Home Ranges, Territories, and Seasonal Movements of Vertebrates of the Natural History Reservation

BY

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INTRODUCTION

In July, 1948, ecological investigations were initiated on the newly created University of Kansas Natural History Reservation, a 590-acre division of the original "Robinson Farm." Although all phases of ecology have been given some attention, greatest effort has been devoted to autecological studies of the more abundant kinds of vertebrates.

Invariably in such studies a major amount of time and effort is expended in an investigation of spatial relationships. In order to understand the ecology of a species it is necessary to recognize individuals and to trace individual histories. It is necessary to ascertain how the typical individual animal is limited in time and space in order to understand the population dynamics of the species. As stated by Dice (1952: 231) most individual animals do not wander about at random, but the great majority spend their lives in closely limited areas, each confining his movements to a small part of the
habitats that are fully suited to his existence, and over which he is potentially free to roam.

From a practical standpoint it is important to understand the daily and seasonal movements of an individual, and the spatial requirements of a breeding population for those species that have major economic bearing. Such information serves as a basis for control measures for those kinds that are harmful, and as a basis for encouragement through positive management for those kinds that are beneficial.

In the course of routine field work, information concerning movements has been obtained for most of the species of vertebrates recorded from the Reservation. However, the quantity and quality of the information obtained varies greatly from species to species. Ideally the information obtained for each species would have answered the following questions: What is the size of a typical home range and how much does it vary in size and shape? Is the home range permanent; if not, how much and how often does the animal alter it? How is the home range affected by weather, food supply, and population density? What are the essential habitat features that a home range must include? How do home ranges differ between male and female, between adult and young, or between any other special groups within the species? Is the home range in whole or in part defended as a territory? If so, what classes of individuals (according to size, age, or sex) are active in such defense, and what classes of individuals (or what other species of animals) are objects of territorial hostility? Does the male share his territory with a mate or with a family group? Is the territory a phenomenon of the breeding season, or is it maintained throughout the year?

For none of the species studied was the information obtained sufficiently extensive to answer all these questions completely. For the rarer and more elusive species, the data obtained are scanty. Nevertheless, for many of the more abundant species, the essential items of information have been obtained.

Birds as a group have been studied in the past much more extensively than the other groups of vertebrates, with regard to spatial relationships. In general birds are more easily studied, because they can be more readily observed. On the Reservation, observing birds was unusually difficult because of the dense sheltering vegetation, and the shyness of most species. Attempts to trace movements of individuals were often unsatisfactory. Because of the
large number of species present, the time available to devote to any one species was limited. The mammals, and especially the reptiles and amphibians, have been studied less, heretofore, and I made concentrated efforts to secure information concerning those kinds that were abundant and available.

In the course of my field study, spanning more than nine years, emphasis has shifted from time to time. Short lines of live-traps for small mammals were first operated in 1948, and these operations were much expanded in the spring of 1950. Live-trapping of reptiles and amphibians was begun, on a small scale, in the summer of 1949, and was gradually expanded. Observations on birds were most concentrated in the years 1952 through 1955. Many of my data concerning spatial relations of the narrow-mouthed toad, five-lined skink, Great Plains skink, collared lizard, opossum, coyote, prairie vole, eastern woodrat, and summer tanager have already been published. The manuscript resulting from the present study was completed in essentially its present form in 1956, but significant items of data obtained since then have been incorporated. The species accounts of amphibians and reptiles were written first, on the basis of data on hand on July 1, 1955. Although more data were collected subsequently for most species, the new figures were incorporated into the account only in those instances where they seemed to alter substantially the trends previously revealed.

