COMPARATIVE METHODS OF TRAPPING SMALL MAMMALS IN AN ILLINOIS WOODS

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The two basic methods for censusing small mammals are live-trapping and snap-trapping. Because of its relative convenience, the latter method is the one most commonly used. However, Bole (1939) has reported an inverse relationship between the size of the sample area snap-trapped and the population density obtained, suggesting a possibility of serious error in the method.

Stickel (1946) attempted to determine the magnitude of error involved, if any, in an experiment in bottomland forest on the Patuxent Research Refuge, Maryland, in September, 1945. She live-trapped a circular 17-acre area for 7 nights with 293 Sherman metal box traps spaced at 50 foot intervals. Following this, a circular acre in the center of the 17-acre area was snap-trapped for 3 nights with 200 traps. Live-trapping indicated a density of 6 to 7 white-footed mice (*Peromyscus leucopus noveboracensis*) per acre; snap-trapping, 23 per acre. The population density obtained by snap-trapping appeared to be significantly erroneous. Therefore, she concluded that densities obtained by snap-trapping should be used only as relative indices.

Other workers drew conclusions that were contradictory to Stickel's. Goodnight and Koestner (1942) compared live-trapping and snap-trapping on two plots of Illinois prairie and concluded that, in general, 6 to 7 days were required to determine the population density by live-trapping, with 3 days of snap-trapping giving the same density. However, their plots were only 62½ meters long by 10 meters wide, and their conclusions were based on cumulative totals of 7 species. Also, spacing of live-traps and snap-traps was alike.

Buckner (1957) compared live-trapping and snap-trapping in southeastern Manitoba. He used three trapping methods: live-traps set with a 66 foot grid spacing, snap-traps with the same spacing, and a standard line of snap-traps. He concluded that the results of all three methods were reliable, except that, perhaps due to habitat conditions, snap-trapping in early summer gave a population density only one-half that of live-trapping. No white-footed mice were taken in his study.

Wetzel (1949) made several comparisons of live-trapping and snap-trapping in undisturbed woods near Champaign, Illinois. His methods were essentially similar to those of Stickel. His results, however, were directly contradictory. He found the population densities of white-footed mice obtained by live-trapping and snap-trapping to be nearly identical.

In view of these findings, the present study was undertaken to obtain additional evidence concerning the reliability of population densities obtained by snap-trapping. Field work involving live-trapping of 13.9 acres was carried out in an upland deciduous woods in Illinois in July and August, 1960. *Peromyscus leucopus noveboracensis* was used as the experimental animal.

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STUDY AREA

Geographic location and climate. The tract of land comprising the study area is the E½, SE¼, SE¼, Sec. 1, T.8N., R.6E., in the northeastern part of Effingham County, in south-central Illinois. The latitude is 37°10′ N; the longitude, 88°28′ W. The Shelbyville glacial moraine, the dividing line of the dark soils to the north and the light soils to the south, is 20 miles north of the area. Drainage is to the Little Wabash River and thence into the Wabash and Ohio rivers.

The climate is characterized by a wide range of temperatures. The maximum summer temperature is 100° F or more. During the summer, there are often extended periods of hot, dry weather. The minimum winter temperature may be below -10° F. The temperature may fluctuate widely during the winter, with an occasional extended cold spell. The average monthly temperature of January is 31.5° F; that of July, 77.4° F (Illinois Climatological Data, 1958). These represent the low and the high average monthly temperatures. The average annual rainfall is about 40 inches. The high average monthly rainfall (4.51 inches) occurs in June; the low (2.16 inches), in December (Illinois Climatological Data, 1958).

Geologic history, topography, and soil types. The present appearances and characteristics of the study area resulted primarily from the effects of Pleistocene glaciation. Of the four advances of the ice-sheet into Illinois during the Pleistocene, only the third, or Illinoian, reached the study area. It left drift deposits that constitute the present subsoil. The topsoil is formed of loess deposits blown in during interglacial periods. It varies in thickness, but averages only a few inches.

Drainage of the area occurs in 3 directions. To the south, drainage occurs through an east-west ditch, with two fingers extending 300 to 500 feet northward. A large percentage of the remaining area drains westward to the creek. Some drains northward through a shallow ravine extending to the creek. A small area near the center is relatively flat. The greatest difference in ele-

vation is about 30 feet, the highest elevation being a little more than 600 feet above sea level.

