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Summer Distribution of the Federally Endangered Indiana Bat (*Myotis sodalis*) in Illinois

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ABSTRACT

During the summers of 1985 through 1994, mist netting was conducted at 191 sites in 71 Illinois counties to determine the summer distribution of the federally endangered Indiana bat (*Myotis sodalis*). A total of 115 Indiana bats was captured at 35 sites in 21 counties in the southern three-fourths of Illinois. Adult male Indiana bats were also found to be using two caves and one mine during the summer. Because one cave was located in an additional county, summer records were obtained for 22 counties. Captures of reproductively active females or juveniles at 24 sites in 16 counties indicated that maternity colonies of this species occur throughout its range in Illinois. Recaptures of banded individuals in the same area during different summers demonstrated that Indiana bats displayed loyalty to their summer ranges.

INTRODUCTION

The federally endangered Indiana bat (*Myotis sodalis*) is a migratory species that congregates in caves and abandoned mines during the winter, but is more widely dispersed during the summer (Barbour and Davis 1969). The majority of this species hibernates in a few caves and one mine in Missouri, southern Indiana, and Kentucky (Brady et al. 1983). During the summer, the Indiana bat has a fairly extensive range in the midwestern and eastern United States -- from Arkansas north to Iowa and southern Michigan, through the Appalachian region to Vermont, and south to North Carolina and Tennessee (Barbour and Davis 1969, Thomson 1982). Until recently, relatively little was known about the actual summer distribution or habitat requirements of this species (Barbour and Davis 1969, Thomson 1982). Barbour and Davis (1969) felt that information was limited because Indiana bats roosted singly or in small groups in hollow trees or underneath loose bark during the summer. The first maternity colony (reproductively active females and their young) of Indiana bats to be studied was not discovered until 1971 when its roost tree in Indiana was bulldozed (Cope et al. 1973).

In Illinois, many of the early records (prior to 1970) of Indiana bats were specimens collected during hibernation from caves in southern (Union and Hardin counties) and western (Pike and Madison counties) portions of the state, an abandoned lead mine in Jo Daviess County, and Blackball Mine, an abandoned limestone mine in La Salle County (Miller and Allen 1928, Smith and Parmalee 1954, Layne 1958, Hall 1960, Hoffmeister 1989). Spring or autumn records of migrating individuals exist for Adams, Christian, Cook, Franklin, Jackson, Madison, McDonough, Morgan, and Sangamon counties (Clark and Clark 1987; Hoffmeister 1989; Illinois Natural History Survey, unpublished data). Prior to 1985 there were summer records of reproductively active female or juvenile Indiana bats only for Jackson (Gardner and Taft 1984), Perry (Kirkpatrick 1980), Pike (Gardner and Gardner 1980; Gardner and Taft 1984; Clark and Clark 1987), Union (Brack 1979), and the border of Wabash and Edwards counties (Kessler and Turner 1980). In addition, three male Indiana bats had been collected in Blackball Mine in La Salle County in May (Hoffmeister 1989) and an adult male and adult female (reproductive condition unknown) from Adams County were examined by the Illinois Department of Public Health during summer months (Illinois Natural History Survey, unpublished data).

A cooperative research project of the Illinois Natural History Survey, Illinois Department of Conservation (now Natural Resources), Illinois Department of Transportation, and Shawnee National Forest (U.S. Forest Service) was initiated in 1985 to study the statewide distribution and summer habitat requirements of the Indiana bat. This paper presents findings on the summer distribution of this species in Illinois.

METHODS

The primary method used to determine the summer distribution of the Indiana bat was mist netting at surface sites, nearly all of which were along intermittent and perennial streams and small rivers. Netting sites were established at locations where overhanging branches of riparian trees formed a canopy above the stream channel; such a situation creates a tunnel through which bats can fly to drink or feed on aquatic insects.