A faculty grant for the years 1956-1957, and 1957-1958 has aided substantially in the completion of this project. Many persons have contributed to the work in various ways. Richard E. Freiburg (1951), Edwin P. Martin (1956), Robert L. Packard (1956) and Dennis G. Rainey (1956) have published separate reports concerning several species of vertebrates studied by them on the Reservation, and I have drawn freely upon their findings. Other persons who have contributed data or have assisted me with field work include: Maurice F. Baker, William N. Berg, Alice V. Fitch, John H. Fitch, Richard W. Fredrickson, Richard D. Harder, the late Robert M. Hedrick, Donald W. Janes, Richard B. Loomis, John Poole, Louis M. Sandidge, and my wife, Virginia R. Fitch who also typed much of the manuscript. Mr. Robert M. Hedrick, Mrs. Connie Wynkoop, and Mrs. Lorna Cordonnier completed the illustrations. Dr. E. Raymond Hall, Director of the University of Kansas Museum of Natural History, has provided valuable counsel and suggestions at various stages of the work, and has made available the services of the Museum staff artists.
To supplement my original findings a large amount of published literature has been examined, and the findings of other authors are often cited in the species accounts for purposes of contrast or comparison. However, because of the large number of species involved, a thorough survey of the literature for all was not feasible. For the birds, especially, many pertinent published papers probably have been overlooked.

METHODS OF STUDY

To facilitate ecological studies the University of Kansas Natural History Reservation has been subdivided into 80 separate areas, having as their boundaries, creeks, ravines, wire fences, rock walls, roads, trails, and, in some instances, imaginary lines. Each subdivision has within it numerous specific landmarks. Most of these are trees, but boulders, fence posts, logs and other objects, even metal stakes especially placed for the purpose, have also been utilized. Each record of an individual animal was located with reference to some such named landmark. Distances sometimes were actually measured with a steel tape, but normally they were estimated to the nearest ten-foot interval. In studies of small mammals, traps were usually laid out in grids (50-foot, 30-foot and 20-foot intervals were used) with each position measured from a definite landmark. Many of the landmarks were discernible on an aerial photograph made on the scale of one inch to a hundred feet. A map on the same scale, with two-foot contour intervals, was also available.

Various methods were used, depending on the species, in determining the area covered by an individual animal. For a small minority of kinds it was possible to keep an individual under continuous observation as it moved about, carrying on its normal activities. The male dickcissel is perhaps the best example. As he moves about his territory, with frequent shifts, usually perching on the topmost twigs of the largest shrubs or saplings, he soon reveals the approximate extent of his territory. An individual may be recognized on successive occasions, even though he is not distinctively marked, by his habit of returning regularly to the same favorite perches.

The same method also applied well to the field sparrow, but was more difficult because this species more often stayed in concealing cover, because the sexes could not be readily recognized, and because the species was so abundant that confusion might often arise concerning the identity of an individual that was momentarily out of sight, or that encountered another.

Most other kinds of birds were less readily kept under observation, because they were more wary or more secretive in their behavior. For many kinds, including the wood thrush, the Kentucky warbler, and the several species of vireos, the song of the male provided the chief basis for tracing movements since the birds themselves were glimpsed only occasionally. However, under favorable conditions, the frequent and regular bursts of song by the bird as it moved about slowly in its foraging, served to keep the observer informed as to its course. Little was learned concerning the movements of the females in these particular species, but in each instance it is known that the members of a pair are the joint occupants of a territory.
In many of the other species of birds that were studied, a combination of
sight and sound was used in keeping the individuals under observation and
tracing their movements. In some instances distinctive artificial marking of
individuals was an important aid. Besides the regular metal bands, provided
by the U. S. Fish and Wildlife Service, colored celluloid bands, or dyed
feathers crimped onto the tail, or colored nylon ribbons, were used for sight
identification. In practice positive sight identification of individuals was made
only rarely, even with the aid of these various devices. The nylon ribbons
were most effective. Each was looped around the tarsometatarsus and sewn
snugly in place with a free end of approximately half an inch projecting out
behind, like the jess on a falcon. This colored ribbon, presenting several
times as much surface as an ordinary leg band, could be distinguished at a
greater distance. Most sight records from colored ribbons were obtained
for red-bellied woodpeckers, downy woodpeckers, and field sparrows.