Management history. The study area has been the property of the present owners for 35 years. During that time, it has never been pastured and none of the boundaries have been fenced. Occasionally some of the larger trees were cut for lumber. Even then, only the logs were removed from the woods, the rest of the tree being left to rot. Dutch elm disease has caused high mortality to the American elms. High winds annually bring down many of these dead elm trees along with other branches and trees. As a result of wind action and logging operations, a great amount of rotting debris is scattered throughout the woods. A system of logging roads, most of it overgrown with herbs and small saplings, branches out from an exit located near the center of the eastern border of the woods.

Fauna. No attempt was made to define the invertebrate community. Vertebrate species observed during the trapping operations were listed. The Fowler toad (*Bufo woodhousei fowleri*) and the leopard frog (*Rana pipiens*) were the only amphibians noted. The eastern box turtle (*Terrapene carolina*) and the five-lined skink (*Eumeces fasciatus*) were the commonly observed reptiles. The avian species noted most often was the tufted titmouse (*Parus bicolor*). The cardinal (*Richmondena cardinalis*), blackcapped chickadee (*Parus atricapillus*), blue jay (*Cyanocitta cristata*), white-breasted nuthatch (*Sitta carolinensis*), whip-poor-will (*Caprimulgus vociferus*) and red-bellied woodpecker (*Centurus carolinus*) were also commonly observed.

Three species of mammals were caught in the live-traps: white-footed mouse (*Peromyscus leucopus noveboracensis*), short-tailed shrew (*Blarina brevicauda*) and eastern chipmunk (*Tamias striatus*). Individuals of three other species, the eastern cottontail (*Sylvilagus floridanus*), eastern gray squirrel (*Sciurus carolinensis*) and eastern fox squirrel (*Sciurus niger*) were observed. Four species were known by sign only. These were the red fox (*Vulpes fulva*), striped skunk (*Mephitis mephitis*), opossum (*Didelphis marsupialis*) and raccoon (*Procyon lotor*). The southern flying squirrel (*Glaucomys volans*) has occasionally been observed during logging operations.

Flora. A dense stand of shrubs and trees was present over most of the study area. White oak (*Quercus alba*), black oak (*Quercus velutina*), shagbark hickory (*Carya ovata*), bitternut hickory (*Carya cordiformis*) and green ash (*Fraxinus pennsylvanicus*) were the dominant tree species. Other species were present, but insignificant as regards crown cover. Poison-ivy (*Rhus radicans*) was the most prevalent shrub, occurring in dense patches, as scattered erect plants, and as climbing vines. Other common shrub species were buckbrush (*Symphoricarpos orbiculatus*), Virginia creeper (*Parthenocissus quinquefolia*) and riverbank grape (*Vitis riparia*). White snakeroot (*Eupatorium rugosum*) was the most prevalent herb, being present over most of the area. Other common herbs were the Virginia knotweed (*Poly-*

gonum virginianum), false Solomon's-seal (*Smilacina racemosa*), mayapple (*Podophyllum peltatum*) and common wood-sorrel (*Oxalis cymosa*).

Materials and Methods

Traps and baits. Two types of live-traps were used in this study. One was constructed mostly of wood, with a hardware cloth top and galvanized metal door. The trigger mechanism was of the type described by Fitch (1950). The other was constructed of hardware cloth. Its trigger mechanism was a modified and improved version of the former, a swinging hardware cloth partition and brass wire fulcrum replacing the heavy wire mechanism. No more than 6 of the latter type were used at any one time. Museum Special snap-traps were used.

Preliminary trapping to find a convenient and effective bait was begun on July 1. After 4 days of experimental trapping, shelled corn soaked in peanut oil was determined to be a suitable bait for the live-traps. To have a somewhat comparable bait for the snap-traps, cornmeal, mixed with peanut oil to a crumbly consistency, was used.

Trap layout. All of the live-trap locations employed during this study are shown in Figure 2A. For convenience, all of the locations are shown as spaced at 50 foot intervals. Such preciseness was not the case, however, for no attempt was made to space the traps at exact 50 foot intervals. The trap locations were marked by means of strips of white cloth hung from convenient branches. When setting the traps, they were not all set just below the markers, but at favorable locations within 10 feet. There were 242 trap locations, but no more than 177 were utilized at any one time. Total effective coverage was 13.9 acres, each trap location being assigned an area of 2500 square feet.

