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BATS UNDER AN INDIANA BRIDGE

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ABSTRACT. A survey of over 200 bridges and culverts in southwest Indiana was completed in 2004 and 2005. Only a single bridge showed roosting bats, including federally endangered Indiana bats (*Myotis sodalis*) and gray bats (*Myotis grisescens*). Other species present included little brown bats (*Myotis lucifugus*), big brown bats (*Eptesicus fuscus*), and eastern pipistelles (*Perimyotis subflavus*) or now called tri-colored bats. Surveys of this bridge occurred 2006 to 2011. The little brown bat was the most common (6,887) followed by Indiana (878), big brown (774), eastern pipistrelle (29), and gray bat (2). There were more male than female Indiana and little brown bats, especially in the late summer and early fall. The bridge serves as a mating site, day/night roost, and migratory stop-over for little brown bats and Indiana bats. Big brown bats were found throughout the year, while eastern pipistrelles were occasional in winter to early spring. Banding showed many bats have a high fidelity to this bridge, and wing membrane scores did not indicate white-nose syndrome (WNS). Data loggers were placed under the bridge for temperature readings from July 2008 to March 2009 and showed *Myotis* avoiding them (but *Eptesicus* did not) due to ultrasonic noise at about 30 kHz. The bridge acted as a thermal sink at night and throughout most of the day, especially during warmer months. The bridge was warmer and had more constant temperatures than outside temperatures from July to February.

Keywords: Bats, bridges, environment

INTRODUCTION

Bats make extensive use of bridges and culverts for both day and night roosts (Keeley & Tuttle 1999; Whitby et al. 2000; Sandel et al. 2001). In Indiana, most available data indicate that bridges are being used as day and night roosts (Duchamp et al. 2004; Whitaker et al. 2004), although one study emphasized bridge use by bats, specifically the Indiana bat (*Myotis sodalis*), as a thermal sink for night roosting during feeding bouts (Kiser et al. 2002).

Efforts to use bridges and culverts as bat management tools remain rare (Arnett & Hayes 2000; James & Palmer 2007). However, with ongoing bat population declines and habitat destruction, more managers are recognizing and appreciating bridges as important alternative roosting habitat. Bridges can provide day, night, maternity, and migratory roost sites (Adam & Hayes 2000; Lance et al. 2001), while also providing temperature stability, predator protection, and proximity to foraging areas. Thus, with the loss of natural roosts and the ready availability of bridges and culverts, it is not surprising that 24 of 45 bat species in the United States roost in these anthropogenic sites (Keeley & Tuttle 1999). In the United States, there are six federally endangered bat species, two of which (*Myotis sodalis* and *Myotis grisescens*), sometimes roost in bridges (Keeley & Tuttle 1999).

In the US roughly 3,600 highway structures (about 1%) are used by an estimated 33 million bats (Keeley & Tuttle 1999). Features of bridges that correlate with bat use are well known (Davis & Cockrum 1963; Adam & Hayes 2000; Erickson 2002). According to a California Department of Transportation (CALTRANS) study (James & Palmer 2007), major bridges attractive to bats are: (1) built before 1950; (2) located in rural areas; (3) constructed over water ways; and (4) possess girder construction including concrete, timber and steel materials. Keeley & Tuttle (1999) found that bats day roost in expansion joints and crevices where they are protected from predators and inclement weather. They also observed that bats prefer bridges that have roost heights at least 3.1 m above ground, are rain-watered sealed, exhibit full sun exposure, and are not situated over busy roadways (Keeley & Tuttle 1999). In particular, bats gathered in the open areas between support beams to digest food. There the large thermal mass remains warm at night and the

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vertical concrete surfaces between provide protection.

In Indiana, there are over 18,000 state and county-owned bridges (B. Dittrich, INDOT, Pers. Comm.) with INDOT responsible for about a third of them. During the course of a highway study in 2004 and 2005, over 200 bridges and culverts were surveyed for bats. Only one bridge had roosting Indiana bats. This bridge, located in southwestern Indiana, was found to have Indiana bats, little brown bats, and big brown bats; two red bats were mist netted near the bridge (Bryan et al. 2004; Kudlu & Brack 2005). Bridge surveys from 2006 to 2011 showed a limited number of eastern pipistrelles under this bridge. One gray bat was observed in April 2007 and another in September 2012. No bats observed at this bridge showed signs of white-nose syndrome (WNS) which was first reported in Indiana in January 2011 (IDNR 2016).

This paper provides data and observations made at this specific bridge located in Greene County, Indiana. Between October 2006 and April 2011, this bridge was studied to determine what bat species use it seasonally, to learn features of the bridge suitable for roosting, and to collect life history data.