Bats were captured in black, 38-mm mesh, monofilament mist nets; these nets range from 5.5 to 18.5 m in length and can be spread to a height of 2.2 m. A pair of metal poles either 6.1 or 9.2 m high was positioned under overhanging tree branches on opposite sides of the stream (or river) channel. Nets of equal length were stacked vertically and suspended above the stream between rope and pulley systems attached to both poles. With this system it was possible to raise the top of the uppermost net to the canopy and block most of the flyway above the stream. An additional mist net was frequently spread across the channel just above water level to catch low-flying bats. A complete description of the netting system can be found in Gardner et al. (1989).

Mist netting was conducted primarily between 1 May and 30 August on nights when environmental conditions were favorable (i.e., no precipitation or strong winds, limited moonlight, and temperatures above 9°C). Nets were raised at dusk and checked at 10- to 15-minute intervals until 2400 h or later. Bats were removed from the net and examined to determine species, sex, age (juvenile or adult), and reproductive condition. Age class was determined by the degree of closure of the phalangeal epiphyses; juveniles (i.e., less

than one year old) are recognizable by the incomplete ossification of the epiphyses (Barbour and Davis 1969). The reproductive condition of males was assessed by the size of the epididymides; sexually mature males have enlarged or distended epididymides which can be seen through the interfemoral membrane (Racey 1988). Pregnant females were recognized by gently palpating the fetus through the abdomen, and lactating and post-lactating females by examination of the teats. Weights were determined to the nearest 0.1 g by suspending the bats from a Pesola scale. One size XCL consecutively-numbered, color-coded, plastic split-ring bird band (A.C. Hughes, England) was placed on a forearm of each Indiana bat for individual identification. Bats were released at the capture site after examination.

More than two dozen caves and mines were visited during the summer to determine if they were used by roosting Indiana bats. Bats were also captured at some cave entrances using a portable harp trap similar to one described by Tidemann and Woodside (1978). The trap consists of an aluminum frame that has a double rank of monofilament lines strung vertically under tension; a large canvas bag is suspended below the frame to catch bats that hit the lines. After the trap had been placed in a cave's entrance, coarse nylon netting was used to cover the remainder of the entrance and direct emerging bats into the trap. The trap was checked periodically from dusk until bats were no longer emerging.

RESULTS AND DISCUSSION

From May through August during the years 1985 through 1994, 299 nights of mist netting were conducted at 191 surface sites in 71 Illinois counties (Figure 1, Appendix). A total of 1856 bats was captured at these locations, 115 (6.2%) of which were Indiana bats. This greatly increased the number of summer records for this species in Illinois. Indiana bats were caught at 35 surface sites in 21 counties (Figure 2, Table 1). Adult male Indiana bats were also found to be using two caves and one mine in three counties during the summer (Figure 2). Seven adult males were trapped at the entrance to Cave Spring Cave in Hardin County during June and July 1985; three males were caught there in June 1986. This cave had been a known hibernation site for Indiana bats (Layne 1958, Hall 1960, Whitaker 1975), but these were the first summer records of the species using the cave. However, this cave may no longer be a suitable roost site because of alterations caused by nearby quarrying activity. A cluster of bats in an Adams County cave examined in June 1987 included 13 adult male Indiana bats as well as 47 little brown bats (*Myotis lucifugus*). Five male Indiana bats were found in this cave in July 1988. Three adult males were caught at the entrance of an abandoned silica mine in Alexander County in June 1991; 750 Indiana bats were observed roosting within the mine at that time.

In all, summer records for the Indiana bat were collected in 22 of the 71 Illinois counties sampled during this study. No previous summer records had existed for 17 of these counties and additional summer records were obtained for Adams, Jackson, Perry, Pike, and Union counties. The only other previous summer localities for this species were Blackball Mine (three males) in La Salle County (Hoffmeister 1989) and Bonpas Creek (lactating female and juvenile female), the boundary between Wabash and Edwards counties (Kessler and Turner 1980). Five nights of mist netting on Bonpas Creek during 1986, 1987, and 1991 yielded no Indiana bats, suggesting that a maternity colony may no longer occur in that area. Prior to 1985, mist netting had been conducted in five addi-

tional counties (Bureau, Christian, Clinton, Stephenson, and Warren), but no Indiana bats were captured in any of them (Gardner and Taft 1983, 1984). Thus, 76 of Illinois' 102 counties have been sampled for bats since 1980.