The location of the circular acre in which snap-trapping was carried out is also shown in Figure 2A.

Field techniques. Marking was accomplished by clipping the distal 2 joints of a toe, or combination of toes, on the front feet. Age was determined by use of the juvenile molt pattern described by Gottschang (1956). Three age classes were recognized: juveniles — those not yet starting the juvenile molt; subadults — those in the process of the juvenile molt; adults — those having completed the juvenile molt. Two breeding conditions were recognized for males: testes descended and testes not descended. Three breeding conditions were recognized for females: not visibly pregnant, pregnant and nursing.

Trapping methods. The essence of the trapping procedure was to live-trap a large area until the apparent home range of supposedly all the individuals was known, and then to snap-trap a central acre for a 3-day period. In live-trapping, the traps were set in late afternoon or early evening and checked the following morning, at which time they were snapped. The decision to leave the traps unset during the midday was influenced by two factors. Ants quickly carried off unprotected bait. With the traps closed, it was not possible for the ants to remove the

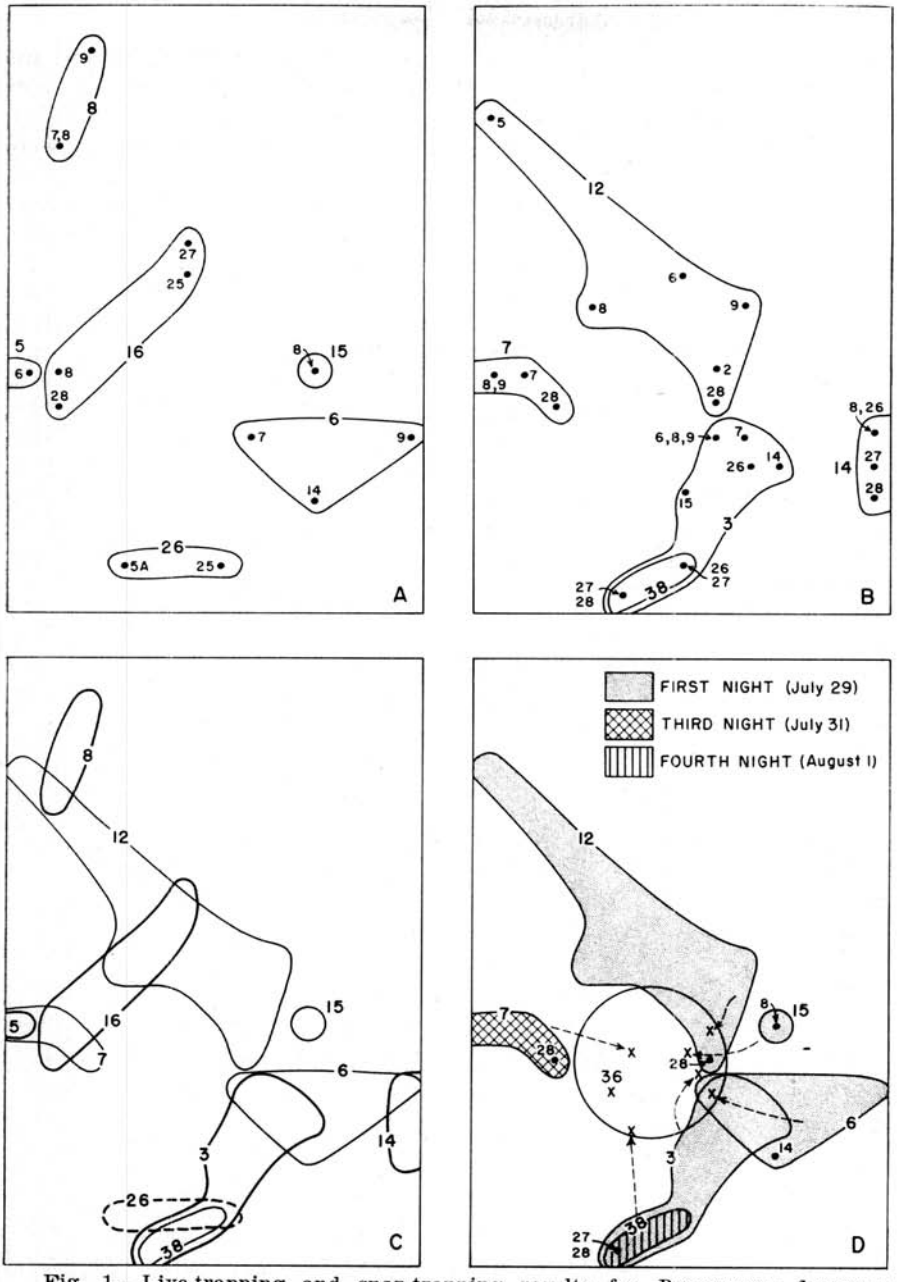

Fig. 1.—Live-trapping and snap-trapping results for *Peromyscus leucopus*. A and B, location and date of each live-capture for all individuals. C, composite of apparent ranges (note amount of overlap). D, snap-trapping results, showing date and location of last previous live-capture. Point at which individual was taken in snap trap is shown by an X. No. 36 not previously taken in a live-trap. Small numbers indicate date of capture in July except where "A" indicates date of capture in August. Where ranges of Numbers 3 and 38 overlap, lower dates are for No. 3.

kernels of corn. Also, the midday heat would very likely have caused the death of any animal captured shortly after the traps had been checked in the morning.

