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Determination of Summer Distribution and Habitat Utilization
of the Indiana Bat (Myotis sodalis) in Illinois

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INTERIM SEGMENT PERFORMANCE REPORT

STATE OF ILLINOIS

PROJECT NO. E-3

STUDY: Determination of Summer Distribution and Habitat Utilization of the Indiana Bat (Myotis sodalis) in Illinois

ABSTRACT: This study is a five-year ecological investigation into the distribution, abundance, habitat utilization, and status of the Indiana bat (Myotis sodalis) in Illinois. During the second year of field work, extending from 24 April through 10 September 1986, 50 nights of mist netting and bat trapping efforts were conducted at 36 surface sites and two cave entrances. These efforts resulted in the capture of 456 bats representing 10 species. Twenty-five M. sodalis were mist netted over surface creeks and rivers and three were trapped at one cave entrance. Data suggested the occurrence of Indiana bat maternity colonies at two study sites not investigated during 1985 field efforts. Indiana bats were captured in two counties (Bond and Pulaski) in Illinois from which they had not been previously reported.

A total of 24 Myotis sodalis were banded during the second year of field work. One Indiana bat banded in 1985 was recaptured during this year, and one banded in May was recaptured in June 1986. Bands were placed on an additional 42 bats of five species as part of long-term studies at one site. One red bat (Lasiurus borealis) banded during 1985 was recaptured in 1986 and one eastern pipistrelle (Pipistrellus subflavus) banded during May 1986 was recaptured nine days later.

Two roost trees utilized by Indiana bats were discovered during the second year of field work. One tree was discovered while routinely examining potential roost trees with a bat detector. The other was located after following a juvenile male that had been equipped with a superminiature radio transmitter.

INTRODUCTION

Myotis sodalis (Indiana bat) has been known from Illinois since it was first described as a new species (Miller and Allen 1928). Until recently, information on Illinois populations was limited to winter studies of one cave in the extreme southeastern portion of the state (Hardin County) and one abandoned mine in north-central (LaSalle County) Illinois (Layne 1958; Hall 1962; Walley 1971; Humphrey 1978). Myotis sodalis have been reported from a cave in Madison County. Winter records from a lead mine in JoDaviess County are over 30 years old. Until recently, only one hibernaculum for Indiana bats was known to occur in Illinois. An additional hibernacula for this species was confirmed during the winter of 1985-86 (IDOC, unpubl. data).

There is a definite lack of accurate data concerning Myotis sodalis summer distribution in Illinois. Previous records range throughout the state, but they probably more closely illustrate individual records and areas that have been sampled selectively rather than meaningful population structures (Figure 1). Juvenile and reproductively active adult female Myotis sodalis have been captured in Adams, Bond, Jackson, Johnson, Perry, Pike, Pulaski, Schuyler, Scott, Union, and Wabash/Edwards counties in Illinois (Brack 1979; Sparling et al. 1979; Gardner and Gardner 1980; Kessler and Turner 1980; Kirkpatrick 1980; Dunstan and Warnock 1981; Gardner and Taft 1984; Gardner et al. 1986; Illinois Department of Conservation (IDOC)/Illinois Natural History Survey (INHS), unpubl. data). Additional Illinois records for the Indiana bat are of migrating individuals or adult males. These records are from Adams, Christian, Cook, Hardin, McDonough, Morgan, and Sangamon counties (Thom 1981; Gardner and Taft 1983; IDOC/INHS, unpubl. data).

Scant information exists on the migration patterns of Illinois Myotis sodalis. Hall (1962) reported the recovery of a female Myotis sodalis banded at Blackball Mine in LaSalle County, Illinois, on 6 December 1958, and recovered at Colossal Cave in Edmonson County, Kentucky, on 18 December 1959. Another Myotis sodalis (sex unknown) was banded at Blackball Mine on 10 November 1963 and was recovered at Palmyra in Marion County, Missouri, on 20 August 1966 (Walley 1971).