Study area.—The metal bridge spans a large river. The exact location is being withheld at the request of the U.S. Fish and Wildlife Service (USFWS) to prevent potential disturbance to bats by unauthorized visitors. It is located on a two-lane road through a broad open valley with much farmland. Built in 1940, it contains 10 spans and is 300 m long and ranges from 6 to 20 m above the river and floodplain. The north and south reinforced concrete girder spans have full depth concrete sidewalls that are open inside and placed into a hillside which creates the appearance of a cave. The underside of the bridge has cracks and crevices. The bridge span is oriented roughly NNE/SSW 20° with prevailing winds from the southwest (Figs. 1–4).

There is a cleared area about 6 m wide on both sides of the bridge. Beyond that, the tree-lined banks include green ash (*Fraxinus pensylvanica* Marshall), cottonwood (*Populus deltoides* W. Bartram ex Marshall), silver maple (*Acer saccharinum* L.) and sycamore (*Platanus occidentalis* L.). The ground below the north and south ends (concrete) have no vegetation and are sloped uphill from their opening to the back. In this paper, data from both the north and south ends were compiled to represent the bridge as a whole. The middle portion of the bridge over the river included eight metal spans set on concrete piers. No bats roosted on these metal spans.

This bridge is within 24 km of one of the largest Indiana bat hibernacula in its range (n = 49,617 in January 2013); within 40 km of 12 other Indiana bat hibernacula; and about 3 km upstream of known Indiana bat and northern long-eared bat (*Myotis septentrionalis*) maternity colonies. Indiana bats did not use this bridge as a hibernaculum nor have they used other bridges as hibernacula (USFWS 2007). In contrast, Indiana bats frequently are found hibernating in a variety of other man-made structures such as abandoned mines, tunnels, and a dam (USFWS 2007). In Indiana, only natural caves are currently known to serve as hibernacula (Whitaker et al. 2007).

METHODS

Presence of bats (especially the Indiana bat) near concentrations of graffiti and trash under each end of the bridge prompted INDOT, FHWA and the USFWS to install a 6-foot chain-linked fence with a locked gate in April 2006. This fence excluded entry of any unauthorized persons near the roosting bats. In September 2007, signage was erected that stated coordination with INDOT and USFWS was required prior to work on or within 200 feet of this bridge.

In 2004, Hal Bryan and others from Eco-Tech found Indiana bats under this bridge. Early observations of this bridge occurred from April to September 2006, and, with a plan in place, formal bridge inspections began 13 October 2006 and continued to 3 April 2011. Sampling usually occurred between 1100 and 1300 hrs. Data included the number of bats by species, locations, and behaviors. The underside of each end of the bridge was divided into sections and tiers using stringers and cross beams (Figs. 1 & 2). Three tiers were located under the north end, while there were two tiers under the south end.

Generally, sampling was conducted weekly in the fall (September through November) when bats tend to leave for their hibernacula (Bryan et al. 2004) and in spring (March through May) when bats emerge from hibernation and move to their summer habitat. Field surveys in summer (June through August) and winter (December through February) were monthly. In 2008, a 24-hour survey was completed from 1200 on 28 September until 1200 hrs on 29 September at 2 hr intervals.