After a suitable bait was found, live-trapping in rows 6 through 19 (see Fig. 2A) was continued through July 9. Trapping records for mice captured more than once indicated that all but one seemed to have home ranges near the periphery of the trapping area. All but 2 were near the southern edge. A large rectangular barren area of nearly 5 acres seemed to exist. Eighty-four traps were set within this area on the afternoon of July 11. There were no captures the following morning. It was felt that snap-trapping a central acre, most of which was apparently unoccupied, would be of little or no value. Consequently, the traps in rows 18 and 19 were taken up and 19 of them placed in the form of an "E" within the area of rows 1 through 5. It was felt that this would probably reveal the presence of any new individuals within that area. However, in 3 nights of trapping, July 13, 14, and 15, only 3 captures were made, all of the mice being individuals previously marked in the adjacent area. After a one-week delay, the traps in rows 14, 15, 16, 17, 18, and 19 were used to fill in rows 1 through 5, which bordered the area where most of the mice were caught. This arrangement of traps was thought to

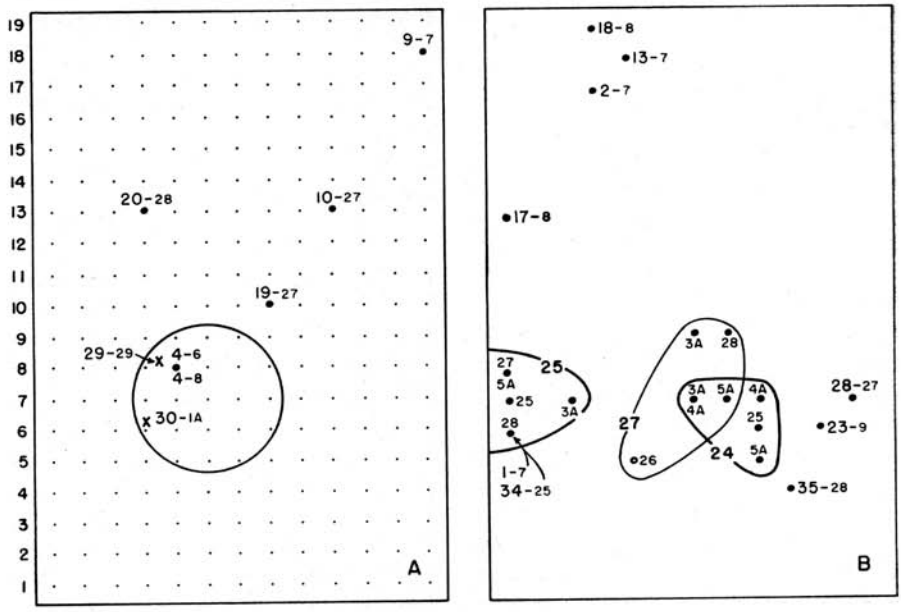

Fig. 2.—Trapping results for *Blarina brevicauda* and *Tamias striatus*. A indicates date in August. Number preceding the hyphen is the number of the individual; that following, the date of capture. A, date and location of each capture of a short-tailed shrew. Capture in a snap-trap indicated by an X. Dots represent live-trap locations used during this experiment. Circle represents 1-acre snap-trapping area. B, date and location of each capture of a chipmunk.

permit the obtainment of more adequate data on home range. Live-trapping in rows 1 through 13 was then carried on for 4 nights, beginning July 25. An exception occurred on July 26 when, due to a thunderstorm, only the traps in rows 2, 3, 4, 5, 6, and 7 had been set the previous afternoon. After this period, the location and apparent home range of all or a majority of the individuals was known.