Human disturbance has been the single most detrimental factor to declines in hibernating populations of Indiana bats. However, flooding, ceiling collapses, and freezing are all natural disasters that have been responsible for population declines in hibernacula (Hall 1962; Humphrey 1978; Brady 1982). Other factors contributing to the decline of the species include stream channelization, deforestation, and pesticide poisoning. Conlin (1976) reported that 29.7% of the interior streams (or 5,566 km) in Illinois had been channelized by 1976. Deforestation by agricultural clearing, road and utility construction, urban expansions, and a host of other "progress" related developments all adversely impacted the continued existence of Myotis sodalis. Pesticide-induced mortality of insectivorous bats has been documented for other states and undoubtedly has contributed to the decline of Indiana bat summer populations in Illinois (Mohr 1972; Geluso et al. 1976; Clark et al. 1983). Questions still unanswered concern possible impacts from poor water quality and shortages in food sources, which may have even more adverse impacts on Myotis sodalis.

Approximately 70% of the study sites investigated during 1986 field work occurred randomly throughout Illinois and were chosen on the basis of potential for adverse impacts to Myotis sodalis habitat by Illinois Department of Transportation (IDOT)

construction activities. The remaining sites represented initial attempts to collect base-line data on habitat utilization by Indiana bats and to identify areas where in-depth investigations could be focused. Two surface sites and one cave site have data concerning previous captures (or observations) of Myotis sodalis. Efforts to document the occurrence and distribution of Myotis sodalis in Illinois during this project were focused upon filling obvious gaps in the understanding of the distribution of this species (Figure 1).

The primary objectives of this five year project are as follows:

1. To determine the summer distribution of M. sodalis populations in Illinois.
2. To evaluate habitats where M. sodalis are present.
3. To locate a maternity roost site(s) in any area where immature and/or reproductively active females are captured.
4. To gather data on all aspects of M. sodalis ecology in Illinois.
5. To develop management recommendations for habitats utilized by M. sodalis in Illinois.

These objectives will be accomplished with funding provided by the U.S. Fish and Wildlife Service (U.S.F.W.S.), the Division of Natural Heritage (IDOC), and the Bureau of Location and Environment (IDOT). All field work is conducted by personnel from IDOC and the Illinois Natural History Survey. Additional cooperation in this study involves the U.S.F.W.S./Indiana Bat Recovery Team, the Missouri Department of Conservation, and the Iowa Conservation Commission.

Authorization for conducting banding studies of Indiana bats is provided by the U.S. Fish and Wildlife Service in a letter dated 19 May 1986, by adhering to a study description submitted to the Federal Wildlife Permit Office on 28 March 1985. The banding research and this project are conducted under USFWS/IDOC cooperative agreement dated 17 July 1979.

PROCEDURES

Live Capturing Bats

Live capturing bats at surface locations was accomplished by utilizing black nylon Japanese mist nets. These nets are 38-mm mesh and each can be spread to a height of 2.2 m. The nets range in length from 5.5 m to 18.3 m. A pair of 9.2 m high interconnecting poles was used to position nets well above ground level. On such high net sets, four mist nets of equal length were stacked vertically, one on top of the other, and suspended between the poles by a rope and pulley system. The top of the uppermost net could be raised to a height of 9.2 m and lowered easily to retrieve bats captured in upper sections of the nets. Whenever these nets were set over streams, areas were chosen where the trees created a complete, natural canopy. The nets were placed immediately behind, or underneath the canopy to create a netting plane between the water and the tree canopy. Oftentimes, an additional net was placed at water level adjacent to the high net set to completely close off the flyway. Nets were placed in the capture position at sunset and checked at maximum intervals of fifteen minutes until midnight, and sometimes later.