The same types of ribbons, attached to the ears of cottontails (Janes, MS),
often served for sight records of these animals. Colored collars and ear disks
on gray squirrels and fox squirrels served the same purpose (Packard, 1956: 9).
For the six-lined racerunner, paints of various colors, carefully applied on dif-
ferent parts of the body surface, served effectively to render individuals dis-
tinguishable in the field for short periods. Through bleaching and wear these
colors rapidly dulled and after a few days they were no longer distinguishable.
The addition of bright colors, unnatural to the species involved in the attach-
ment of ribbons, bands, feathers, or paint, may of course, have rendered the
animals more susceptible to certain predators, and also may have affected
their social status adversely, reducing their chances of survival. Actually, no
evidence of such adverse effects was noticed, and it seems safe to assume that
the over-all ecology, and especially the movements, were not altered to any im-
portant degree, in most species at least.

For most kinds of mammals, reptiles, and amphibians, and some kinds of
birds, individual identification could be made with certainty only by recaptur-
ing and handling the animal. Many kinds are too wild, secretive, or nocturnal
to observe in the field. For birds, trapping was carried on principally in
winter. Procedure was not uniform, because of variation in the number of
traps and time available. Ordinarily 30 or more traps were set at fairly uni-
form intervals in a line extending from the Reservation headquarters for a
quarter mile or more in one direction, then looping back to the starting point.
From time to time the trap line was altered by moving one leg of it beyond
the other, and in the course of an entire winter the whole trap line was rotated
through 360 degrees about the central point of the headquarters. In the course
of a season, therefore, traps were well distributed over an area as large as 125
acres. For individuals ranging entirely within the area encompassed by the
trap lines the pattern of records obtained might show the extent of home
range (or territory) fairly well.

Most of the mammals recorded were caught in live-traps set in a grid pat-
tern or in parallel lines; the interval between traps was varied from time to
time and place to place, from ten to 120 feet. Mammals were marked by a
combination of ear-clipping and toe-clipping, or by toe-clipping alone (Fitch,
1952: 32-33), in those species having small and inconspicuous ears. In the
latter (\textit{Microtus ochrogaster} and \textit{M. pinetorum}) one toe was clipped on each of four feet (excluding the minute "thumbs") and a total of 400 combinations were possible without duplication. In others only two toes were clipped in combination with a distinctive ear mark. Because of the short life span of small mammals in general, the animal marked with any one formula had died long before there was need to use the same combination again. For some of the most abundant species the same series were used repeatedly.

Toe-clipping was used also in the marking of frogs, toads and lizards. These animals were secured by a variety of techniques. Many were caught by hand. Others were taken in strategically placed funnel traps or pitfalls. The captures in funnel traps and pitfalls were less randomly distributed than the records obtained otherwise, as they were mainly along rock ledges or other natural obstacles that might affect the movements of the animals. For the glass lizard the marking technique consisted of removing three scales from the edge of the lateral fold, from which a formula was derived. The nick from the most anterior excision served as a base mark from which the positions of the other two nicks could be recorded according to the number of scales between.

Snakes were marked by excising subcaudals in different combinations, counting backward from the base of the tail. Only the proximal portion of the tail was used, up to subcaudal number 20. When all possible combinations were exhausted, they were used again in combination with ventral scutes clipped on either right or left sides. Snakes were obtained by various methods. Some were found by chance in the course of routine field work, some were discovered by raising sheltering objects such as rocks and boards beneath which they had taken cover, and some were located by attention to the calls of birds, mammals or frogs caught or pursued by the snakes or by the calls of blue jays and certain other birds that harrassed the snakes. Even more snakes were caught in funnel traps. Success with these traps was greatest in September, October, and sometimes early November, along the hilltop rock outcrops where many snakes congregated to hibernate. So far as known, there were no major "dens" on the area. A snake having gained a rock outcrop might travel along it a longer or shorter distance, and might retreat into any deep crevice favorable for hibernation, perhaps solitarily or perhaps in company with several others of its own species and other species. Attempts to trap snakes in these same situations in spring, after their emergence from hibernation, were notably unsuccessful. At this time of year there was rapid dispersal into other habitats. In summer, funnel traps were set along specially constructed screen drift fences, in grassland, thickets, and at woodland edge.