Snap-trapping was begun on July 29. A circular acre was marked off, using the eighth trap from the east end of row 7 as the center (Fig. 2A). This was one trap position removed from the center of the area covered by the live-traps in rows 1 through 13. The reason for this dissymmetry was practical, rather than scientific. The author wished to avoid an extensive patch of poison-ivy. A total of 160 traps was set within this acre. In each quarter of the acre, 40 traps were set at random. Snap-trapping was carried on for 5 nights. The first three nights were used to determine population density, the last 2 only to see if the rate of ingress changed. As a further check on movements, live-trapping was continued in rows 1 through 13 on August 3, 4, and 5, at which time thievery by a squirrel hunter forced a halt to trapping operations.

Results

Trapping success. The results of live-trapping are summarized in Table 1. Individuals of 3 species were captured. *P. leucopus* will be treated extensively. Data for the other 2 species will be treated later in summary form. Live-trapping was conducted 15 nights before and 3 nights after snap-trapping, for a total of 18 nights. Of the former, the 8 nights included in the periods of July 6 through 9 and 25 through 28 are of primary importance. During these 8 nights, which represented only 71.6 per cent of the total trap nights (1679), 91.4 per cent of the total captures (58) occurred. July 1, 2, and 5, represented 21 per cent of the trap nights, but accounted for only 3.4 per cent of the captures. This period occurred before a suitable bait was found. The period of July 12 through 15 represented 7.5 per cent of the trap nights, and accounted for 5.2 per cent of the captures. This was a period of exploratory trapping.

Eleven white-footed mice were taken a total of 38 times, or an average of nearly 3.5 captures per individual. By July 9, the fourth day of effective trapping in rows 6 through 19, all of the mice taken were recaptures. In the effective trapping of rows 1 through 13, no new individuals were found after the second day.

A summary of snap-trapping results is given in Table 2. Of the 6 marked mice captured, 4 were taken the first night, one the third night, and one the fourth night. An unmarked individual was taken the third night. No individuals were caught the second and fifth nights.

Population composition. Of a total of 12 individuals taken during the present study, 7 were males and 5 were females. The age classes were somewhat difficult to categorize, since some individuals progressed to a succeeding age class during the trapping period. For convenience, the age class of an animal at its initial capture has been given in Table 3.

TABLE 1.—Live-trapping results.

Date	No. of traps set	*P. leucopus*			*B. brevicauda*			*T. striatus*			Total
		New individuals	Recaptures	Total	New individuals	Recaptures	Total	New individuals	Recaptures	Total	
	Pre-snap-trapping										
July 1....	177	0	0	0	0	0	0	0	0	0	0
2...	104	1	0	1	0	0	0	0	0	0	1
5...	73	0	1	1	0	0	0	0	0	0	1
6...	78	2	1	3	1	0	1	0	0	0	4
7...	177	3	1	4	1	0	1	3	0	3	8
8...	177	3	4	7	0	1	1	2	0	2	10
9...	177	0	5	5	0	0	0	1	0	1	6
12...	68	0	0	0	0	0	0	0	0	0	0
13...	19	0	0	0	0	0	0	0	0	0	0
14...	19	0	2	2	0	0	0	0	0	0	2
15...	19	0	1	1	0	0	0	0	0	0	1
25...	169	1	1	2	0	0	0	2	0	2	4
26...	84	1	2	3	0	0	0	1	0	1	4
27...	169	0	4	4	2	0	2	1	1	2	8
28...	169	0	5	5	1	0	1	1	2	3	9
Total..	1679	11	27	38	5	1	6	11	3	14	58
	Post-snap-trapping										
Aug. 3....	169	0	0	0	0	0	0	0	3	3	3
4....	169	0	0	0	0	0	0	0	2	2	2
5....	163	0	1	1	0	0	0	0	3	3	4
Total..	501	0	1	1	0	0	0	0	8	8	9

TABLE 2.—Snap-trapping results.