A collapsible, portable trap similar to the one described by Tidemann and Woodside (1978) was used to live-trap bats at cave entrances. Measuring approximately 1.5 meters square, the trap has an aluminum frame with strands of monofilament fishing line suspended vertically under tension. When the trap is positioned in a cave or

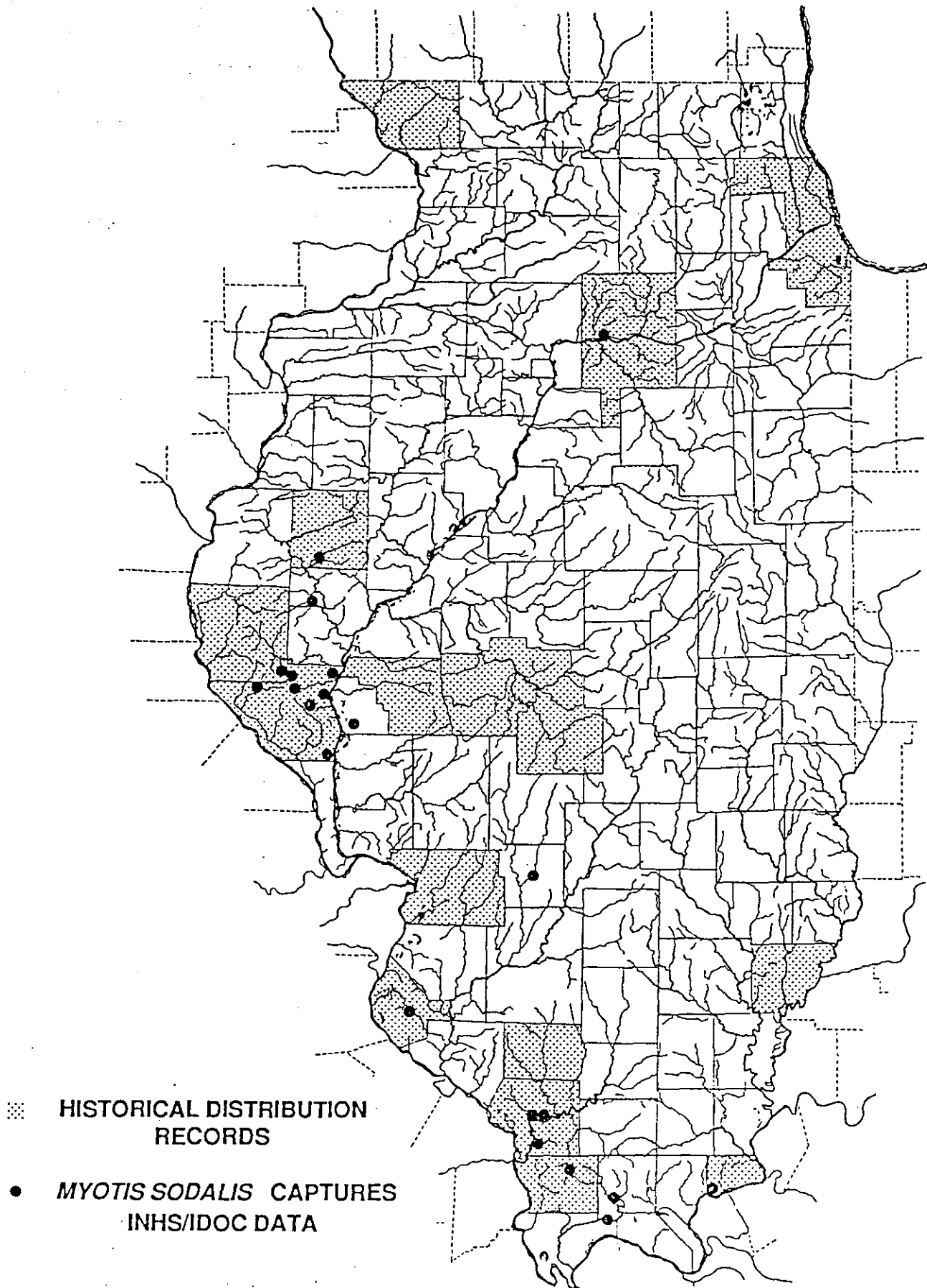


Figure 1. Distribution records of *Myotis sodalis* collected during 1985 and 1986 field work compared to the previously reported historical distribution of the species.

mine entrance or passageway, heavy nylon netting is draped around its edges and attached to the ceiling, walls and floor. This arrangement forces bats to fly towards the monofilament strands, which they cannot detect with their echolocation. Stopped in flight by the strands, the bats falls uninjured into a canvas bag from which they are easily removed.