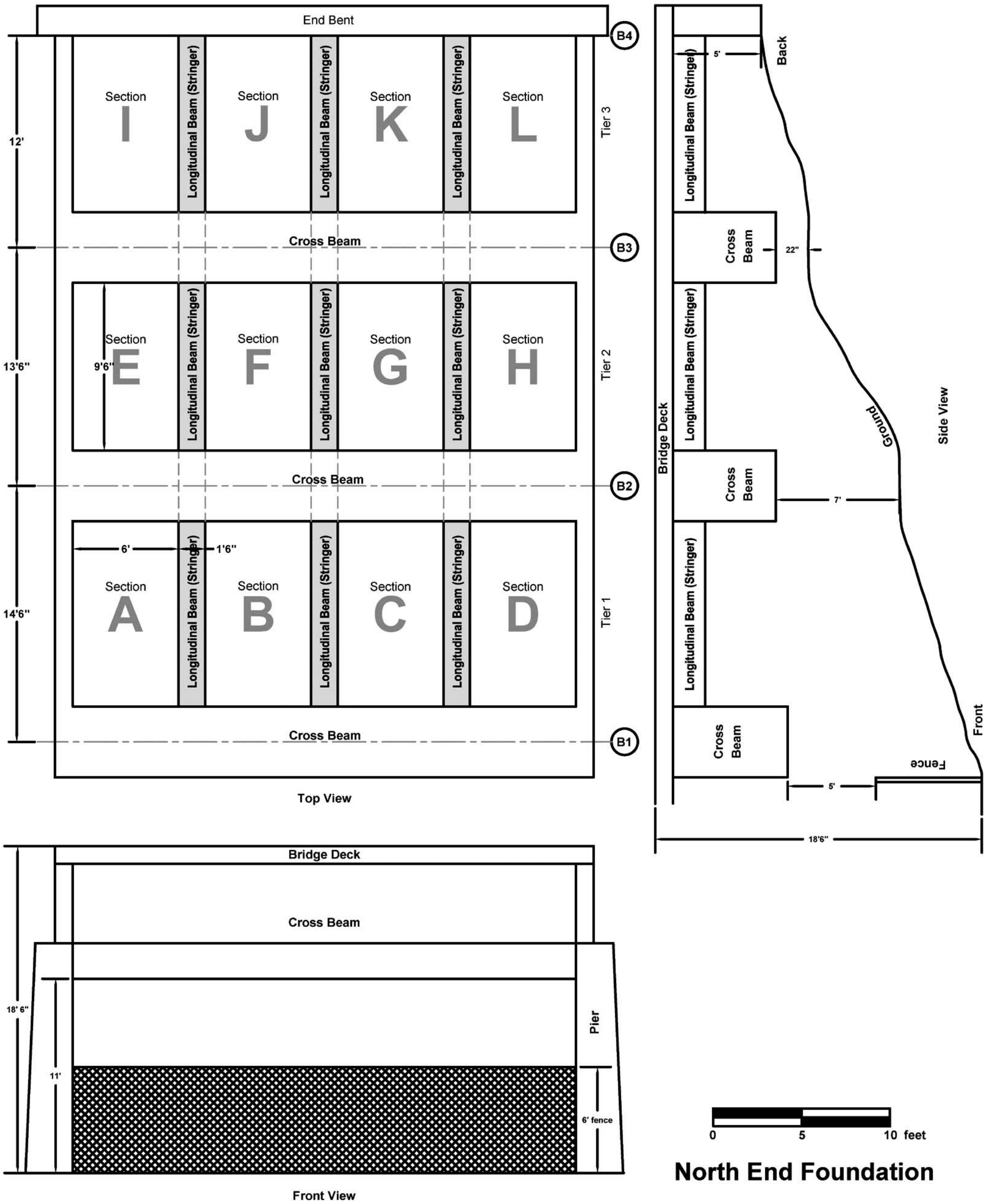

Figure 1.—Front, top and side views of the bridge, north end.

Air and substrate temperatures and relative humidity (specific to the bridge) were measured with an Extech model RH101 infrared thermometer and humidity meter under each concrete end of the bridge with every visit. In 2008 (July through December) and in 2009 (January through March) automated temperature readings were provided by Thermocron iButton dataloggers. Five were secured on a stringer in each tier under the north and south ends of the bridge where bats normally roosted. One datalogger was left outside of bridge for outside air temperatures.

Lighting under the bridge was measured using an Extech light meter. Readings were taken in