Date	Total individuals	*P. leucopus*			*B. brevicauda*		
		Marked	Unmarked	Total	Marked	Unmarked	Total
July 29.....	5	4	0	4	0	1	1
30.....	0	0	0	0	0	0	0
31.....	2	1	1	2	0	0	0
Aug. 1.....	2	1	0	1	0	1	1
2.....	0	0	0	0	0	0	0

Of 7 males, 3 were juveniles, 3 were sub-adults and one an adult. None of the males had descended testes until the last week of July, when all males captured had descended testes. One juvenile, 2 subadult, and 2 adult females were taken. None was pregnant or nursing.

Distribution. The location and date of capture for each mouse taken are shown in Figures 1A and 1B. From these data, an approximation of the home range of each individual has been drawn. All of the home ranges are shown in Figure 1C. A large amount of apparently unoccupied space is evident. Clumping is so pronounced that every individual captured more than once shows some degree of overlap of home range. The home ranges vary considerably in size and shape. The numbers involved are too few and the variations too extreme to make data on size of home range meaningful.

The location of the one-acre plot that was snap-trapped is shown in Figure 1D. Each of the 6 mice taken in a snap-trap is noted. The date of capture and the approximate location of the trap in which it was taken is given, along with the location and date of the last capture in a live-trap.

Movement. The maximum distance between recaptures is given for each individual in Table 4. The greatest distance was 570 feet (12). The least was 100 feet (14). The average for the 9 individuals captured more than once was 234 feet. For 6 males it was 229 feet; for 3 females, 243 feet. One mouse (12) moved 525 feet during a 3 night period, and the next night moved 390 feet back toward the original point of capture.

The distance traveled from the last previous capture to the point at which the animal was taken in a snap-trap is given in Table 5. Only 2 animals were taken on consecutive dates. One (3) traveled the greater distance, while the other (12) traveled the shortest distance. The remaining animals traveled intermediate distances over periods varying from 3 to 21 days.

Population densities. From the 13.9 acres live-trapped, only 11 white-footed mice were taken. This gives a population density of 0.8 mice per acre. By employing a buffer strip, one-half of the average maximum distance between capture locations (117′) added to the periphery of the trapping area, the population density is lowered to 0.5 mice per acre.

A 3-night period of saturation trapping with snap-traps is generally thought to take all of the resident animals in a one-acre trapping area. The first 3 nights of snap-trapping in the present study yielded 6 animals, giving a population density of 6 mice per acre. Adding the same width of buffer strip as before lowers the population density to 1.5 mice per acre.

Other Mammals. Trapping data for the short-tailed shrew (*Blarina brevicauda*) are summarized in Tables 1 and 2. Five individuals were taken a total of 6 times in the live-traps, the single recapture occurring in the same trap as the initial capture and only 2 nights later. Three of the shrews died in the live-

TABLE 3.—Population composition (*P. leucopus* and *T. striatus*)

Sex	Age group	Total	
		P. leucopus	*T. striatus*
Male	Juvenile	3	..
	Subadult	3	0
	Adult	1	4
Female	Juvenile	1	..
	Subadult	2	4
	Adult	2	3

TABLE 4.—Maximum distance between recaptures of *P. leucopus*

# of individual	Sex	Age*	# of times captured	Max. distance between recaptures
3	male	J to SA	9	320′
5	female	A	1	....
6	female	A	3	260′
7	male	SA to A	4	115′
8	male	J	3	160′
12	male	J to A	6	570′
14	male	SA to A	4	100′
15	female	J	1	....
16	female	SA	4	320′
26	female	SA	2	150′
38	male	A	2	110′

*J = juvenile; SA = subadult; A = adult; "to" indicates change in age class over trapping period.

traps. Two unmarked shrews were taken in the snap-traps, one the first night and the other the fourth night.

The point of capture is given in Figure 2A for all of the animals taken. Live-trapping yielded a population density of less than 0.4 individuals per acre; snap-trapping, one per acre. Five of the 7 shrews captured apparently were females. Based on size, all of them were thought to be adults. One had been nursing young.

Data on live-trapping of the eastern chipmunk (*Tamias striatus*) are summarized in Table 1. Eleven individuals were taken alive, and another was accidentally captured and later found dead in the trap. The former were captured a total of 22 times with 3 animals accounting for all of the recaptures. None of the 3 was recaptured until the seventh day of effective trapping, at which time all but one individual had been taken at least once.