Captures of reproductively active females and/or juveniles at 24 sites during this study indicated the presence of Indiana bat maternity colonies in 16 counties (Figure 2, Table 1). A maternity colony was discovered in an additional county (Cass) by Kurta et al. (1993) in 1992. These records indicate that Indiana bat breeding colonies occur throughout the species' range in the state.

Most of the Indiana bats were captured at sites in west-central and southern portions of the state where mist netting effort was greatest. Despite the fact that mist netting has been conducted in more northerly Illinois counties during this study and previously by Gardner and Taft (1983), no Indiana bats have been caught north of Henderson and Ford counties. Except for the hibernaculum (Blackball Mine) in La Salle County, the only Indiana bat records north of 41°N latitude are for three specimens collected at a mine in Jo Daviess County in December 1953 (Smith and Parmalee 1954) and a migratory individual in Cook County in September 1928 (Hoffmeister 1989). Similarly, the only record for Wisconsin is a specimen collected in an abandoned lead mine in Grant County (adjacent to Jo Daviess County) in November 1954 (Davis and Lidicker 1955). Thus, it appears that the summer range of the Indiana bat does not extend into the northern quarter of Illinois.

In Iowa, reproductively active female and juvenile Indiana bats have been captured only in the southern third of the state, south of 42°N (Clark et al. 1987) and no more than 50 km north of Henderson County, Illinois. Clark et al. (1987) suggested that climatic factors and distance to major hibernacula limit the summer distribution of this species in Iowa. A female captured in Marion County, Iowa, had been banded at Pilot Knob Mine in Missouri, 463 km to the southeast (LaVal and LaVal 1980). East of Illinois, the summer range of Indiana bats extends considerably farther north; maternity colonies occur throughout Indiana (3D/Environmental Services, Inc. 1993) and in lower Michigan, south of 43°N (Kurta 1980). Five Indiana bats captured in Michigan (at five separate locations) had been banded at two caves in Kentucky (Kurta 1980); the greatest linear distance between these southern Michigan locations and the cave at which the individual had been banded is approximately 520 km. Any location in northern Illinois is within 520 km of at least one of the Priority 1 hibernacula in Missouri, southern Indiana, and Kentucky (as designated by the Indiana Bat Recovery Team). This suggests that Indiana bats could occur farther north than Henderson and Ford counties. The Chicago metropolitan region may not provide suitable habitat for Indiana bats, but their absence (or scarcity) elsewhere in northern Illinois is probably a reflection of declining population levels for this species (Clawson 1995).

The recapture of banded individuals at sites during more than one year demonstrated that Indiana bats are loyal to their summer ranges. Repeated mist netting was conducted at a cluster of sites along Fishhook Creek in Pike and Adams counties for an intensive study of Indiana bat summer habitat requirements. Indiana bats were captured in this area every summer from 1985 through 1989 and three individuals banded there were recaptured during subsequent summers. An adult male was caught at two sites approximately 1 km apart during the summers of 1986 and 1987. A pregnant female banded in 1987 was recaptured

at a site 250 m away during the same summer and recaptured, again pregnant, at the latter site in the summer of 1988. A female banded as a juvenile in 1986 was caught at a location approximately 900 m from her original capture site two years later. In addition, an adult male banded at Cave Spring Cave (Hardin County) in 1985 was recaptured there in 1986 and another male was found occupying the same cave in Adams County during the summers of 1987 and 1988. Similarly, Cope et al. (1973) and Humphrey et al. (1977) found that a maternity colony occupied the same area along the Noland Fork River in Indiana for five consecutive summers.