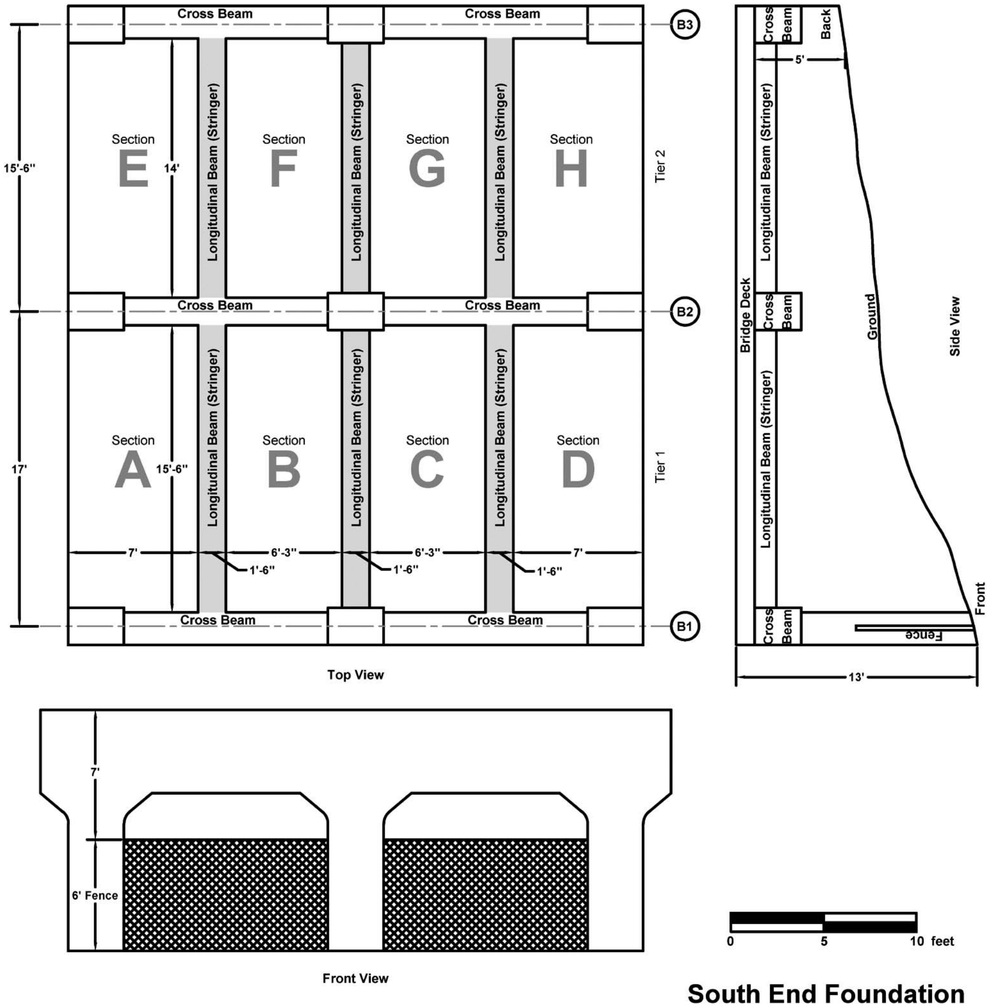

Figure 2.—Front, top and side views of the bridge, south end.

each tier. Sound levels were measured using a Larson-Davis DSP 82 sound level meter (calibrated with a Larson-Davis CAL 200 acoustic calibrator) on the underside and top of the bridge. Wind speed was measured using a Kestrel 1000 Pocket Weather Meter. Calipers were used to measure seam widths in areas associated with bat staining and in areas not stained. Identification of species was by climbing ladders and hand picking bats in order to see species-specific morphological characters.

Banding of bats under the bridge was approved by USFWS under USFWS Federal Permit #TE-179711-0. Banding of 224 bats (60 Indiana bats, 154 little brown bats, 6 big brown bats, and 4 eastern pipistrelles) using silver-colored bands occurred between 29 April and 16 October 2008, while previously, Eco-Tech banded 84 bats (8 Indiana bats, 51 little brown bats, 24 big brown bats and 1 red bat) with orange-colored bands between 26 May and 3 August 2004 (Bryan et. al. 2004). In both efforts, males were banded on the right forearm and females on the left. Data in this paper on sex ratios come from having the bat in hand for identification.

RESULTS AND DISCUSSION

Sound and vibrations.—On 3 May 2007, traffic counts from 1100 to 1200 hrs and from 1330 to 1430 hrs yielded 216 and 252 vehicles,

Figure 3.—Photo of north side of bridge.

Figure 4.—Photo of south side of bridge.

respectively (70% to 80% cars). Sound levels above the bridge were 81.4 to 84.6 dBA, while under the bridge they were 84.1 to 85.0 dBA. Generally, bats did not appear affected by sound or vibrations conducted through the concrete from traffic. However, more intense vibrations caused bats to take to the air, but to ultimately return to roosting. Our results were similar to Keeley & Tuttle (1999) in that the bats appeared to be habituated to vibrations and sounds associated with normal traffic.

Seams and staining.—A seam under the bridge is a groove in the concrete along a stringer or cross-beam with the fillet/ceiling. Average seam width ($n = 50$) within bat stained areas was 2.9 mm, while average seam width outside stained areas ($n = 50$) was 2.0 mm. Outside walls (wing walls) did not have seams, but did show some irregular surface areas. A seam is important for bats to get a foothold to roost. Some bats were seen roosting in between loose concrete that had separated from the deck of the bridge. Stains on the concrete were visible year round and tended to be centrally located along stringers (Fig. 5). Staining was not observed within 0.6 m from cross beams and no bats were seen roosting along stringers less than 1.2 m above the ground even though bats had adequate open seams for roosting. Keeley & Tuttle (1999) found bats prefer the highest roost heights. Avoiding predators is likely an explanation in both cases. On one occasion, a domestic cat was observed under the bridge and a black rat snake was observed on the upper end of the fence. Raccoon tracks were routinely seen under the bridge.

Light, wind, temperature, and humidity under the bridge.—On 26 October 2007, light readings (measured in lux units) under the bridge were $\leq$ 162 lx, while above the bridge they were $\geq$ 9,688 lx. Moving to the back of the bridge, each tier had less light. On the north end, bats preferred darker roosting areas: 1,327 bats (45%) roosted in the back, 1,026 (34%) roosted in the middle and 631 (21%) roosted in the front. On 5 December 2007, wind exterior to the underside of the bridge averaged 4.3 kph with wind speeds under the bridge in all tiers measuring 0 kph. Thus, the bridge not only has varying degrees of darkness, it is also windless and protects bats from the outside weather.