From this account it is evident that in the course of the study significant movements of animals were actually observed only on rare occasions. For the most part movements had to be reconstructed from the fragments of information obtained by occasional captures, in live-traps or otherwise. Obviously, in most instances the animal did not move directly from one recorded point to another, but usually covered a much greater distance, coming to the second point by a roundabout route. When two or more such locations were recorded for an individual within a short time, the assumption seemed justified that they were probably within a home range (or territory) and partly defined its extent. However, when much time had elapsed between two consecutive records, there was no assurance that the animal had not shifted more or less permanently. Ex-
tensive comparison of long-term and short-term records was necessary to establish the probability of shifts in range.

In general, any point where an animal is recorded within its home range or territory is located at random with reference to any other point of record, but there are many exceptions. If records are based on live-trapping, trap habit may become an important factor altering the behavior of the individual, and may cause it to return regularly to one or a few traps while neglecting to visit other parts of its home range. An animal that has a regular home base relied upon for shelter and escape, such as the home burrow of a vole, the stick house of a woodrat, or the home blackberry patch of a cottontail, naturally tends to stay within easy reach of this shelter, and in outlying portions of its range, activities become increasingly diffuse. For a parent bird, the nest or young similarly provide a focal point of attraction, and activity tends to be much more concentrated near the nest than it is in remote parts of the territory.

Other animals actually tend to move about more or less at random over their territories or home ranges. Tracks of a foraging opossum, for instance, show that the animal wanders circuitously in what seems to be an aimless course. Opossums live-trapped show little or no tendency to return to any one trap regularly. A male wood thrush, singing as he forages, seems to cover his territory rather uniformly. In many other kinds of birds, the male uses a series of territorial perches for singing, and these are usually well distributed over the area to which his activities are confined.

The term "minimum home range" has been widely used in studies of small mammals, in recognition of the fact that the area disclosed by investigation nearly always is somewhat smaller than the total area utilized, because data

![Fig. 1. Hypothetical home ranges of the same size, showing patterns of records for: (A) an animal that has a central home base and uses the various parts of its range in inverse proportion to their distance from the home base; and (B) an animal that wanders at random over its area.](image)
are incomplete in varying degrees. Thus a minimum home range could be plotted on the basis of only three records, providing that all three were at separate locations, and that these locations did not fall in a straight line. However the triangular area encompassed by the three locations would almost certainly amount to only a small part of the total range. A fourth record of the same individual might fall within the original triangle, or it might fall outside, increasing the minimum home range and altering it to quadrangular form. Obviously many more records would be needed before the minimum home range disclosed would be expanded to an approximation of the entire home range occupied by the individual. Odum and Kuenzler (1955) have presented a scholarly discussion of this problem, showing that the rate of increase is, on the average, reduced with each additional record, until it becomes insignificantly small. For practical purposes Odum and Kuenzler advocated accepting as complete a minimum home range in which the increase for each additional record is below the one per cent level. Their procedure was to connect outlying points with lines and measure the enclosed area after each series of ten records. When such a series of ten added less than ten per cent to the previously plotted range, they considered addition of further records superfluous. As demonstrated by Odum and Kuenzler, the number of records required to achieve this one per cent level varied widely according to the species and also varied within the species, according to the stage of the nesting cycle and other factors. In a pair of chipping sparrows that were feeding nestlings, the one per cent level was obtained by means of only 20 observations. Earlier, in the nest-building stage, 55 records of the same pair of birds were necessary to achieve the one per cent level, and the area covered was nearly three times as large as it was in the nestling stage.

Using a wood pewee as an example, Odum and Kuenzler (op. cit.: 131) show the increasing size of minimum home range (actually a territory in this instance) with the addition of successive tens of records. The one per cent level was attained after the fourth series of ten records. The polygon outlining the bird's known range at this stage had nine marginal points (each represented by a single record). The other records, inside the polygon, tended to be clustered at a few favored locations. In this respect the pewee's pattern of records resembles those of various other animals, including the small mammals that are taken in live-traps exclusively.

