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BATS OF THE INDIANAPOLIS INTERNATIONAL AIRPORT AS COMPARED TO A MORE RURAL COMMUNITY OF BATS AT PRAIRIE CREEK

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ABSTRACT: The Indianapolis International Airport is in a highly developed area. The bats there have been studied since 1991 and comprise a diverse community of all the species one might expect, including the federally endangered Indiana myotis (*Myotis sodalis*), the state endangered evening bat (*Nycticeius humeralis*), and six other species (big brown bat, *Eptesicus fuscus*; eastern red bat, *Lasiurus borealis*; hoary bat, *L. cinereus*; little brown myotis, *M. lucifugus*; northern myotis, *M. septentrionalis*; and eastern pipistrelle, *Pipistrellus subflavus*). This community offers an interesting contrast to the bat community along Prairie Creek in Vigo County which occupies a more pristine and, until recently, nearly unfragmented bottomland forest. Prairie Creek harbors these same eight species (as well as the silver-haired bat, *Lasionycteris noctivagans*), but their abundance is very different. In both 1997 and 1998, the evening bat, Indiana myotis, northern myotis, and eastern pipistrelle were significantly more common at Prairie Creek than at the airport. All of these species are woodland bats, and their lower abundance at the airport may represent the effects of habitat fragmentation. Similarly, the big brown bat, a common human associate, was significantly more abundant at the airport in 1998. The existence of multiple-year data, large numbers of roost structures, diversity in the chiropteran community, ease of comparison with Prairie Creek, and presence of easily accessible colonies of the northern myotis make the airport's bat community worthy of further research.

KEYWORDS: Bats, Chiroptera, conservation, habitat fragmentation, Indianapolis International Airport, *Myotis sodalis*, urbanization.

INTRODUCTION

The continuing development of rural areas and the resulting expansion of urban and suburban areas present an ever-increasing challenge to conservation biology. Unfortunately, relatively little information is available about how various organisms, including bats, respond to the landscape-level changes that are associated with development.

In 1991, the Indianapolis Airport Authority wished to begin construction of a new United Airlines Regional Service Hub just west of Indianapolis and just north of I-70 in Marion County. For this work to proceed, the area had to be surveyed for the federally endangered Indiana myotis (*Myotis sodalis*). Because Indiana myotis begin to migrate to their hibernacula in mid-August (Humphrey,

et al., 1977), surveys for summer colonies of this species are restricted to a window between 15 May and 15 August which had just passed when the Indianapolis Airport Authority requested the survey. Construction could not be delayed until 1992; therefore, the Indianapolis Airport Authority entered into an agreement with the U.S. Fish and Wildlife Service to assume that the Indiana myotis was present on the study site and to mitigate for potential habitat losses that might occur because of construction. Development and implementation of the mitigation plan was allocated to a private consulting firm. The plan included regular mist-net surveys in areas near the new service hub, planting of new woodlands and wetlands to replace those lost to construction, placement and monitoring of a large number of roost structures for bats, and radiotelemetry of any Indiana myotis captured during the study.

The work was underway when the situation was further complicated by the capture of three Indiana myotis in 1994. Radiotelemetry of two Indiana myotis captured during 1996 resulted in the discovery of a roost site just south of I-70. Beginning in 1997, responsibility for monitoring the bat community passed to American Consulting Engineers, Inc., who subcontracted the bat studies to Indiana State University. The main purpose of this paper is to describe the chiropteran fauna in the developed area near the Indianapolis International Airport. A second purpose is to compare that fauna with a community of bats from Prairie Creek, a large, undeveloped Wabash River floodplain woodland in southern Vigo County, Indiana.

The airport site consists of many small, fragmented woodlands which are surrounded by a mix of agricultural, industrial, and residential areas. Conversely, the Prairie Creek site is a large (650 ha), relatively pristine remnant of bottomland hardwood forest bordered by agricultural fields to the north, west, and south. Farther west, the Wabash River borders the agricultural fields. Prairie Creek is the site of an ongoing long-term study on the community ecology of bats (Whitaker, 1997) that began in 1994. A comparison of these two communities has the potential to yield abundant information useful in the conservation of bats in general.

METHODS AND MATERIALS

Bats at both sites were captured in mist-nets. We captured most bats at the airport as part of a program of regular mist-netting at ten permanent stations. These stations are relatively equally spaced along the East Fork of White Lick Creek between the towns of Plainfield (Hendricks County) and Mooresville (Morgan County), Indiana. In addition, some data are included from mist-netted sites near two known roosts of the Indiana myotis (A and B).

