex, and reproductive condition, and their handling followed guidelines in Gannon et al. (2007).

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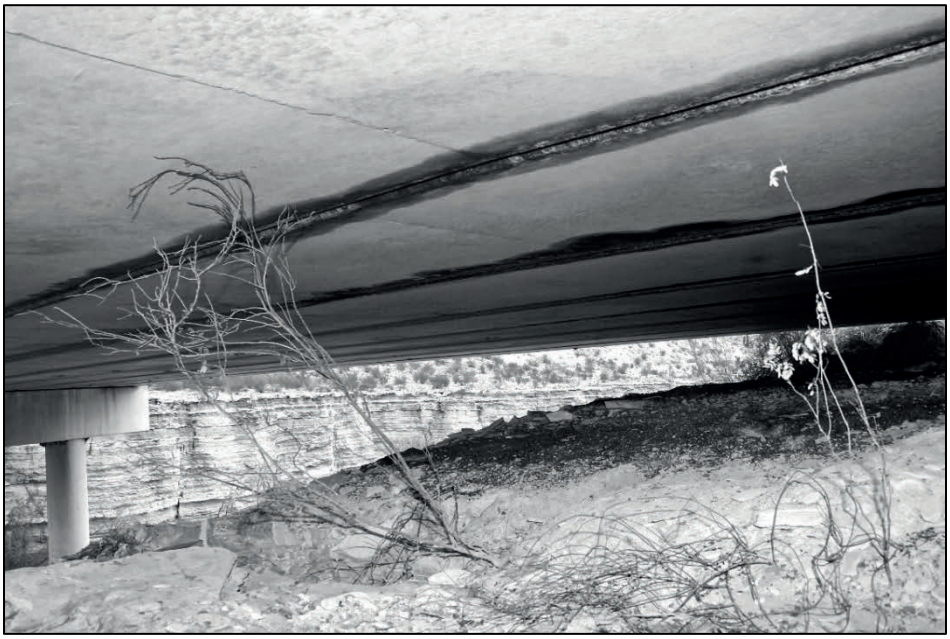

Figure 1. View of underside of the Fresno Creek Bridge in Big Bend Ranch State Park, Presidio Co., Texas. Vertical slots used as year-round roosting sites for *Tadarida brasiliensis mexicana* are visible running the length of the bridge. Dark areas around bottom of vertical slots are urine stains and dark material on the canyon ledge below the bridge is accumulated guano.

Figure 2. View from Fresno Creek Bridge in Big Bend Ranch State Park, Presidio Co., Texas, looking south to north. Habitat at the level of the bridge is typical Chihuahuan Desert scrub, with streamside riparian vegetation occurring along Fresno Creek below.

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Each *T. b. mexicana* was determined to be an adult or juvenile (considered herein as fledgling or young of the year) based on the degree of ossification of the metacarpal-phalangeal finger joints of the forelimbs and shape of finger joints after the cartilaginous plates have become fully mineralized (Anthony 1988). Finger joints follow a continual progression from evenly tapered closed joints to the adult condition of fully knobby or bulbous joints; experienced qualitative assessment can readily determine young of a season easily through the following winter and has been used to identify bats to one year of age (Anthony 1988). Juvenile bats in this study are considered to be maternity colony fledglings of the current or previous summer. Location of each bat examined was recorded in terms of the end of bridge (west or east) and specific slot number (numbered 1-7 north to south). Selected voucher specimens (skin, skull, tissues) were collected and deposited in the Natural Science Research Laboratory of the Museum, Texas Tech University. All other *T. b. mexicana* individuals were released immediately at the capture site after data were collected.

RESULTS & DISCUSSION

The Fresno Creek Bridge was examined 10 times from 3 January 2016 to 28 July 2017. Numbers of *T. b. mexicana* were conservatively estimated to be between 2,000-4,000 for dates when an exodus was observed and photographed, whereas on other dates bat density was estimated based on distant visual examination of slot fill and vocalizations. During eight of 10 visits, some bats roosted in slots at the ends of the bridge, allowing access for sampling of individuals. On two visits, although bats were present in substantial numbers (estimated from slot observation toward center of bridge and vocalizations), no individuals roosted near the ends of the bridge and capture by hand was not possible. A total of 153 *T. b. mexicana* was sampled; nine adult females, 80 adult males, 28 juvenile females, and 36 juvenile males (Table 1). The sample on 17 April 2017 included a mixture of older adults with fully bulbous metacarpal-phalangeal finger joints and a large number of presumptive juveniles of the previous summer, which had highly variable metacarpal-phalangeal finger joints that were near the adult condition. All 30 individuals on this date were considered

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Table 1. Results of surveys for *Tadarida brasiliensis mexicana* at the Fresno Creek Bridge, Big Bend Ranch State Park, Presidio, Co., Texas, and the 24 h temperature ranges (°C) at the airport in Presidio, Texas. Activity is defined as being in torpor or active (bats were either vocal, moving within slots, or in flight). N = total number of bats captured, sexed, and aged for the sampling date; ns = none sampled, bats present but not accessible.