Air temperatures at the time of surveys were between 5° C to 32° C in spring and 5° C to 29° C in fall. In summer, temperatures were between 25° C to 33° C and in winter ranged between -1° C to 21° C. The south concrete foundation was significantly warmer than the north in July to September ($p < 0.0001$) and October ($p < 0.0062$), while there was no difference in November to March,

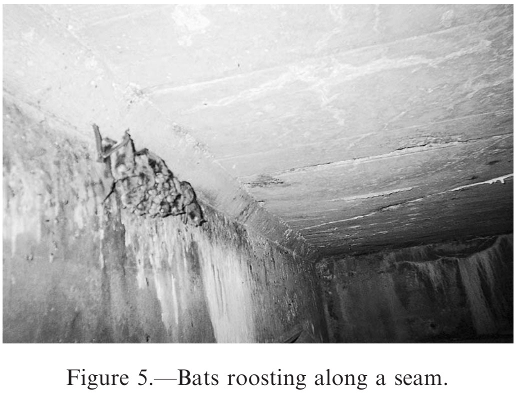

Figure 5.—Bats roosting along a seam.

Table 1.—Monthly data on visits and bat species observed under bridge.

Month	# of Visits	Indiana	Big Brown	Little Brown	Tri-Colored	Gray	Total
January	5	0	33	0	1	0	34
February	5	0	9	0	5	0	14
March	5	3	10	13	1	0	27
April	19	31	16	82	5	1	135
May	9	64	18	440	6	0	528
June	10	8	33	1274	0	0	1315
July	8	55	69	1464	0	0	1557
August	9	39	212	1844	0	0	2050
September	7	85	105	1214	0	1	1405
October	16	449	152	472	0	0	762
November	16	136	50	81	7	0	155
December	7	1	67	3	4	0	62
Totals	118	878	774	6,887	29	2	8,570
% of Total		10.3%	9.0%	80.3%	0.3%	<0.1%	

possibly because of the smaller volume of air in the south than in the north. No readings were taken in April or June 2009 since dataloggers were removed in mid-March 2009, after they were found to emit ultra-sonic sound affecting bat roosting (Willis et al. 2009).

During a 24-hour study on 28–29 September 2008, air temperatures ranged from 12° C to 30° C. Warmest temperatures were from 1200 to 1600 hrs at 26° C to 30° C, respectively. Coolest temperatures were from 0400 to 0800 at 12° C to 14° C, respectively. From 2000 to 0800 hrs, substrate temperatures were warmer than air temperatures. Such data are consistent with the typical pattern of temperature collected under the Mauxferry Road bridge over Nineveh Creek for 36 h, from 1–3 August 2001 (Kiser et al. 2002). The bridge acts as a thermal sink at night and throughout most of the day except possibly in the afternoon. This characteristic is especially notable during warmer months. From July to February the bridge substrate was warmer than outside temperatures and the temperatures changed more slowly and had less overall fluctuation. March did not show such a trend.

Average relative humidity (specific to under bridge) was 48% to 83% in spring, 39% to 80% in fall, 43% to 76% in summer, and 50% to 79% in winter. Relative humidity during a 24-hour study on 28–29 September 2008 ranged from 30% to 83% with the lowest readings from 1200 to 1800 hrs (30% to 50%) and highest readings from 0200 to 0800 (53% to 83%). Lacki (1984) reported greater activity of male little brown bats under conditions of both higher temperature and relative humidity suggesting that these bats alter their flight activity in response to changes in air saturation.

Bat surveys.—There were 118 visits to the bridge in which 8,570 bats were observed comprising five species (Table 1). The little brown bat was the most common (6,887) followed by the Indiana bat (878), big brown bat (774), and to a lesser degree, the eastern pipistrelle (29) and two gray bats. Information on each species follows.

Indiana bats: A total of 878 Indiana bat observations were made under the bridge. They were observed in every month but January and February (Table 1) increasing from three in March (earliest observation was 28 March) to 64 in May and only eight in June. July, August, and September showed a range from 39 to 85. October showed the most at 449 Indiana bats but declined through December when only one Indiana bat was observed. Sex ratios overall were 70 males to 21 females (Table 2). Ratio of male to female Indiana bats in the spring was 13 males to 12 females, while in late summer to fall (during mating season) it was 57 males to 9 females. Two matings were observed in fall, none in other seasons. Females were present in May and from July through September at which time mating occurred. Males were present in April, May and July through October, the times females were most abundant. From such data and the occurrence of this species under this bridge in spring, and late summer through late fall, this bridge may be a migratory stopover. Similar timing of their occurrence has been seen each year in this

Table 2.—Monthly data showing gender and bat species.

	Indiana bats		Big brown bats		Little brown Bats		Tri-colored bats	
Month	Females	Males	Females	Males	Females	Males	Females	Males
January				1				
February				1			1	1
March			1	1	3			
April		1			8	7	2	
May	12	12		2	21	24	1	1
June			2	3	48	64		
July	5	21	3	7	63	91		
August	2	10	17	8	60	102		
September	2	21	2	1	4	56		
October		5	2	7		22		
November			2	4		1		
December				1				
Totals	21	70	29	36	207	367	4	2

investigation. The bridge serves as a day and night roost for this species.