We netted each of the ten creek sites three times during 1998 (for 30 net nights) and nine of them three times and one twice during 1997 (for 29 net nights). Mist-nets (9 x 6 m or 9 x 9 m) were suspended from poles by a pulley system similar to that described by Gardner, *et al.* (1989). Mist-nets were placed over the creek such that their tops reached as close to the canopy trees as possible,

and their bottoms were just above the stream. We monitored these nets continuously using a bat detector (an Anabat II detector, Titley Electronics, Sidney, Australia; or a Summit mini-2 bat detector, Birmingham, England) to determine the amount of bat activity. In 1997, the nets along the creek were tended from dusk until 2 A.M. (all times are Eastern Standard Time). In 1998, netting ceased after midnight when activity (as evidenced by echolocations) decreased.

We also netted periodically near the original roost (A) and a second roost (B) discovered by radiotracking an Indiana myotis captured at Roost A in 1997. Some nets were checked from dusk until dawn, and others were taken down shortly after dusk and then put back up at 3 A.M. This procedure was used because many individuals of the Indiana myotis were captured early in the morning, and the objective of this netting was to capture Indiana myotis for radiotracking studies. Data from these sites were not included in our analyses because the netting techniques at these sites were dramatically different from those used along the East Fork of White Lick Creek or along Prairie Creek.

The netting along Prairie Creek differed from that at the airport in duration, seasonality, and intensity. Nets at Prairie Creek were usually left in place until 1 A.M. Rather than being limited to a 15 May to 15 August window, nets were used at Prairie Creek once per week from March through October, except when prevented by flooding. The sampling effort at the airport was more intense (10 times per month) than at Prairie Creek (4 times per month). At Prairie Creek, we netted 21, 26, 16, 31, and 33 times per year between 1994 and 1998, respectively.

Statistical analysis was done using SPSS 6.1 for Windows (SPSS, 1996). All tests were two-tailed, and a rejection level of $\alpha = 0.05$ was used throughout the study. A Kruskal-Wallis test was used to examine the annual variation within the species at Prairie Creek for all data and also for a subset consisting of only those data that were collected during the 15 May to 15 August window. We used Mann-Whitney *U* tests to compare the annual variation at the airport. Because of the presence of significant year-to-year variation in the Prairie Creek data, all comparisons were limited to data from the 15 May to 15 August window within a given year. We used Mann-Whitney *U* tests to compare the capture records at Prairie Creek to those along the East Fork of White Lick Creek for the 1997 and 1998 field seasons.

RESULTS

The two communities, although in very different ecological situations, both contain the same species (all the species that would be expected at those sites during the time of year studies were conducted, Table 1). There was, however, great variation in the relative abundance of the species. Efforts at all our sites resulted in the capture of 1,321 bats representing nine species. The regular mist-net surveys along the East Fork of White Lick Creek at the airport resulted in the capture of 233 bats representing eight different species, whereas 71 bats representing six species were captured by mist-netting near the known Indiana myotis

Table 1. Total number and capture rates of bats caught at the Indianapolis International Airport in Hendricks and Marion Counties and along Prairie Creek in Vigo County. A subset of these data are compared in Table 2.

Site	East Fork of White Lick Creek		Known Indiana Myotis Roosts at the Airport		Prairie Creek	
Number of Net Nights	59		14		127	
Species Caught	Number of Bats	Bats Caught per Night	Number of Bats	Bats Caught per Night	Number of Bats	Bats Caught per Night
Eptesicus fuscus	158	2.68	33	2.36	207	1.63
Lasiurus borealis	29	0.49	2	0.14	88	0.69
Lasiurus cinereus	1	0.40	1	0.07	1	0.01
Myotis lucifugus	24	0.41	4	0.29	62	0.49
Myotis septentrionalis	13	0.22	10	0.71	188	1.48
Myotis sodalis	0	0.00	11	0.79	44	0.35
Nycticeius humeralis	8	0.14	7	0.50	354	2.79
Total	233	3.95	68	4.86	944	7.43

roosts at the airport in 1997 and 1998. Netting along Prairie Creek resulted in the capture of 944 bats representing nine species. With the exception of the silver-haired bat, these species were the same eight species as recorded at the airport during the same time period.