The sex and age composition of the chipmunk population is shown

TABLE 5.—Distance from last previous live-capture to point at which taken in a snap trap. (*P. leucopus*)

# of individual	Distance traveled	# of days
3	300′	1
6	160′	15
7	120′	3
12	50′	1
15	150′	21
38	200′	4

in Table 3. Age was subjectively based on size. Differential growth rates of males and females might have caused unreliable age class data, since no males were classified as subadults. One male appeared to have undescended testes, only a shriveled scrotal sac being present.

Distribution of the chipmunks is shown in Figure 2B. Approximate home ranges have been drawn for the 3 animals that were recaptured. The maximum distance between capture locations was 250 feet for an adult male (27), 140 feet for another adult male (24), and 110 feet for a subadult female (25). The average was 167 feet. The population density was less than 0.9 chipmunks per acre.

DISCUSSION

Trapping success. It was felt that all or nearly all of the white-footed mice within the trapping area were caught at least once during the live-trapping operation. This conclusion is supported by the fact that only one unmarked mouse was caught in the snap-traps. The 2 white-footed mice (3 and 12) caught most frequently also had the largest home ranges, indicating the presence of little or no trap proneness. Neither was caught more than 2 nights consecutively in the same trap.

There is evidence that the recent capture of one white-footed mouse in a live-trap predisposes that trap in some way for the capture of another individual. Three different individuals were caught in one trap within 3 consecutive nights, while in 4 other traps different individuals were caught during 2 consecutive nights. In still another trap, 2 different individuals were captured within 3 nights. These instances accounted for nearly one-third of the total captures. Thus, in many cases, the overlap of home ranges would seem to be primarily the result of an artifact. Even in nature, however, this same sort of overlap very likely occurs due to some stimulus, such as urinating posts. It may be assumed, therefore, that the data obtained from the live-trapping were reasonably reliable.

Distribution and movement. Home ranges of white-footed mice, as shown in Figure 1C, were drawn by using a 50 foot strip between successive captures. The sharp angles thus formed were then subjectively rounded off. For the purposes of this study, only an approximation of the position of the home range was needed. The variations in size and shape of home ranges was perhaps a reflection of the low population density.

The distribution pattern of the 11 mice taken was unexplainable. Large barren areas existed. Where animals were present, much overlap of home range occurred. The topoggraphy and the amount of debris

present were thought to be determining factors. The mice seemed to be in close proximity to the drainage ways and in areas containing relatively larger amounts of debris. Yet a similar situation existed in the northeastern part of the trapping area, with no mice being found. Therefore, some other factor, or a combination of factors, may have caused the clumped distribution.

The average maximum distance between recapture locations was 229 feet for 6 males and 243 feet for 3 females. The corresponding distances found by Stickel (1946) were 146 feet and 93 feet. Nicholson (1941) found that most of the mice he studied moved less than 200 feet. The animals in the present study traveled considerably greater distances, especially the females. The number of animals is so small that this variation might be due to chance alone. However, Blair (1940), in a study of the meadow vole in southern Michigan, found greater movements in areas of lower population densities.

Population densities. A total of 11 animals were taken in the live-traps. Five of 7 animals captured 3 or more times had a home range extending to the periphery of the trapping area. Therefore, some individuals may have ranged a considerable amount outside of the 13.9 acre trapping area. Some workers (Dice, 1938; Stickel, 1946; Wetzel, 1949) have used a buffer strip in their calculations in order to lessen the amount of error involved. Stickel (1946) used a buffer strip based on the average maximum distance between capture locations. In this study, the average maximum distance between capture locations was 234 feet. The addition of one-half of this amount to the periphery of the trapping area as a buffer strip gives a corrected trapping area of 24.0 acres. By this method of calculation, the population density is lowered from 0.8 to 0.5 mice per acre.

Saturation trapping of a circular acre for a period of 3 nights is a method of determining population density by the use of snap-traps. Within the 3 night period of snap-trapping in the present study, 6 mice were taken. Employing the same type of buffer strip as before, the population density obtained by snap-trapping is lowered from 6.0 to 1.5 animals per acre.