Little brown bats: A total of 6,887 little brown bat observations were made under the bridge. They were the most common bat, present in every month except January and February (Table 1), and increased from 13 in March (earliest observation was 28 March) to 82 in April. In May, adults numbered 440, while the number of little brown bats increased to 1,274 from adults giving birth to pups in June. Pups were observed on 8 June and 13 June. July showed a slight increase to 1,464 with August showing the greatest number of little brown bats at 1,844. This increase may be attributed to recruitment under the bridge from being a migratory stopover. Little brown bats decreased in September to 1,214 and in October to 472 as they left the bridge for hibernation diminishing to only three in December. Sex ratios overall were 367 males to 207 females (Table 2). The ratio of male to female little brown bats in September was 56:4 and 22:0 in October. Mating was observed on 23 August and 28 September 2008 in this species, none in other seasons. Females were present in March through September at which time mating occurred. Males were present primarily in April through November, the times females were most abundant and present after females were gone. This bridge was used by this species as a maternity, nursery, mating, and possibly a migratory stopover. A maternity colony of roughly 300 little brown *Myotis* were found in an Idaho bridge at 44° north latitude (Keeley & Tuttle 1999). Feldhamer et al. (2003) found this species under bridges in southern Illinois.

Big brown bats: A total of 774 big brown bat observations were made under the bridge (Table 1). Although consistently found under the bridge, their numbers were usually five or fewer (55% of the time) or 10 or fewer (78% of the time). On 13 July 2007, there were 35 big brown bats, while on 24 August there were 73. Whether this increase is related to recruitment by young is unknown, but highly probable.

They were present in every month (Table 1) of the year increasing from 9 in February to 212 in August. In September and October, their numbers were 105 and 152 respectively. Sex ratios overall were 36 males to 29 females (Table 2). No mating was observed, but juveniles were observed on 12 July alongside a lactating female. Females and males were most abundant in August (Table 2). Data suggest the bridge may be used as a maternity nursery and for mating. Big brown bats do raise young in bridges and were the second most abundant bridge-dweller (Keeley & Tuttle 1999). The presence of big brown bats in winter is consistent with observations that they often hibernate in buildings and are prone to be active during winter warm spells (Whitaker et al. 2007). Big brown bats were common under bridges in southern Illinois (Felhamer et al. 2003).

Eastern pipistrelles/tri-colored bats: A total of 29 eastern pipistrelle observations were made under the bridge. They were present in winter and early spring, but not observed in summer or fall (Table 1) similar to Sandel et al.

(2001). Ferrara & Leberg (2005) found an increased presence of this species during winter under bridges in Louisiana. Sex ratios overall were two males to four females (Table 2). No mating was observed in this species. From 2006 to 2011, eastern pipistrelles were observed under the bridge from November through May but not in June through October (Table 1). One eastern pipistrelle died in a roosting position sometime in January to April. Data suggest they use the bridge seasonally and it may function as a hibernaculum. Sandel et al. (2001) found the eastern pipistrelle in box culverts in Texas under Interstate Highway 45. They found selection of winter hibernacula in temperate regions may not be dependent on microclimate parameters alone, and the presence of bats in hibernacula varied throughout the year with minimum temperature in winter the only significant microclimate predictor in abundance of bats. Analyses of land-use by Sandel et al. (2001) revealed a significant correlation between number of bats present at each roost and amount of agriculture and forest surrounding each site. There was also a correlation between distances from the opening of the culvert to forest. The bridge studied in this paper was situated in an agriculture and forest matrix.

Gray bats: A gray bat was observed under the bridge on 13 April 2007. The distribution for the gray bat in Indiana is primarily in south central counties bordering the Ohio River (Whitaker & Mumford 2008). This bat is considered an outlier to the main summer distribution of gray bats in Indiana. In September 2012, a gray bat was reported under this bridge (Jared Helms, Pers. Comm.).

Red bats and northern long-eared bats: Two red bats were mist netted and banded on 3 August 2004 next to the bridge (Bryan et al. 2004). During surveys under the bridge in 2006 to 2011, no red bats were observed. The red bat is a solitary species that roosts in foliage (Whitaker et al. 2007).

Even though northern long-eared bats, a federally threatened species, have been found in the vicinity of this bridge, no northern long-eared bats have been observed roosting under this bridge. However, Feldhamer et al. (2003) and USFWS (2014) report this species has been observed roosting under bridges elsewhere.

Roosting behaviors.—Indiana bats roosted singly or in groups of up to 20 individuals. They roosted with little brown bats on occasion and with a big brown bat on a few occasions. Little brown bats also roosted singly or in small groups of up to 30 individuals or occasionally up to 70 bats. Big brown bats usually roosted singly or in pairs and occasionally with little brown bats.