Data recorded for each bat capture included: species, sex, age (adult or juvenile), reproductive condition, weight, direction and height in the mist net, and capture time. Bats were captured, examined, and immediately released unharmed at site of capture. Environmental factors, such as sky condition, moon phase, temperature, and wind were used to assess bat activity and capture success. Age was determined by the degree of closure of the phalangeal epiphyses. Bats were designated as juvenile by their small overall size and incomplete ossification of the epiphyses.

Reproductive condition of males was determined by size and position of the epididymides. Scrotal bats were characterized by enlarged, or swollen, epididymides in pigmented sheaths dorsolateral to the tail. Enlarged testes usually accompany descended epididymides. Female bats were diagnosed as lactating, or post-lactating, on the basis of teat examination. Pregnant females were examined and their condition diagnosed by gently palpating the fetus through an obviously enlarged abdomen (care must be taken not to mistake a food-distended stomach for a fetus), or by body weights characteristic of pregnancy.

Observations of early foraging activity by bats were conducted at each netting locality. These observations provided valuable data on time of initial bat flight, as well as location of bats in relation to the tree canopy when they first emerged. Foraging behavior of the bats can be observed in this manner, and can be used to aid in evaluations of capture success and significance of foraging areas. In addition to visual observations, activity of bats was monitored with QMC S200 and "Mini" bat detectors.

Potential roost trees were located and investigated within each study area. Trees were determined to offer adequate roosting sites for certain bat species based on their structural characteristics. Potential roost trees are usually mature (over 40 cm dbh) with at least some senescent portions. Although cavities provide an obvious access for bats into hollow bole portions, trees with exfoliating sheets of bark are considered to provide more favorable roost structures. The Indiana bat (*Myotis sodalis*) is known to establish maternity roosts beneath the loose bark of trees (Cope et al. 1978; Humphrey et al. 1977; INHS/IDOC, unpubl. data).

Habitat evaluation

Vegetation analysis at roost sites includes a detailed evaluation of the overstory, understory, and the herbaceous layer. The methodology for each is detailed below.

Point-centered quarter method - overstory analysis

Random points are located along the flyway. The area around each point is divided into four 90° quarters of the compass, and the nearest tree in each quarter is sought. Each tree is identified to species, its basal area is measured, and its distance from the random point is measured. Average distance for all trees taken together is computed and this is converted to total density by the equation: $Density = \frac{10000}{(Ave. dist., in m.)^2}$

Relative density of each species is calculated by the equation

$$\text{R.D. of Species A} = \frac{\# \text{ of trees of Species A}}{\text{Total \# of Trees}} \times \text{Density}$$

Cover or dominance of each species is calculated by the equation

$$D = \text{rd} \times \text{average basal area.}$$

Five meter circular quadrant - understory analysis

Random points are located along the flyway. A five meter circular plot is centered around the point. All sapling were counted and identified to species.

Relative and Absolute Densities were then calculated.

Point method - herbaceous layer analysis

In this method a frame is constructed which rigidly limits ten pins, each one decimeter apart, to a vertical path perpendicular to the ground. The frame is located at random points along the flyway.

As the pin is lowered, the first plant it touches is recorded, then the pin is lowered more until it touches another plant part, and so on until bare ground is reached. If no plant is hit, the point is recorded as bare ground.

These data permit two calculations.

- i. $\% \text{ cover} = \frac{\# \text{ pins which hit Species A at least once}}{\text{Total \# of pins}} \times 100$
- ii. $\% \text{ Sward} = \frac{\# \text{ of contacts with Species A}}{\text{Total \# of Contacts}} \times 100$

RESULTS

Capture Data

Capture data for the 1985 field season is summarized in a previous report (Gardner 1985). During the 1986 field season, extending from 24 April through 10 September, 36 surface sites were mist netted for bats (Figure 2). These activities resulted in 40 successful capture nights and seven nights with no captures. An additional three nights were devoted to trapping bats at two cave entrances. These combined efforts resulted in the captures of 456 bats (273 surface mist netting captures; 183 cave captures) (Table 1). Ten species of bats were represented in these captures. Of special interest was the capture of 25 Myotis sodalis from surface sites in four Illinois counties. Trapping the two cave entrances resulted in capturing three Myotis sodalis from one cave in Hardin County.

