MOVEMENTS OF *MYOTIS LUCIFUGUS LUCIFUGUS* FROM A COLONY IN LASALLE COUNTY, ILLINOIS

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ABSTRACT. — The movement pattern of *Myotis lucifugus* banded at Blackball Mine, 1.75 miles West of Utica, LaSalle Co., Illinois during winter, and recovered elsewhere during the summer is summarized. Dispersal is shown to be closely correlated with the Illinois River waterway. Data on distance traveled, seasonal movement, and degree bearing are recorded for both *M. lucifugus* and *M. sodalis*.

Considerable scientific literature reporting homing ability and possible use of vision in orientation of bats has been published in the past decade. Few studies regarding routes of travel, and nothing regarding seasonal migration of *Myotis lucifugus* in Illinois have been reported.

The possible use of rivers as flyways for bats has been postulated by Hall (1962) for *Myotis sodalis* in Illinois, Indiana and Kentucky. Humphrey & Cope (1964) hypothesize that *M. lucifugus* follows a route along the line of caves in which they hibernate in southern Indiana. Hassell & Harvey (1965) in testing Hall's idea postulate that waterways as routes of travel for *M. sodalis* taken in Kentucky, and released in Ohio, North Carolina, and Kentucky are not necessary for successful homing.

The present study was primarily concerned with migration, although it yielded other information on the winter population of this species.

METHODS AND MATERIALS

From 1961-1968, over 12,000 bats, of which 7,873 were *M. lucifugus* were banded at Blackball Mine, 1.75 miles west of Utica, LaSalle Co., Illinois. The majority of the visits were made from fall to spring, although occasional visits were made during the summer months. The commonly used band was No. 2, furnished by the U.S. Fish and Wildlife Service. A few 1-B bands were also used at the beginning of this project.

For each bat the path traversed was plotted as a straight line distance between the colony and point of recapture. This line denotes the direction of movement, although there is no implication that this is the actual route followed by the bat. Spring and fall recoveries are pooled, as no differences in flight pattern are apparent.

For each recovery the degree bearing was tested by using the Rayleigh Test (Batschelet, 1965) with a cut-off criterion of $P = 0.1$. Mean direction ϕ, and mean angular deviation, S, were calculated by vector analysis (Batschelet, *ibid*).

OBSERVATIONS

Blackball Mine was mined by the Illinois Hydraulic Cement Manufacturing Company in the early 1900's.

The mine covers approximately 40 acres of subterranean passages (Hall, 1962), with entrances facing north, south and west.

The Illinois River closely parallels Blackball Mine, and from its origin, fifty-miles southwest of Chicago, flows almost due west (270° mean direction) for some sixty miles, to a point not far from Hennepin, where it turns abruptly, flowing southwest by south a hundred and sixty-five miles (220° mean direction) to its union with the Mississippi (Pickels & Leonard, 1929).

Females are the first to leave Blackball Mine in Spring. The exodus begins about the third week in April, and appears fairly rapid, as males represent 85-94% of the remaining population during May and early June. This closely agrees with Davis & Hitchcock (1965) and Barbour & Davis (1969) for the New England States.

The recovery rate of *M. lucifugus* banded in winter and recovered in summer is low. Of 7,873 (plus 841 banded by Dr. Wayne H. Davis in 1954) banded at Blackball Mine in winter, only 38 were recovered in summer, Table 1). This can be accounted for by not having found summer colonies within north-central Illinois. All recoveries are based on reports submitted by private individuals to the U. S. Fish & Wildlife Service. These returns varied from 2 miles to 105 airline miles, the average distance being approximately 25.6 miles.

The average minimum age of bats recovered was 2 years and the greatest minimum age was 11.7 years, in a specimen banded by Wayne H. Davis, 2 February 1954, and recovered at Henry, Marshall County, Illinois in August 1965, 24 miles from the place of banding.

Rather than dispersing generally over Illinois, *M. lucifugus* banded at Blackball Mine disperse in a fairly direct west southwest to south-southwest pattern. This pattern is closely correlated with the Illinois River watershed (Fig. 1).