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Table 1. Mist netting records for Indiana bats (*Myotis sodalis*) in Illinois, 1985-1994

County	Location	No.	Maternity colony*
Adams	Fishhook Creek (5 sites)	19	X (3 sites)
	Ursa Creek	2	
	Long Island Lake (Mississippi River)	5	X
Alexander	Lake Creek	2	
	Black Creek	2	X
Bond	East Fork Shoal Creek	7	X
Cass	Panther Creek	1	
Ford	Middle Fork Vermilion River	1	X
Henderson	Jinks Hollow Creek	1	X
Jackson	Cedar Creek (2 sites)	6	X (1 site)
Jersey	Piasa Creek	2	X
Johnson	Cache River (Boss Island)	1	X
Lawrence	Brushy Creek	1	
Macoupin	Macoupin Creek	1	X
McDonough	Camp Creek	1	X
Perry	Galum Creek	1	
Pike	Fishhook Creek (4 sites)	39	X (4 sites)
	Beebe Creek (2 sites)	3	X (1 site)
Pope	Big Grand Pierre Creek	1	
Pulaski	Cache River	6	X
Saline	Bankston Fork	2	X
Schuyler	Missouri Creek	4	X
Scott	Sandy Creek	2	X
Union	Clear Creek	1	
Vermilion	Little Vermilion River (2 sites)	4	X (2 sites)

* pregnant, lactating, or post-lactating females and/or juveniles captured at site(s)

APPENDIX

Locations of mist netting sites in Illinois, 1985-1994

SITE	COUNTY
Fishhook Creek (7 sites)	Adams
Ursa Creek	Adams
Long Island Lake (2 sites)	Adams
Black Creek (Horseshoe Lake)	Alexander
Cooper Creek No. 5	Alexander
Lake Creek (3 sites)	Alexander
Sandy Creek	Alexander
East Fork Shoal Creek	Bond
Kingsbury Creek	Bond
Kishwaukee River	Boone
Kishwaukee River Slough	Boone
Carroll Creek	Carroll
Panther Creek (2 sites)	Cass
Sangamon River (2 sites)	Champaign
Lincoln Trail State Park Lake	Clark
Dismal Creek	Clay
Greasy Creek	Coles
Little Embarras River	Coles
Whetstone Creek	Coles
Brushy Creek	Crawford
Hurricane Creek	Cumberland
North Fork Salt Creek	Dewitt
Embarras River (2 sites)	Douglas
Lyman Woods	DuPage
Waterfall Glen	DuPage
West Fork Big Creek	Edgar
Bonpas Creek (2 sites)	Edwards
Bishop Creek	Effingham
Ramsey Creek	Fayette
Middle Fk Vermilion R (2 sites)	Ford
Big Muddy River	Franklin
Rice Lake	Fulton
Eagle Creek (2 sites)	Gallatin
Ohio River tributary	Gallatin
Robinette Creek	Gallatin
West Fork Mazon River	Grundy
Waupecan Creek	Grundy
Big Creek (2 sites)	Hardin
Hogthief Creek	Hardin
Wallace Branch	Hardin
Jink's Hollow Creek	Henderson
Smith Creek	Henderson
Mud Creek	Henry
Mineral Creek	Henry
Iroquois River (2 sites)	Iroquois
Cave Creek	Jackson
Cedar Creek (2 sites)	Jackson
Piles Fork	Jackson
Otter Creek	Jersey
Piasa Creek	Jersey
Apple River	Jo Daviess
Smallpox Creek (2 sites)	Jo Daviess
Yellow Creek	Jo Daviess
East Fork Galena River	Jo Daviess
Furnace Creek	Jo Daviess
Irish Hollow Creek	Jo Daviess
Bay Creek	Johnson
Cache River (Boss Island)	Johnson
Little Black Slough	Johnson
Sugar Creek (4 sites)	Johnson
Davis Creek	Kankakee
Momence Wetlands	Kankakee
Des Plaines River (4 sites)	Lake
Mill Creek/Des Plaines River	Lake
Little Vermilion River	La Salle
Brushy Creek	Lawrence
Franklin Creek	Lee
Rooks Creek (2 sites)	Livingston
Kickapoo Creek	Logan
Sugar Creek	Logan
Joe's Creek	Macoupin
Macoupin Creek	Macoupin
East Fork Wood River	Madison
Slough at Cahokia Creek	Madison
West Fork Wood River	Madison
Dumms Creek	Marion
Skillet Fork	Marion
Crow Creek	Marshall
Sandy Creek	Marshall
Prairie Creek (2 sites)	Mason
Main Ditch	Massac
Massac Creek	Massac
Sevenmile Creek (2 sites)	Massac
Camp Creek	McDonough
Willow Creek	McDonough
Mackinaw River (3 sites)	McLean