The wood pewee and chipping sparrow studied by Odum and Kuenzler, are, of course, almost ideal subjects for such observation. For such active and vocal small birds that are not especially wary of humans many location records can be obtained in a short period of observing. In studies of small mammals, thousands of trap nights may not yield a comparable set of records for any one individual. In only a few instances was I able to obtain records of individual movements as complete as the set shown for the pewee by Odum and Kuenzler. Because most animals tend to return frequently to favored spots, the number of marginal locations, rather than the total number of records, or even the total number of points, is the best indication of reliability in the minimum home range plotted. While a home range plotted on the basis of only three or four points is almost sure to be much smaller than the true home range, one plotted from six points may outline the range fairly accurately, especially if the points are well spaced along the margin. Home ranges based on seven
or more marginal points are considered to be sufficiently representative of the area covered by the animal.

As numbers of marginal points increase with more complete records, the range plotted generally tended toward a circular or elliptical shape. If only marginal points are connected, there are no concavities in the outline of the polygon representing the home range. Concavities in the outline of the home range polygon are permissible when uninhabitable areas extend within it. For example water may extend into the home range of a terrestrial animal, or forest may extend into the home range of an animal closely limited to grassland. The irregular borderline between forest and grassland resulted in many home ranges of irregular shape among those that were plotted, both for species characteristic of forest and those typical of prairie habitat.

Because a large number of records are necessary to plot the home range of any individual with reasonable completeness, according to this method, relatively few of the animals recorded are usable. In my study, an alternative method of determining size of home range was used, which permitted inclusion of individuals even when only two records were available. This method was based on the theory that any two locations where an individual was recorded in its range, were situated at random with respect to each other. Distances between successive points of record were averaged for all individuals of a species, or according to sex, age group or season. The average figure obtained in each instance was considered representative of a home range radius. The home range is visualized as tending toward a circular shape, and random points within it will be separated by, on the average, half the diameter of the area. In an animal the range or territory of which has one or more focal points, where activity tends to be concentrated, the distances between randomly selected points will average less than the home range radius reflecting the extent to which activity is concentrated within one part of the total area.

From the average distance between successive locations recorded, the area covered was computed from the formula \( \pi r^2 \) or the area of a circle. Obviously this method is subject to various sources of error; the home range nearly always deviates from a circular shape, and usually some parts of its are used more than others. The advantages of this method are (1) that it makes possible a calculation of approximate size of home range on the basis of a relatively small amount of data, (2) that it provides a check on size of area plotted as a minimum home range from actual points of capture.

Still another method of computing area covered, is applicable specifically to territorial birds. This method involves measuring the distances between males that are singing simultaneously and answering each other, in situations where the habitat is continuous. Under such conditions the territories presumably have a common boundary. The distance between two singing males may be considered representative of the distance from one territorial center to another, the equivalent of a territory's diameter. A possible source of error in this method is that males happening to be in adjacent parts of their territories may be stimulated to competitive singing in defense of their boundaries, but it seems doubtful that this was an important factor in any of my records. In most instances when distances were recorded, singing was general and the males tended to be rather uniformly spaced. The method provided an important means of checking the figures obtained from the two methods previously discussed.
Fig. 2. Map showing areas where field work was done: (A) the 160-acre Rockefeller Experimental Tract, and (B) the 590-acre University of Kansas Natural History Reservation, showing distribution of weedy fields, grassland and woodland. The grassland includes prairie, both original and reestablished, dominated by bluestems and other tall grasses. Former pastures are mostly dominated by awnless brome.
In the following species accounts, binomials are used for the kinds of animals discussed. Subspecific identities can be determined from the appropriate reference among the following: Smith, 1956 (reptiles and amphibians); Tordoff, 1956 (birds); and Hall, 1956 (mammals).