Of the 38 recoveries one was taken outside the Illinois River watershed. This was a male banded 11 May 1963, and recovered 12 miles north of Mt. Carroll, Jo Daviess, 14 July 1964, within the Mississippi River drainage system. Two additional recoveries from Ottawa, LaSalle Co., and one from Marseilles, LaSalle Co., are within the 90° bearing, also corresponding with the Illinois River watershed.

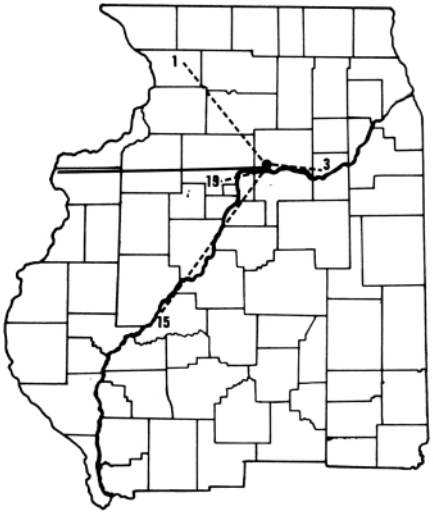

FIGURE 1. Movement pattern of 38 *Myotis lucifugus* banded in winter at Blackball Mine, LaSalle Co., Illinois, and recovered in summer. Numbers represent number of individuals taken at each recovery site. Double line represents Illinois-Michigan Canal, while solid line denotes the Illinois River.

TABLE 1.—Bat Recoveries.

Band No.	Date Banded	Date Recovered	Locality	Age	Distance Traveled	Sex
East:						
60278662	10–20–63	10–00–64	Ottawa, LaSalle Co.	1 yr.	10 mi.	M
60223024	10–22–61	09–07–67	Ottawa, LaSalle Co.	6 yrs.	10 mi.	M
64273983	11–08–64	09–00–65	Marseilles, LaSalle Co.	1 yr.	17 mi.	M
Northwest:						
60223913	05–11–63	07–14–64	Mt. Carroll, Jo Daviess Co.	1 yr.	75 mi.	M
West South West:						
05490379	02–20–54	08–28–64	Tiskilwa, Bureau Co.	10 yrs.	26 mi.	M
64273552	11–07–64	04–25–64	LaSalle, LaSalle Co.	1 yr.	2 mi.	M
00714133	10–18–68	09–00–69	LaSalle, LaSalle Co.	1 yr.	2 mi.	F
00713772	10–18–68	07–24–69	LaSalle, LaSalle Co.	1 yr.	2 mi.	M
00714991	10–18–68	04–30–69	Hennepin, Putnam Co.	1 yr.	18 mi.	F
64274362	10–20–63	06–04–69	Hennepin, Putnam Co.	6 yrs.	18 mi.	F
60223258	04–15–62	02–00–65	Hennepin, Putnam Co.	3 yrs.	18 mi.	M
64274033	10–20–63	09–16–65	Hennepin, Putnam Co.	2 yrs.	18 mi.	F
60223741	09–29–62	08–18–65	Hennepin, Putnam Co.	3 yrs.	18 mi.	M
64272239	11–09–63	02–16–64	Peru, LaSalle Co.	1 yr.	9 mi.	F
64274554	11–07–64	10–26–66	Peru, LaSalle Co.	2 yrs.	9 mi.	F
05419142	02–20–54	06–10–54	Washburn, Woodford Co.	4 mo.	33 mi.	M
60223202	11–05–61	09–23–63	Lake Depue, Bureau Co.	2 yrs.	16 mi.	F
64272759	11–10–63	06–15–64	Elmore, Peoria Co.	1 yr.	66 mi.	F
60278926	11–09–63	07–00–64	Putnam, Putnam Co.	1 yr.	21 mi.	M
64272563	11–09–64	07–00–65	Bureau, Bureau Co.	2 yrs.	18 mi.	M
60278612	10–20–63	08–16–65	Buda, Bureau Co.	2 yrs.	33 mi.	M
00549032	02–20–54	07–12–55	Bureau, Bureau Co.	1 yr.	18 mi.	M
60278252	05–11–63	06–02–63	Princeton, Bureau Co.	1 mo.	24 mi.	M
South South West:						
60223534	04–15–62	09–12–63	Lacon, Marshall Co.	1 yr.	30 mi.	F
64274744	11–07–64	05–15–66	Lacon, Marshall Co.	2 yrs.	30 mi.	F
60223822	09–29–62	10–17–63	Rome, Peoria Co.	1 yr.	42 mi.	F
64273496	11–07–64	05–00–66	McNabb, Putnam Co.	2 yrs.	15 mi.	M
60278629	10–20–63	06–14–64	McNabb, Putnam Co.	1 yr.	15 mi.	M
00713710	10–18–68	05–20–69	McNabb, Putnam Co.	1 yr.	15 mi.	M
60223582	04–22–62	08–23–62	Peoria, Peoria Co.	4 mo.	51 mi.	F
64274100	10–20–63	05–20–67	Peoria, Peoria Co.	4 yrs.	51 mi.	F
05419005	02–20–54	09–00–65	Henry, Marshall Co.	11 yrs.	24 mi.	M
64273478	11–07–64	06–09–65	Henry, Marshall Co.	1 yr.	24 mi.	M
06505365	04–22–62	08–23–62	Henry, Marshall Co.	4 mo.	24 mi.	F
60223319	02–04–62	05–30–62	Henry, Marshall Co.	3 mo.	24 mi.	M
00549008	02–20–54	05–03–54	Washburn, Marshall Co.	3 mo.	33 mi.	M
00713889	10–18–68	07–00–69	Bath, Mason Co.	1 yr.	105 mi.	F
00714706	10–18–68	08–22–69	Chillicothe, Peoria Co.	1 yr.	40 mi.	F