Pregnant or lactating adult female and/or juvenile Myotis sodalis were captured at six of the 36 surface mist netting sites. Adult male Indiana bats were captured at two of these six sites. One site (Fishhook Creek) was sampled repeatedly throughout the summer, accounting for 17 of the 25 Myotis sodalis captured at surface sites during the 1986 field season. The first four pregnant females were captured on 13 May, and were followed by captures of lactating females during June (Table 2). One nonreproductive adult female captured on 13 May may have been pregnant,

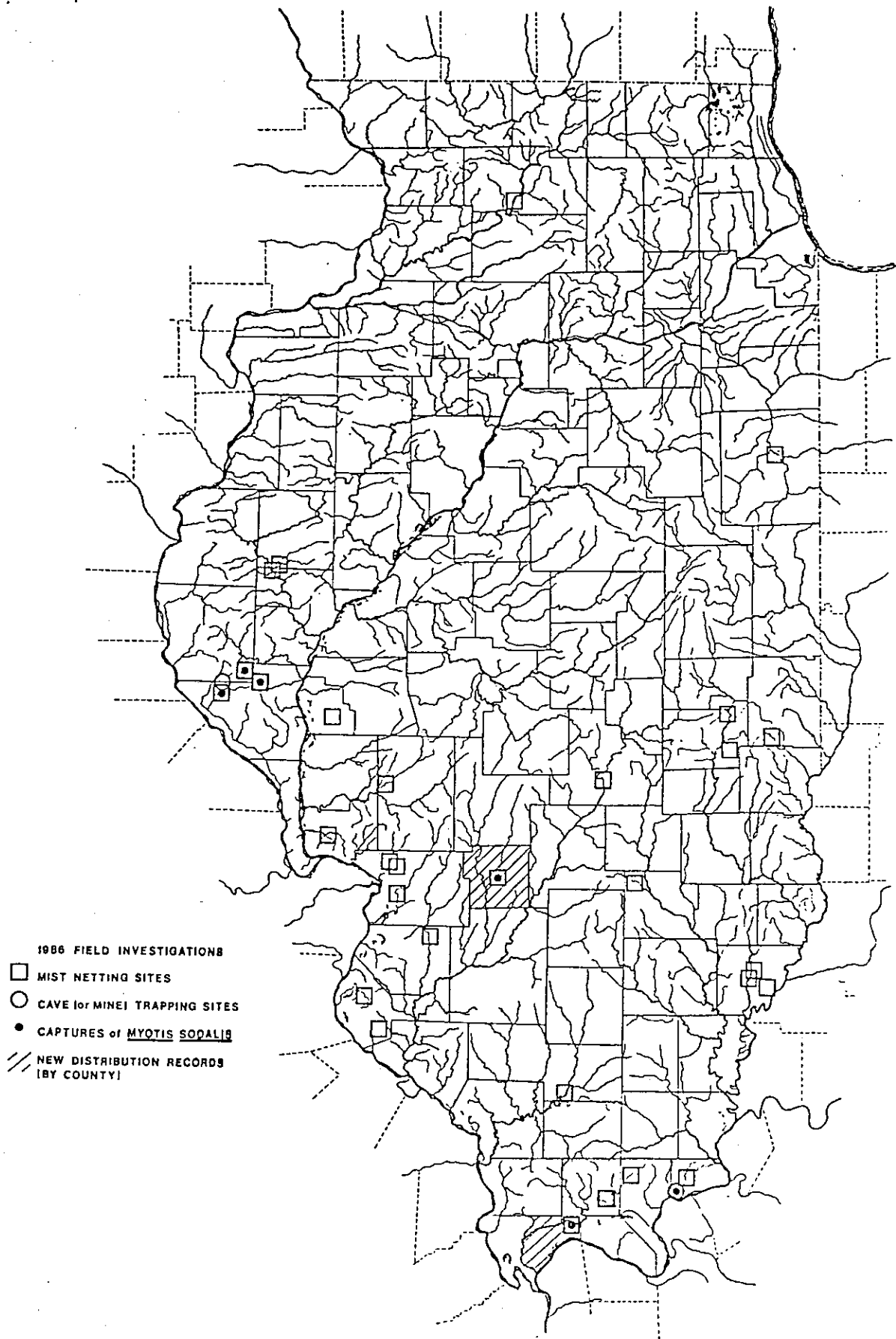


Figure 2. Captures of *Myotis sodalis* in relation to locations of mist netting sites and cave trapping sites during 1986 field investigations. (More than one mist netting site may be indicated by a single symbol.)

but her weight was 7.0 grams (compared to the 8.0 gram weights of the four obviously pregnant females captured that same night).

Table 1. Numbers of each species of bat captured during 1986 in Illinois.

Species	Captured on Surface	Captured at Cave Entrances	Total Captured
<u>Myotis sodalis</u>	25	3	28
<u>Myotis grisescens</u>	1	-	1
<u>Myotis lucifugus</u>	19	12	31
<u>Myotis keenii</u>	21	72	93
<u>Myotis</u> * sp.	3	-	3
<u>Pipistrellus subflavus</u>	58	96	154
<u>Eptesicus fuscus</u>	31	-	31
<u>Lasiurus borealis</u>	108	-	108
<u>Lasiurus cinereus</u>	3	-	3
<u>Nycticeius humeralis</u>	3	-	3
<u>Plecotus rafinesquii</u>	1		1
Total	273	183	456

*escaped from net before handling

Table 2. Sex, age and date data for Myotis sodalis captured at Fishhook Creek, Pike County, Illinois during 1986.

Date (1986)	Adult Female				Juvenile Female	Adult Male		Juvenile Male
	NR	Pg	L	PL	NR	Scr	NR	NR
13 May	1	4						
14 May		4						
22 May		1						
11 June			2				1	
26 June			1				1	
4 September					1			
10 September								1

NR=nonreproductive; Pg=pregnant; L=lactating; PL=post-lactating; Scr= scrotal