We found significant year-to-year effects at Prairie Creek but not at the airport. When data from all years at Prairie Creek were compared, significant annual variation was present for the big brown bat ($\chi^2 = 10.627$, $p = 0.031$), little brown myotis ($\chi^2 = 12.612$, $p = 0.013$), northern myotis ($\chi^2 = 10.351$, $p = 0.035$), and Indiana myotis ($\chi^2 = 18.687$, $p = 0.001$). We then limited our analysis to only the data on bats captured between 15 May and 15 August. Even with this more restrictive data set, we still found significant year-to-year variation for the northern myotis ($\chi^2 = 9.624$, $p = 0.047$) and Indiana myotis ($\chi^2 = 14.992$, $p = 0.005$) as well as a trend for the little brown myotis ($\chi^2 = 9.001$, $p = 0.061$). Finally, we compared the data from Prairie Creek which was collected between 15 May and 15 August in 1997 and 1998. Both the northern myotis ($U = 121.5$, $p = 0.0338$) and Indiana myotis ($U = 133.0$, $p = 0.0290$) were significantly more abundant in 1997 than in 1998. Thus, we limited comparisons to within years (1997 data from the airport compared with 1997 data from Prairie Creek and 1998 data compared with 1998 data). Comparisons were further limited to data collected between 15 May and 15 August.

The big brown bat was significantly more common at the airport in 1998 and tended (but not significantly) to be more common there in 1997 (Table 2). The Indiana myotis, evening bat, northern myotis, and eastern pipistrelle were significantly more common at Prairie Creek during both 1997 and 1998 (Table 2).

Table 2. A comparison of bat captures between the regular airport nettings and the nettings along Prairie Creek in 1997 and 1998. Prairie Creek data are restricted to efforts that took place during the same time period as at the airport (15 May to 15 August). Species are listed in the apparent order of abundance at the regular netting sites at the airport. Asterisks (*) indicate significant differences (rejection set at $\alpha = 0.05$).

1997	Airport		Prairie Creek		Comparison	
Number of Net Nights	29		17			
Species Caught	Number of Bats	Bats Caught per Night	Number of Bats	Bats Caught per Night	Mann - Whitney *U*	*P*
Eptesicus fuscus	64	2.21	8	0.47	177.0	0.099
Lasiurus borealis	16	0.55	4	0.24	203.0	0.211
Myotis lucifugus	10	0.34	9	0.53	194.0	0.121
Myotis septentrionalis	10	0.34	28	1.65	100.5	< 0.001*
Nycticeius humeralis	1	0.03	56	3.29	90.0	< 0.001*
Pipistrellus subflavus	4	0.14	12	0.71	173.0	0.025*
Lasiurus cinereus	1	0.03	0	0.00	238.0	0.444
Myotis sodalis	0	0.00	11	0.65	130.5	< 0.001*
1998	Airport		Prairie Creek		Comparison	
Number of Net Nights	30		23			
Species Caught	Number of Bats	Bats Caught per Night	Number of Bats	Bats Caught per Night	Mann - Whitney *U*	*P*
Eptesicus fuscus	94	3.13	13	0.57	155.5	< 0.001*
Lasiurus borealis	13	0.43	9	0.39	334.5	0.812
Myotis lucifugus	14	0.47	5	0.22	297.5	0.279
Myotis septentrionalis	3	0.10	18	0.78	207.0	0.001*
Nycticeius humeralis	7	0.23	54	2.35	179.0	< 0.001*
Pipistrellus subflavus	2	0.07	9	0.39	2447.0	0.010*
Lasiurus cinereus	0	0.00	1	0.04	330.0	0.253
Myotis sodalis	0	0.00	5	0.22	300.0	0.044*

DISCUSSION

Only nine bat species could be expected to occur at the airport or Prairie Creek (Mumford and Whitaker, 1982). Eight of these species were captured at both sites in 1997 and 1998, and the ninth species, the silver-haired bat (*Lasionycteris noctivagans*), was present at Prairie Creek but not at the airport in 1997 and 1998. Silver-haired bats are present in Indiana primarily as migrants (April to early June and again in September and October) although rare hibernating individuals can be found (Mumford and Whitaker, 1982). The silver-haired bat is undoubtedly present at the airport but was not collected during the limited work there.