(Appendix concluded on next page)

APPENDIX (concluded)

SITE	COUNTY
North Henderson Creek	Mercer
Camp Creek	Mercer
Dry Fork Horse Creek	Monroe
Fountain Creek	Monroe
Rock River tributary	Ogle
Galum Creek	Perry
Sangamon River	Piatt
Beebe Creek (3 sites)	Pike
Fishhook Creek (5 sites)	Pike
Bay Creek	Pope
Big Grand Pierre Creek (3 sites)	Pope
Flat Lick Branch	Pope
Hunting Branch Creek	Pope
Lusk Creek	Pope
Pond (south Millstone Bluff)	Pope
Robnette Creek (2 sites)	Pope
Cache River (3 sites)	Pulaski
Mill Creek	Randolph
Silver Creek (2 sites)	St. Clair
Little Silver Creek	St. Clair
Silver Creek tributary	St. Clair
Bankston Fk (2 sites)	Saline
Rock Branch	Saline
Brush Creek	Sangamon
Horse Creek (3 sites)	Sangamon
Spring Creek	Sangamon
Missouri Creek	Schuyler
Willow Creek	Schuyler
Little Sandy Creek	Scott
Sandy Creek	Scott
Jordon Creek	Shelby
Lake Shelbyville	Shelby
Richland Creek	Shelby
Prairie Creek	Tazewell
Alloway Creek	Tazewell
Clear Creek	Union
Clear Creek Ditch	Union
Line C Ditch	Union
Lingle Creek	Union
Wolf Lake tributary	Union
Little Vermilion River (2 sites)	Vermilion
Middle Fork Vermilion River	Vermilion
Vermilion River	Vermilion
Bonpas Creek (2 sites)	Wabash
Coffee Creek	Wabash
Greathouse Creek	Wabash
Beaver Creek	White
Deer Creek	Whiteside
Lynn Creek	Whiteside
Forked Creek	Will
Plum Creek	Will
Grant Creek	Will
Prairie Creek	Will
Crab Orchard NWR (2 sites)	Williamson
Sugar Creek	Williamson
Sugar Creek	Williamson
Mackinaw River	Woodford

Figure 1.
Locations of mist netting sites, 1985-1994.

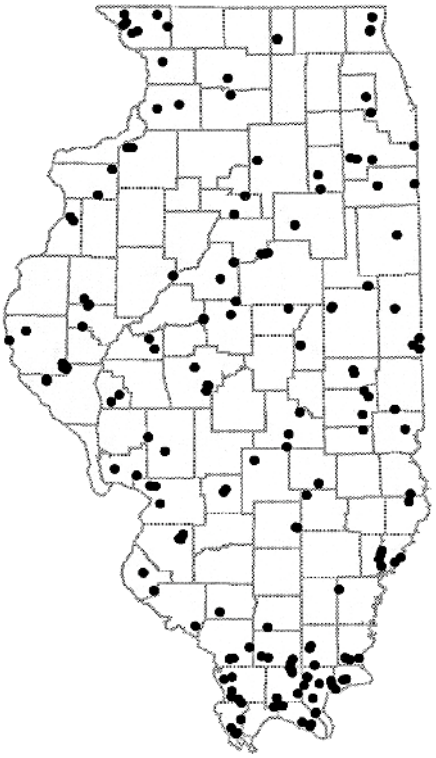

Figure 2.
Summer records of the Indiana bat (*Myotis sodalis*) in Illinois, 1985-1994.