Extensive searches for and examinations of potential maternity trees in the Fishhook Creek study area were successful in 1986. On 14 May, an Indiana bat maternity roost tree was discovered at Fishhook Creek. This tree, a dead northern red oak (Quercus rubra), was situated at the base of a south-facing slope along a small, narrow, intermittent tributary of Fishhook Creek, 300 m from the creek itself. The bark on the lower portion of the main trunk was split open and in the process of exfoliation. Three of an estimated 15 bats were captured as they emerged from the tree and began foraging. The captured bats were pregnant Myotis sodalis. Bats were entering and leaving through a horizontal slit less than 2 cm wide in the bark occurring approximately 5 m above the ground. Numerous shagbark hickories in the immediate vicinity could serve as potential alternate roosts. Dominant canopy species surrounding the roost tree were walnut, shingle oak, and other hickory. Another roost tree, a 45 cm dbh dead cottonwood, was discovered in a small area of bottomland forest bordering the creek on 5 September, within the same 1.75 km segment of Fishhook Creek.

The occurrence of a nearby Myotis sodalis maternity colony was strongly suggested by the capture success from at least two new sites in Illinois which were not investigated during 1985 (Bond and Pulaski counties). Two lactating adult females and 3 juvenile females were captured during one night of mist netting in the Bond County site. A juvenile male was captured in Pulaski County.

Banding Data

Specific banding data are submitted to the National Fish and Wildlife Laboratory (USDI, Fish and Wildlife Service, National Museum of Natural History, Washington, D.C.), Indiana/Gray Bat Recovery Team, and to other states cooperating in this project. Of the total 28 Myotis sodalis captured during the 1986 field season, 24 were banded. Two Indiana bat captures represent recaptures. One bat which was banded at a cave during 1985 was recaptured at the same cave during June 1986. Another bat was banded at a surface location in May 1986 and recaptured at the same location the following June.