Excluding the silver-haired bat, the same species were present in both study areas. However, the two sites did differ greatly in the relative abundance of these species (Table 2). The big brown bat is the dominant species at the airport, but this species is less common at Prairie Creek. The big brown bat is commonly found in buildings (Cope, *et al.*, 1961; Whitaker and Gummer, 1989), and, thus, this difference in abundance is not surprising given the proximity of the airport to urban and suburban areas. Four colonies of the big brown bat were found near the airport despite the fact that we did not conduct a formal survey for them. The big brown bat was not present at Prairie Creek during the maternity season although at least one post-lactation colony was established there in late July. Of the nine bat species studied, the big brown bat was the only species that was significantly more abundant at the airport during 1998.

Four other species (the evening bat, Indiana myotis, northern myotis, and eastern pipistrelle) were significantly more abundant at Prairie Creek during both 1997 and 1998. All these species roost in trees (Whitaker and Hamilton, 1998). Thus, the differences in abundance are probably related to the greater variety of forested habitat and the greater abundance of potential roosts at Prairie Creek.

Further evidence suggesting that the fragmented nature of the woodlots at the airport is the main cause of this pattern is evident in our data from Prairie Creek. In September 1997, a 2.5-mile stretch of Prairie Creek in our study area was bulldozed as part of an attempt to increase stream drainage. A comparison of the 1997 and 1998 data from Prairie Creek demonstrates a significant decrease in the abundance of the Indiana myotis and northern myotis. Interestingly, a comparison between Prairie Creek and the airport for 1997 and 1998 shows these species to be more abundant at Prairie Creek during both years. Prairie Creek still supported more of these woodland bats than the airport even after this disturbance.

The evening bat was the species captured most frequently at Prairie Creek, but this species was relatively rare at the airport. In Indiana, the evening bat lives primarily near large river bottoms (J.O. Whitaker, Jr., unpubl. data) although 12 colonies have been found in buildings (Whitaker and Gummer, 1994). We radiotracked two evening bats to a total of four roosts near the airport. The only roost located in 1997 was a hollow in an American beech (*Fagus grandifolia*) located on private property north of I-70. This roost was occupied between 15 and 17 August, and three bats were observed leaving this roost on 16 August. We were surprised that the bats were roosting in this woodlot given that this species prefers secluded bottoms and here the roost was near an active construction site. The three roosts located in 1998 were all south of I-70 in a series of connected woodlots that also housed the main roost of the Indiana myotis as well as several northern myotis roosts. These roosts were located by radiotracking a female evening bat. The first roost was in a bitternut hickory *(Carya cordiformis*) that was occupied on the night of 14 July. The second roost was also in a bitternut hickory where 69 bats were observed emerging on 15 July. The third and final roost was in a white oak (*Quercus alba*) snag near the site of the main

Indiana myotis roost. The woodlots containing these roosts are targeted to become part of a permanent habitat set-aside created as part of the airport's conservation efforts. When young evening bats become volant, the maternity colonies of that species break up, and the individuals become widely scattered. Because all the evening bats we radiotracked were captured after the young were flying, we were unable to determine if any of these roosts were a primary maternity colony of that species.

The northern myotis was the fourth most abundant bat at the airport, at least as indicated by our netting, but this species was taken at a relatively low rate (0.21 per night). This result was surprising because the northern myotis is the species that occupied the roost structures at the airport. The northern myotis was the second most common species at Prairie Creek. This result was also not surprising because this bat is a woodland species and a gleaner. This pattern of feeding may result in the bats at Prairie Creek spending more time under the dense canopy that covers that stream than the bats at the airport did under the less dense forest along the East Fork of White Lick Creek.

The Indiana myotis was not captured during the regular mist netting at the airport and was only captured during irregular netting near the Indiana myotis maternity colonies. The Indiana myotis has been captured at Prairie Creek (16 between 15 May and 15 August). Perhaps this indicates that this bat often forages in areas of dense cover similar to that found along Prairie Creek. The lack of the Indiana myotis at the airport, when a known maternity colony occurs nearby, could call into question the technique of netting streams to determine the presence of the Indiana myotis, at least in situations with little canopy cover over streams.