Banded bats.—Indiana bat records from 2008 to 2011 showed nine silver banded recaptures (eight males and one female) and observations of 60 silver banded bats (43 males and 17 females). All Indiana bats were recaptured in 2008 except one female which was recaptured two years later. One orange banded male Indiana bat (banded in 2004) was recaptured in 2006.

Little brown bats showed 14 orange banded recaptures, 49 silver banded recaptures and observations of 90 males and 64 females. Males and females roosted together in this maternity colony which allowed for greater opportunities for them to be recaptured and bands seen from the ground. One male was recaptured four times. He was banded on 29 May 2008 and recaptured 28 June 2008, 8 July 2008, 18 August 2008 and again two years later on 6 August 2010. Keeley & Tuttle (1999) report that bridges and culverts are used by both bachelor and nursery colonies, and as temporary roosts during migration and mating.

On one occasion, a banded lactating big brown bat banded on 3 August 2004 had two slightly smaller big brown bats on each side. Her teats were exposed and no hair was around them. She was recaptured in 2007 and in 2010. Another female big brown bat banded on 3 August 2004 was recaptured approximately five years later in 2009. A male big brown bat banded with a silver band on 31 July 2008 was recaptured again that year and again in 2009.

Four eastern pipistrelles (three females and one male) were banded with silver bands in 2008. No eastern pipistrelles were banded in 2004. There were no recaptures for eastern pipistrelles during this study.

After Indiana State University (ISU) biologists banded bats under the bridge in 2008, they later captured two little brown bats with silver bands at two caves (John Whitaker, Jr. & Brianne Walters, Pers. Comm. 2009–2010). One little brown bat was captured in Wyndotte Cave located approximately 103 km southeast of the bridge, while the other little brown bat was captured in Ray's Cave located approximately 22 km northeast of the bridge. Both of these caves are Priority 1A hibernacula.

Banded bats were also observed on 28–29 September 2008 during the 24-hour study. An orange band was seen on one little brown bat, while a month later, an orange band was seen on a male big brown bat. These recaptures and visual sightings show that bats banded in 2004 were still using this bridge in 2006, 2007, and 2008. During the period 2008 to 2011 the recapture of orange banded bats included two of 24 big brown bats; nine of 51 little brown bats; and one of eight Indiana bats. In addition, two big brown bats and 17 little brown bats were visually observed with orange bands. Such data indicate a high fidelity by bats for this bridge (Table 3).

24-hour study.—During the 24-hour survey of 28–29 September 2008, 1,699 bats were observed including 1,329 little brown bats, 241 Indiana bats and 129 big brown bats. The number of big brown bats stayed fairly constant (mean = 10 $\pm$ 3), while Indiana bats (mean = 19 $\pm$ 15) and little brown bats (mean = 102 $\pm$ 62) varied during the 24-hour period (Fig. 6). Average number of bats between noon and dusk was 217, night time (dark) was 48, and morning (post-dark) was 124. Fifty bats left from under the bridge between 1800 and 2000 hrs but a greater number ($\sim$ 150 bats) did so between 2000 to 2200. Between 0000 and 0600 hrs, the number of bats under the bridge remained fairly constant (mean = 49 $\pm$ 13); by 0800, many bats returned to the bridge ($\sim$ 115); and by 1000 and 1200 there were 130 and 126, respectively.

At the end of the 24-hour study, there were about 90 fewer bats under the bridge than at the start of the survey. Observations included two Indiana bats mating and a movement by bats to higher elevations which may be explained by bats preferring the highest, darkest locations (Keeley & Tuttle 1999). Bats may have moved to higher heights to be away from investigators. However, Ferrara & Leberg (2005) found no support for the hypothesis that surveys of day roosts affected bat use of bridges.

Conclusion.—This seven year study (2004–2011) of this bridge provided considerable data on the Indiana bat, as well as the little brown bat, big brown bat, and the eastern pipistrelle, known today as the tri-colored bat. Because of the large number of visits (118 visits), seasonal patterns on occurrence, density, and behaviors were observed. Prior to this study, it was not known that Indiana bats would be active as early as 28 March and as late as 3 December. There was no previous data indicating this bridge was biologically connected with two Priority 1A caves in south-central Indiana. This study initiated an investigation that concluded iButton dataloggers emitted ultrasonic sound that displaced bats roosting under the bridge. This discovery resulted in a paper (Willis et al. 2009) that recognized such emissions and alerted users to test all dataloggers before use. Lastly, the study disclosed a high fidelity of these bats to this bridge, and no bats showed signs of WNS.

Environmental conditions under this bridge protected bats from predators, wind, rain, snow, and created a favorable environment for roosting and social interaction. From the knowledge gained in studying this bridge and others, FTA and INDOT developed Appendix D: Bridge Assessment Guidance and Form adapted from the INDOT 2010 Bridge Inspection Manual and the Bernardin, Lochmueller and Associates 2007 document. Appendix D is now a part of the Section 7 Consultation and Conservation Strategy for transportation projects (USFWS 2017). The appendix offers favorable characteristics in bridges for bats to roost, provides preliminary indicators of bat presence helpful in bridge inspections, and images helpful for inspectors and biologists. Much attention and interest in bats roosting under Indiana bridges has resulted from studying this bridge in Indiana.