Bands were placed on an additional 42 bats of five species (including one Myotis grisescens). Except for the single gray bat captured in southern Illinois, banding of species other than Indiana bats was limited to bats captured during repeated sampling of Fishhook Creek (Tables 1 and 3). One Lasiurus borealis banded at Fishhook Creek during 1985 was recaptured in 1986, and one Pipistrellus subflavus banded at Fishhook Creek during May 1986 was recaptured at the same site nine days later.

As per the terms of the U.S. Fish and Wildlife Service banding authorization, Indiana bats were not banded during arrival at hibernacula. However, during the regularly scheduled biennial census of Fogelpole Cave, 23 bats banded at the cave entrance during September 1985 were observed scattered among the clusters of bats totaling 403.

Table 3. Data for species of bats banded and recaptured at Fishhook Creek, Pike County, Illinois, during 1986.

Species	Banded on Surface	Color	Numerical Sequence(s)	Recaptures
<u>Myotis sodalis</u>	23	Orange	38-60	46
"	1	White	1	
<u>Myotis keenii</u>	4	Dark Green	10,11	
"	2	Dark Pink	4,11	
<u>Pipistrellus subflavus</u>	18	Light Green	16-33	16
<u>Eptesicus fuscus</u>	4	Dark Blue	11-14	
<u>Lasiurus borealis</u>	13	Black	28-30, 32-41	4

Vegetation Data

Analysis of vegetation during the reporting period was limited to the northern red oak (Quercus rubra) roost site. Ninety percent (90%) of the ground had herbaceous cover. A shrub (Symphoricarpos orbiculatus) and two species of sedges (Carex albolutescens and C. pennsylvanica) comprised 83.4% of the herbaceous cover (24.8%, 28.3%, and 30.3% respectively).

The absolute density of saplings in the understory was 77/100 m². Eleven species were present in the understory. Relative densities in the understory were highest for white ash (Fraxinus americana), slippery elm (Ulmus rubra), shingle oak (Quercus imbricaria), shagbark hickory (Carya ovata), and white oak (Q. rubra).

The absolute density of trees in the overstory was 3.7/100 m². Twelve species were present in the overstory. Black walnut (Juglans nigra), shingle oak, and northern red oak (Q. rubra) dominated the overstory.

DISCUSSION

Humphrey (1978) favored research on the biology of small populations of Myotis sodalis because he felt that such populations may become increasingly important in management of the species if larger populations continue to be threatened. Efforts during this reporting period have indicated that:

1. Banding studies may yield valuable information on the species' movements between winter and summer habitats. These efforts have already yielded data concerning the philopatry of Myotis sodalis,
2. The use of technologically advanced radio telemetry and ultrasonic sound detection equipment coupled with traditional capture techniques facilitates the location of summer roost sites of the Indiana bat.

Studies during 1986 of Myotis sodalis summer habitat in Illinois already has resulted in the discovery of two new maternity areas in addition to the three new areas discovered during 1985 field work. This project has documented the establishment of a Myotis sodalis maternity colony in one area for three consecutive years and in another area for two consecutive years. The recovery of a banded Indiana bat in the same summer habitat during the same year further substantiated site loyalty. The high potential for recovery of banded bats returning to summer habitat will provide data on habitat selection and site loyalty on an annual basis.

Efforts during the 1987 field season will involve a continuation of the telemetry study of the Fishhook Creek maternity population. This effort will provide data on home range size, roost selection, preferred foraging habitat, and temporal patterns of activity. Additional sampling activities will be targeted at locating other summer roost locations elsewhere in Illinois. Once additional sites are located, it will be possible to begin a comparative analysis of the locations in order to determine what site specific characteristics (e.g. vegetation, stream characteristics, geographical setting) provide suitable roost/foraging habitat for the Indiana bat.

The ultimate goal of this five year effort is to utilize the results to develop criteria for conducting habitat evaluations and assessing potential negative impacts to Myotis sodalis maternity populations due to habitat disturbance, alteration, and destruction.

ACKNOWLEDGEMENTS

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