Survey Date	Temperature Range °C	Activity	N	Male Adult	Female Adult	Male Juvenile	Female Juvenile
3 Jan 2016	5.0--8.9	torpor	3			2	1
4 Jan 2016	6.7--10.6	torpor	8			5	3
19 Mar 2016	8.3--19.5	active	ns				
26 Jun 2016	23.9--37.8	active	4	2	1	1	
18 Sep 2016	24.4--36.1	active	20			19	1
31 Jan 2017	-2.8--13.9	active	ns				
5 Feb 2017	7.8--25.0	active	30			8	22
17 Apr 2017	16.7--33.3	active	30	23	7		
13 May 2017	20.6--36.1	active	32	31	1		
28 Jul 2017	25.0--37.8	active	26	24		1	1
Totals			**153**	**80**	**9**	**36**	**28**

adults (Table 1). Where 20 or more bats were sampled, specific locations of each bat capture in the bridge by sex and age are presented in Table 2. On 17 April 2017, two male Yuma Myotis (*Myotis yumanensis*) were captured, both in separate *T. b. mexicana* clusters. Two male *T. b. mexicana* individuals from 3 January 2016 (TK195516, TK195517) and one *M. yumanensis* (TK195528) were retained as voucher specimens.

Flights of bats at the bridge were viewed on four dates and are here seasonally compared for sunset activity. On 19 March 2016, bats were congregated toward the central two-thirds of the bridge and were vocal

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Table 2. Distribution of *Tadarida brasiliensis mexicana* by sex and age within the slots at the accessible ends of the Fresno Creek Bridge, Big Bend Ranch State Park, Presidio Co., Texas. Only samples of 20 or more are included. Slots are numbered from north to south.

Survey Date	Bridge End	Slot No.	Male Adult	Female Adult	Male Juvenile	Female Juvenile	Slot Total	Date Total
18 Sep	East	E2			19	1	20	20
5 Feb	East	E2			1	9	10	30
		E5			3	7	10	
	West	W2			4	6	10	
17 Apr	East	E2	5				5	30
		E3	3	3			6	
		E5	1	4			5	
	West	W1	2				2	
		W3	6				6	
		W5	6				6	
13 May	East	E1	3				3	32
		E2	3				3	
		E3	2				2	
		E4	3				3	
		E5	3	1			4	
	West	W2	7				7	
		W3	3				3	
		W5	7				7	
28 Jul	East	E4				1	1	26
		E5	3				3	
		E6	6				6	
		E7	14		1		15	
	West	W2	1				1	

and active in slots. After sunset some bats were seen flying under the bridge shifting from slot to slot but were hesitant to fly away from the bridge, suggesting late winter daily temperatures (8.3-19.5° C) were not favorable for a feeding exodus. On 24 and then 26 June 2016 (23.9-37.8° C), summer evening flights began just before sunset with the densest exodus occurring about 7-10 min after sunset. For a winter date of 31 Jan 2017 (-2.8-13.9° C), several bats were noted flying under the bridge at 1844 h and flying continued until *ca*. 1915 h with no flight away from the underside of the bridge. The majority of bats were

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moving and calling but remained in their roosting slots at the center of the bridge.

Although the inability to sample across the full length of the bridge was unfavorable to fully understanding the year-round colony of *T. b. mexicana* using the Fresno Creek Bridge at BBRSP, the bridge consisted of a summer maternity colony and was used by non-reproductive adult males during spring and summer (Table 1). Although non-volant juveniles were not observed in the slots at the ends of the bridge, use of the bridge by *T. b. mexicana* as a maternity colony is evidenced by the presence of volant juveniles over two seasons.

Juvenile bats were found in June and September 2016 and February 2017, and juveniles were again found for another maternity season in July 2017 (Table 1). Overall totals of juvenile sexes were somewhat similar at 36 males and 28 females, however proportions of juveniles are skewed for two larger samples (18 September 2016 and 5 February 2017). These two samples suggest that juveniles may be sexually segregating among slots, at least to some degree (Table 2). A similar pattern of roost use was found in a highway overpass in central Texas where banded *T. b. mexicana* individuals were found to segregate by both sex and age (Sgro & Wilkins 2003).