We failed to find significant differences in abundance for the eastern red bat, little brown myotis, and hoary bat. The second most abundant bat at the airport was the eastern red bat which was the fifth most common bat at Prairie Creek. Red bats roost among the foliage of trees, and, thus, one might expect them to be more common at Prairie Creek. However, these bats often occur in suburban and open areas, so their abundance at the airport is not surprising. The little brown myotis was the third most common species at the airport and was sixth in abundance at Prairie Creek. Nevertheless, these differences were not significant. The little brown myotis, like the big brown bat, is associated with people and their structures; thus, the little brown myotis should be more common near the airport than in the dense woods at Prairie Creek. One possible explanation for why the population sizes at these two stations are not significantly different is that the little brown myotis is becoming less common, and, thus, differences between these sites are less detectable. Cope, *et al.* (1961) located 188 bat colonies in buildings of which 41 (22%) were colonies of the little brown myotis. Using the same techniques, Whitaker and Gummer (1989) located 231 colonies of which only 34 (15%) were of the little brown myotis. We failed to capture enough hoary bats at either site to detect any difference in abundance that might exist.

Some differences noted between the two communities may be due to differences between the forests at Prairie Creek and those along the stream at the airport. The vegetation at Prairie Creek is much better for netting. The canopy tends to be closer to the stream and is more continuous along Prairie Creek, whereas the canopy at the airport is both more open and consists primarily of mature trees. Thus, some of the differences in species abundance may relate to our differential ability to net the two sites.

The airport's bat community offers tremendous potential for future research. Two endangered species, the federally endangered Indiana myotis and the state endangered evening bat, occur there. Given the large number of bat species present, the precarious status of the evening bat in Indiana (Whitaker and Gummer, 1994), the presence of the Indiana myotis, the large number of bat structures present, and the fact that this community is near a large city and adjacent to a large international airport, the airport's bat community has important implications for gathering further biological and conservation data.

As stated earlier, a need exists for information on how species respond to urbanization and development. Forest fragmentation is a major concern in the preservation of Neotropical migratory birds (Robinson, *et al.*, 1995). Many forest birds also show strong area effects (Wilcove, 1985); *i.e.*, the densities of some species decrease precipitously in smaller fragments. To date, little research has been directed at obtaining information about how forest fragmentation might effect bats. Given the fragmented nature of the woodlots at the airport, the presence of the young and more contiguous mitigation woodlands, the multi-year dataset already available, and the presence of similar data from a much less fragmented woodland at Prairie Creek, the airport offers a unique opportunity to study the effects of fragmentation and urbanization on North American bats. The data from our study suggest that forest fragmentation and urbanization may negatively effect forest dwelling bats, but additional data are needed before this hypothesis can be adequately tested.

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LITERATURE CITED

Cope, J.B., W.W. Baker, and J. Confer. 1961. Breeding colonies of four species of bats of Indiana. Proc. Indiana Acad. Sci. 70: 262-266.

Gardner, J.E., J.D. Garner, and J.E. Hofmann. 1989. A portable mist netting system for capturing bats with emphasis on *Myotis sodalis* (Indiana bat). Bat Res. News 30: 1-7.

Humphrey, S.R., A.R. Richter, and J.B. Cope. 1977. Summer habitat and ecology of the endangered Indiana bat, *Myotis sodalis*. J. Mammal. 58: 334-346.

Mumford, R.E. and J.O. Whitaker, Jr. 1982. Mammals of Indiana. Indiana Univ. Press, Bloomington, Indiana, 537 pp.

Robinson, S.K., F.R. Thompson III, T.M. Donovan, D.R. Whitehead, and J. Faaborg. 1995. Regional forest fragments and the nesting success of migratory birds. Science 267: 1987-1990.

SPSS. 1996. SPSS version 6.1 for Windows. SPSS, Chicago, Illinois.

Whitaker, J.O., Jr. 1996. Bats of Prairie Creek, Vigo County, Indiana. Proc. Indiana Acad. Sci. 105: 87-94.

_____ and S.L. Gummer. 1989. Bat colonies in Indiana with emphasis on the evening bat (*Nycticeius humeralis*). Proc. Indiana Acad. Sci. 98: 595-598.

_____ and _____. 1994. Status of the evening bat, *Nycticeius humeralis*, in Indiana. Proc. Indiana Acad. Sci. 102: 283-291.

_____ and W.J. Hamilton, Jr. 1998. Mammals of the eastern United States. Comstock Press, Ithaca, New York, 583 pp.

Wilcove, D.S. 1985. Nest predation in forest tracts and the decline of migratory songbirds. Ecology 66: 1211-1214.