This publication is intended to serve, incidentally, as a list of the vertebrates recorded from the Reservation. Therefore, all species known from the area are listed, although for certain kinds so little information has been obtained that their inclusion would not be justified otherwise. The present list revises and extends one published earlier (Fitch, 1952:23-29). The king snake (*Lampropeltis getulus*) was included in the earlier list on the strength of an individual found on the county road approximately half a mile south of the Reservation. However, the habitat there was somewhat different and the species still has not been definitely recorded from the Reservation. It is therefore deleted from the present list. Besides the species added to the original list, or deleted from it, certain other species have been found to have somewhat different status from that originally attributed to them. Domestic animals are not included in the following lists and species accounts. It is the policy to exclude them from the Reservation; nevertheless, domestic birds and mammals play some part in the ecology of the area. A colony of the domestic pigeon (*Columba livia*) has persisted into 1958 in the old barn on the Rockefeller Tract, but their effect on the ecology of the area seems slight, except as they may compete for nest sites with other species that seek an edificarian habitat. Their foraging is carried on chiefly in cultivated areas remote from the nest sites. Cats (*Felis domesticus*) and dogs (*Canis familiaris*) from nearby farms cannot be entirely excluded from the area, and prey upon various kinds of native vertebrates. Livestock, including cattle (*Bos taurus*), horses (*Equus caballus*), pigs (*Sus scrofa*) and sheep (*Ovis aries*) played an important part in the trends of succession on the area before it was protected from them. They still stray onto the Reservation from time to time, and obviously their presence on adjoining farms affects the native fauna.

**POPULATION DENSITIES**

Over the period of my study every species of vertebrate on the Reservation has undergone great changes in numbers. For most species no precise figures for the entire area have been obtained, even for any one time. The population changes have been actually measured in relatively few instances.

In most instances the figures listed below represent preliminary estimates. For convenience in this discussion, I have divided the species of vertebrates of the Reservation into five main groups as regards their occurrence. These groupings are entirely arbitrary. They overlap each other, and many species constitute borderline cases between two or more groups. Group 1 includes species recorded from the Reservation only once or on but few occasions, and ordinarily not present there. These kinds are of negligible importance in the ecology of the area. Group 2 also consists of species
that ordinarily do not occur on the Reservation, although they appear there as wanderers or stragglers with some regularity. On the whole, this group too is ecologically unimportant, although in some instances, as when a great blue heron stops at the pond for a period of days and eats large numbers of frogs, the fauna may be appreciably affected. Group 3 consists of species that reside on the area (either year round or at one time of year) but are represented there by few individuals. In general these species also are unimportant ecologically because of their small numbers and biomass, but the larger carnivores and raptors may exert important effects on the ecosystem even though only a few are present. Group 4 consists of species which are usually not present on the area, but which make brief seasonal visitations usually in substantial numbers. Species of this group are obviously of greater importance in the ecology of the area than those of the three groups previously mentioned. Group 5 includes those species which regularly inhabit the area (either year round or for part of the year) in substantial numbers. They are the species which have greatest influence on the ecology of the area. It is for the Group 5 species, primarily, that I have attempted to obtain census figures.

In the following lists, the 12 species of birds marked with asterisks in Group 1 and Group 2 are those that have been seen flying over the Reservation but are not known to have stopped there. The census figures listed for Group 5 have been obtained by various methods. The only attempt to obtain complete counts of individuals for the entire Reservation was limited to the birds, and was made in the week January 29 to February 4, 1954. Numbers of some kinds of birds were unusually low at the time of this census, and the counts obtained may be regarded as minimum figures in most instances. For various kinds of reptiles and mammals the census figures cited are mostly based upon relatively small study areas. In some instances these sample areas are typical of major habitat divisions on the Reservation, and the figures obtained may be projected to show an approximation of the numbers on the entire area. In other instances (collared lizard, six-lined racerunner, Plains harvest mouse) the small sample areas where high concentrations were found were almost the only places where the species occurred locally. For many of the more secretive species, direct counts were impracticable, and the figures cited are based on the ratios of new to marked individuals recorded at various stages in the course of field work, with due regard for population turnover through mortality, reproduction, and individual shifts.