Two living bats recovered during February may possibly be explained by these bats wintering elsewhere, or possibly moderate weather during February of 1964-5 had some effect on the movement of these bats. Both localities, Hennepin, Putnam Co., and Peru, LaSalle Co., are within several hours flight from Blackball Mine, and easily traversed in an evenings flight. During May through July males represented 76

percent of the recoveries, which may be accounted for by the females being in established maternity colonies. During August recoveries were near the 50-50 ratio, while from September through October, females represented 61.5% of the recoveries. This can be accounted for by breaking up of maternity colonies, and movement becoming more leisurely. Also males are already returning to winter quarters during August and September (Fig. 2). This is in close agreement with Davis & Hitchcock (1965).

Previous studies on bat migration either show a northward movement in spring, or erratic pattern in any direction. Davis & Hitchcock (1965) found that the majority of the bats banded in Aeolus Cave, Vermont moved in a narrow southeastern pattern, although occasional individuals were recovered in all other directions except southwest. This is the first report of a southwestern movement pattern for *M. lucifugus* leaving winter quarters.

It is apparent that in this study there is a definite correlation between points of recovery and the Illinois River. Essentially all of the bats recovered were from WSW to SSW directions (Fig. 1) with three individuals deviating to the east, and one to the northwest. Due to the abrupt change in the course of the river, individuals were divided into two groups, those recovered from a WSW direction and those from a SSW direction. The WSW direction is correlated with the Illinois River flow to Hennepin (mean 270°) where it abruptly turns towards the SSW. Fifteen (39.5 percent) of 38 bats were recovered from this bearing. The mean angle, 261.93° is significant at the one percent level. Nineteen, 50 percent were recovered from a SSW bearing, with a mean angle 219.66°. The SSW individuals are correlated with the river flow from Hennepin to its mouth (mean 220°). The WSW and SSW bearings represent 89.5 percent of the recoveries. The mean direction for all recoveries 243.15° with an angular deviation of 24.7° also is significant at the one percent level (Table 2).