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Table 3.—Banding data for orange (2004) and silver (2008) bands. BB = big brown bat; IB = Indiana bat; LB = little brown bat.

Band color	Species	Band number	Gender	Original date	Recapture date	Recapture date	Recapture date	Recapture date
Orange	IB	1102	Male	5/26/04	10/20/06			
	BB	1957	Female	8/3/04	6/17/09			
	BB	1965	Female	8/3/04	10/31/07	7/12/08	10/16/08	
	LB	668	Male	5/26/04	9/7/07			
	LB	1107	Male	5/26/04	8/29/07	8/30/07		
	LB	1110	Female	5/26/04	6/13/07			
	LB	1114	Female	5/26/04	8/24/07			
	LB	1119	Male	8/3/04	10/5/08			
	LB	1449	Male	5/26/04	10/5/07			
	LB	1450	Female	8/3/04	8/30/07	9/7/07		
	LB	1453	Female	5/26/04	10/30/06	9/14/07	9/25/08	
	LB	1954	Female	8/3/04	8/29/07	6/28/08		
Silver	IB	48	Male	9/25/08	10/5/08			
	IB	501	Male	5/8/08	9/10/08			
	IB	506	Male	5/8/08	8/18/08			
	IB	507	Male	5/8/08	7/8/08			
	IB	513	Male	5/8/08	7/17/08			
	IB	523	Male	7/17/08	9/10/08			
	IB	525	Male	7/17/08	9/25/08			
	IB	528	Male	7/31/08	10/16/08			
	IB	550	Female	7/17/08	5/14/10			
	BB	202	Male	7/31/08	8/13/08	5/28/09		
	LB	501	Male	4/29/08	5/21/08			
	LB	502	Male	4/29/08	5/21/08			
	LB	505	Male	4/29/08	6/5/08			
	LB	506	Male	4/29/08	6/28/08			
	LB	508	Female	4/29/08	6/5/08			
	LB	510	Female	4/29/08	6/5/08			
	LB	518	Female	5/8/08	7/6/08	6/19/10		
	LB	527	Male	5/15/08	10/5/08	8/6/10		
	LB	531	Male	5/29/08	7/8/08			
	LB	534	Male	5/29/08	6/5/08	9/29/10		
	LB	535	Male	5/29/08	6/28/08	7/8/08	8/18/08	8/6/10
	LB	539	Male	7/17/08	8/7/08	8/18/08		
	LB	541	Male	7/17/08	7/31/08			
	LB	551	Male	9/25/08	10/5/08			
	LB	589	Male	9/25/08	6/28/09			
	LB	597	Male	9/25/08	9/25/08			
	LB	958	Male	7/31/08	6/17/09			
	LB	959	Female	7/31/08	8/6/10			
	LB	964	Male	7/31/08	8/13/08	8/18/08	9/25/08	
	LB	969	Male	8/7/08	9/27/09			
	LB	974	Male	8/7/08	9/25/08			
	LB	975	Male	8/7/08	8/18/08			
	LB	977	Male	8/7/08	9/27/09			
	LB	981	Male	8/27/08	10/16/08			
	LB	990	Male	8/27/08	6/17/09			
	LB	6153	Male	7/17/08	6/7/10			
	LB	6159	Male	7/17/08	9/10/08	7/31/08		
	LB	6199	Female	7/17/08	8/27/08			

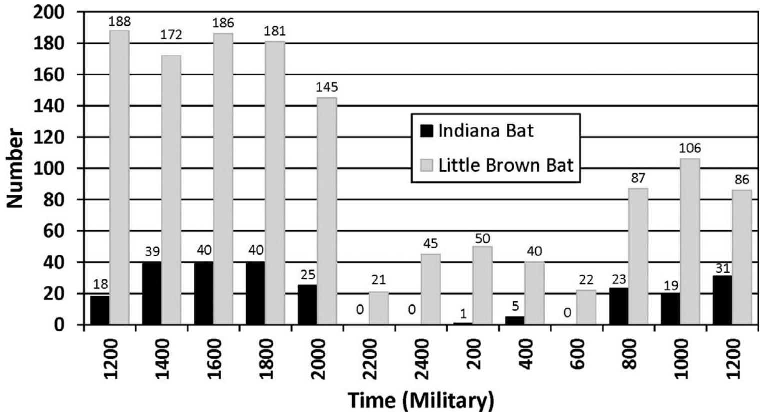

Figure 6.—Number of Indiana bats and little brown bats observed during a 24-hour period on 28–29 September 2008.

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