A comparison of the corrected densities shows the population density obtained by snap-trapping to be 300 per cent larger than that obtained by live-trapping. Wetzel (1949) found the density obtained by snap-trapping to be nearly identical to that found by live-trapping. The results of the present study, however, concur with and corroborate the findings of Stickel (1946). She found adjusted densities of 6 to 7 per acre by live-trapping and 23 per acre by snap-trapping, a discrepancy only slightly larger than that found by the author. The author agrees with her proposal that snap-trapping be used only as a relative index of population densities.

The low population density found in this study is worthy of special note. Wetzel (1949) found a density of 4 mice per acre in a central Illinois woods in August. Burt (1940) has given monthly population densities for the white-footed

mouse in southern Michigan. He found the lowest density in May, with another low point of the cycle occurring in July or August. Although the latter period corresponds to the time of the present study, his population density of slightly more than 5 animals per acre is much higher than that reported here. The reason for this unusually low summer population is not known.

Other mammals. Efficiency of the live-traps in taking the short-tailed shrew (*B. brevicauda*) was low. Five individuals were captured. One of these was taken in the snap-trapping area. Two unmarked individuals were taken in the snap-traps, giving a total of 3 animals within the circular acre. More than 4 shrews were surely present over the remaining 12.9 acres. Moreover, only a single shrew was recaptured.

Distribution of the shrew seemed to be scattered (Fig. 2A), individuals being found in the area left unoccupied by the white-footed mouse. No records of movement were obtained. Live-trapping yielded a population density of less than 0.4 animals per acre; snap-trapping, one per acre. The similarity might make both methods seem reliable. However, the presence of 3 shrews within the circular acre and only 4 outside of it is good evidence that at least one of the trapping methods was in error.

Efficiency of the live-traps in taking chipmunks (*T. striatus*) was similar to their efficiency in taking white-footed mice. No unmarked chipmunks were taken after 8 days of effective trapping. Three chipmunks (24, 25, and 27) seemed to be trap prone, being the only 3 recaptured of a total of 11 taken alive. One (24) was captured 4 times, the other 2 each 5 times. None showed any great movement, the average maximum distance between recaptures being 167 feet. The greatest distance traveled was 250 feet by an adult male.

A comparison of figures 1C and 2B indicates that the distribution of the chipmunk closely paralleled that of the white-footed mouse. This would suggest that surface debris might be the factor influencing the clumped distribution of both, since the shrew, primarily a sub-surface dweller, occurred where both mouse and chipmunk did not.

Twelve chipmunks, including one found dead in a trap, were taken on the study area. Only 3 individuals were recaptured, and they seemed to be trap prone. Hence, data on home ranges were meager and probably unreliable, making the calculation of a buffer strip impractical. Thus, all that can be said is that the population density was less than 0.9 chipmunks per acre.

Summary

Live-trapping of small mammals was conducted over a total of 13.9 acres of upland woods in south-central Illinois in July and August, 1960. Snap-trapping of a circular, centrally located acre was carried on for 5 nights with 160 Museum Special traps. White-footed mice (*Peromyscus leucopus noveboracensis*), short-tailed shrews (*Blarina brevicauda*), and eastern chipmunks (*Tamias striatus*) were captured in live-traps. Individuals of the former 2 species were also taken in snap-traps.

Summarization of the results may be categorized by species.

P. leucopus.—Eleven individuals were captured a total of 38 times in the live-traps. Approximate home ranges were drawn, and great variations in size and shape were noted. The average maximum distance between locations of capture was 229 feet for 6 males and 243 feet for 3 females. The population density determined by live-trapping with a 50 foot grid spacing was 0.8 animals per acre; the population density obtained by saturation snap-trapping for 3 nights, 6 animals per acre. The adjusted population densities were 0.5 for live-trapping and 1.5 for snap-trapping. A serious error in the results obtained from the snap-trapping method is indicated.

B. brevicauda.—Five individuals were taken in the live-traps and 2 in the snap-traps. No data were obtained on home ranges or movements. The population densities obtained were less than 0.4 animals per acre by live-trapping and one animal per acre by snap-trapping. The density figures are felt to be in error, especially that of live-trapping.

T. striatus.—Twelve individuals were taken, giving a population density of less than 0.9 individuals per acre. Only 3 animals were recaptured. Of these, one was taken 4 times; the other 2, 5 times. The greatest distance traveled was 250 feet by an adult male.

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