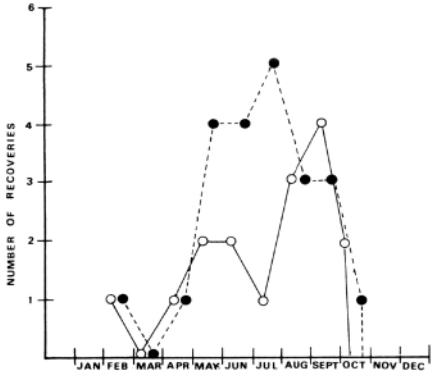

FIGURE 2. Monthly recoveries of *Myotis lucifugus* taken in Illinois. See text.

It is interesting to note that none of the recoveries is from known summer colonies, but apparently represents transitory individuals. All persons reporting recoveries were contacted, and replies reported only straggler individuals.

Hall (1962) reported on one specimen of *M. sodalis* banded at Blackball Mine, and recovered at Colossal Cave, Edmonson Co., Kentucky. This single report lends little support of the possible use of rivers as flyways for *M. sodalis* in Illinois. Another specimen of *sodalis* banded by the author at Blackball Mine,

TABLE 2.—Recovery directions of *Myotis lucifugus* correlated with the flow of the Illinois River.

	Entire Sample	S.S.W. Sample	S.W. Sample
No. of Recoveries	38	15	19
Mean Direction Ø	243.15°	219.66°	261.93°
Angular Deviation S	24.7 °	10.27°	15.82°
Rayleigh Test			
Z Value	27.97	14.52	17.57
P Value	.01	.01	.01

10 November 1963 was taken three years later at Palmyra, Marion Co., Missouri, 20 August 1966, 230° WSW, and 156 miles from the point of banding. Hall felt that no movement took place between Illinois populations of *M. sodalis* and the Ozark area of Missouri. The present recovery tends to show a greater dispersal pattern than was previously hypothesized.

The Illinois-Michigan Canal possibly also plays a significant role in migration of *M. lucifugus* and *M. sodalis*. Three recoveries of *lucifugus* from Tiskilwa, Buda, and Princeton, Bureau Co., Illinois, all border the canal, which also parallels the Illinois River, and extends to the Mississippi River. This would greatly aid *sodalis* in migration from Missouri, and possibly accounts for the small population of *sodalis* in Central Illinois.

Several other factors possibly play important roles in the dispersal pattern of *lucifugus* and *sodalis* in Illinois: 1) Less than one percent of northern Illinois is forested, and all this territory borders major streams. This affords adequate roosting sites for migrants. 2) Assuming that the first human communities in Illinois were established on major waterways, this would provide many older dwellings which are more suitable quarters for summer colonies. On straying away from major waterways in Illinois, bats would be confronted with miles of cultivated fields, and small communities consisting of relatively new homes which would not provide suitable roosting sites for summer colonies.

Topographic features have been shown to aid *M. lucifugus* during spring and fall migration in Indiana (Humphrey & Cope, 1964). In Illinois all major cave systems border major streams (Bretz & Harris, 1961), which would account for all major winter quarters also being restricted to bordering waterways.

SUMMARY

This paper summarizes the movement pattern of *M. lucifugus* from winter to summer in north-central Illinois. The recoveries show a di-

rect WSW to SSW pattern of dispersal, closely correlated with the Illinois River.

Statistical analysis (Table 2) indicates the WSW, SSW, and entire sample bearings are highly significant at the .01 level. Three individuals recovered from the east also fall within the 90° bearing, which also is closely correlated with the rivers course from the east.

It was previously felt that no movement took place between Illinois populations of *M. sodalis* and the Ozark area of Missouri. A recent recovery from Missouri shows a greater dispersal pattern than was previously hypothesized.

The greatest distance traveled by *M. lucifugus* was 105 airline miles, with an average of 25.6 miles. The Blackball Mine population is probably restricted to within a 150 mile radius. No apparent movement takes place between this mine population and either the extreme southern Illinois or northwestern Illinois populations.

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