No adult *T. b. mexicana* individuals were collected during the winter months for both years surveyed at the Fresno Creek Bridge, only juveniles were sampled for January and February. First encounters of adults for each year were 26 June 2016 and 17 April 2017. Overall patterns of sampling suggest that adult bats are absent by mid-to-late summer with at least some young of the year remaining at the bridge through the winter (Table 1). Juveniles of the summer being left at a maternity roost to overwinter is a novel behavior for *T. b. mexicana.* Mass departure of adults during summer could be due to either the natural timing of southward migration or a response to overcrowding at the bridge after fledglings have become volant. Ammerman et al. (2012) noted that after late July at cave colonies, fledglings predominate in feeding flights and tended to reside at their birth place until the onset of cool weather in October and November. In the lower

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Rio Grande Valley of New Mexico, overwintering *T. brasiliensis* individuals were found at 12 bridges over two years with their numbers progressively decreasing from October to winter lows during December, January, February, and March (Table 3 in Geluso and Mink 2009), however this study did not discriminate ages during winter. Other studies from central Texas, which documented *T. b. mexicana* remaining at the roost during winter, also did not differentiate between adults and young of the year (Spenrath & LaVal 1974; Keeley & Keeley 2004; Scales & Wilkins 2007; Mink 2012; Weaver et al. 2015).

During this study, 89 adult *T. b. mexicana* individuals were examined, 80 (90%) were males and nine were females (10%). These highly skewed proportions are most likely due to adult males segregating to the ends of the bridge and consequently are more readily sampled, while females are concentrated in slots at the center of the bridge. Male *T. b. mexicana* have been found to be more faithful to their roost and geographic area than females (Scales &Wilkins 2007) and males at a highway overpass roost in central Texas were found to dominate a single section of an overpass (Sgro & Wilkins 2003). The nine adult females were sampled only during spring and summer (April to July). Based on patterns of bridge use by adult bats, the inference is made that adult females use the central (inaccessible) part of the bridge as a maternity roost with adult males relegated to ends of the bridge. Two maternity period sampling dates in 2017 reinforce this pattern of adult distribution at the bridge. On 13 May, 32 *T. b. mexicana* individuals were removed, 31 adult males and one adult female; on 28 July, 26 bats included 24 adult males, no adult females, and two volant juveniles (Table 1). Furthermore, the central region of the bridge would be more beneficial as a maternity area, as it would not be accessible to local terrestrial predators (e.g., a large, 161 cm, Trans-Pecos Rat Snake, *Bogertophis subocularis*, was observed under the west end of the bridge just before a June sunset). During late spring and early summer, adult females and their juveniles would have fidelity to the center of the bridge, whereas adult males would be segregated to the ends of the bridge. Sgro & Wilkins (2003) found a similar pattern in a highway overpass in central Texas where 70% of banded *T. b. mexicana* segregated by both sex and age, and each group had site-specific

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fidelity within the large roost. Whether non-reproductive spring and summer adult males are transients from other roosts or spring migrants that have remained at a lower latitude is not determinable from sampling in this study.

Compared to natural caves, bridges potentially provide more favorable roosting sites for *T. brasiliensis*. Allen et al. (2011) found significantly higher cortisol levels in cave-roosting *T. brasiliensis* than individuals roosting in bridges, and those authors concluded that bridge-roosting individuals are less stressed than cave-roosting conspecifics. Maternity colonies at bridge roosts may also have favorable conditions for raising pups as supported by having an average heavier birth weight and faster growth than pups from cave roosts (Allen et al. 2010). Additionally, bridges warm faster than caves, especially during the colder, late fall season, which can be beneficial to later fall migrants (Ammerman et al. 2012). A warm bridge in late fall can lead to extended occupancy by individuals in a *T. b. mexicana* colony, which may procrastinate migration through the entire winter season. This is most likely the process that has occurred with the Fresno Creek Bridge *T. b. mexicana* juveniles, at least for the two winter seasons of this study. Bats were observed in torpor on 3 January (5.0-8.9°C) and 4 January 2016 (6.7-10.6°C) when prior and current weather conditions were overcast and rainy. Conversely, on the coldest day that bats were observed during this study on 31 January 2017 (-2.8-13.9°C), many individuals were actively flying under the bridge with most bats vocal and moving within slots. Although cold, conditions on and before this date were dry and sunny, which allowed the bridge to accumulate solar energy. Also, individual bats that were in torpor would be able to readily awaken to an active state with an adequate supply of solar radiation. A prevalence of sunny days during winter in the vicinity of the Fresno Creek Bridge would make the bridge a suitable winter roost in a region where historically *T. b. mexicana* was documented to migrate to warmer latitudes in Mexico (Schmidly 1977). The Fresno Creek Bridge would be able to satisfy basic physiological needs for a winter colony with its close proximity to food resources along the nearby Rio Grande and adequate thermal roosting environment, which

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is maintained by accumulating solar radiation from the black-top road surface.

Temporal shifts and long-term changes in migratory behavior of the subspecies *T. b. mexicana* across its range in Texas may be associated with consequences of a changing climate. Distributions of numerous species of Texas bats have been changing over historic times (Yancey & Jones 2006), probably in response to overall warming of climate as a result of rising CO_2 levels in the atmosphere (Scheel et al. 1996). This is a general theme hypothesized for many taxa of bats occurring in the New World (LaVal 2004; Popa-Lisseanu & Voigt 2009).

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