**GROUP 1. (species seldom present)**

Black Bullhead  
Green Sunfish  
Tiger Salamander  
Eastern Box Turtle  
Painted Turtle  
Franklin’s Ground Squirrel  
Woodchuck  
Gray Fox  
Pied-billed Grebe  
White Pelican  
Black-crowned Night Heron  
American Bittern  
Pintail  
Goshawk  
Rough-legged Hawk  
Bald Eagle  
Prairie Falcon  
Sandhill Crane  
Virginia Rail  
Sora  
American Woodcock  

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<td></td>
<td>Tiger Salamander</td>
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<td>Sharp-shinned Hawk</td>
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<td>Sparrow Hawk</td>
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<td></td>
<td>Gray Fox</td>
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<td>Black-billed Cuckoo</td>
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<td></td>
<td>Pied-billed Grebe</td>
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<td>White Pelican</td>
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<td>Belted Kingfisher</td>
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<td>Black-crowned Night Heron</td>
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<td>Alder Flycatcher</td>
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<td>American Bittern</td>
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<td>Least Flycatcher</td>
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**GROUP 2. (species occasionally present)**

Fathead Minnow  
Great Blue Heron  
Green Heron  
Canada Goose  
White-fronted Goose  
Snow Goose  
Blue Goose  
Mallard  
Green-winged Teal  
Blue-winged Teal  
Shoveller  
Wood Duck  

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<td>Wood Duck</td>
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<td>Long-eared Owl</td>
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**GROUP 3. (species with few individuals)**

Snapping Turtle  
Prairie Skink  
Common Water Snake  
Smooth Earth Snake  
Prairie King Snake  
Milk Snake  
Slender Flat-headed Snake  
Timber Rattlesnake  
Plains Pocket Gopher  
White-tailed Deer  
Coyote  

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<td>Timber Rattlesnake</td>
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<td>Plains Pocket Gopher</td>
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**GROUP 4. (common species absent for most of annual cycle)**

Plains Spadefoot Toad  
Eastern Kingbird  
House Wren  
Catbird  
Robin  
Golden-crowned Kinglet  
Ruby-crowned Kinglet  
Starling  

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<td></td>
<td>Eastern Kingbird</td>
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<td>Robin</td>
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<td>Yellow-throat</td>
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<td>Golden-crowned Kinglet</td>
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<td>Wilson Warbler</td>
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<td>Ruby-crowned Kinglet</td>
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<td>Ruby-crowned Kinglet</td>
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<td>White-throated Sparrow</td>
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<td>Starling</td>
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<td>Lincoln Sparrow</td>
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Group 5. (species of major importance)

**American Toad:** In both 1955 and 1956, 25 males were caught and marked in the chorus at the pond. From the ratios of marked individuals to others, it was evident that many more were present which were not recorded. The breeding aggregation at the pond represented only a part of the population on the Reservation. Normally the population probably fluctuates from a low point of somewhat more than 100 to a maximum of many thousands or even tens of thousands (including recently metamorphosed young).

**Woodhouse’s Toad:** The number has fluctuated from none to perhaps several hundred young.

**Cricket Frog:** Several hundred adults usually are present at the pond and the small creek. At times this number may expand to many thousand.

**Gray Treefrog:** In early summer, breeding aggregations of more than 100 adults normally are present at the pond.

**Chorus Frog:** Breeding aggregations at the pond have varied from as few as ten to more than 100. In the breeding season the numbers may increase to many thousands.

**Great Plains Narrow-mouthed Toad:** This toad is one of the most numerous species; its breeding populations normally amount to several hundred and increase to many thousands, perhaps tens of thousands, in summer after a successful reproductive season.

**Bullfrog:** Numbers of adults and well grown young have fluctuated from none to probably more than a thousand.

**Leopard Frog:** Numbers have fluctuated from few or none to probably several thousand.

**Western Box Turtle:** Population density of this species is estimated as one to 13 acres, on the basis of numbers found each year in the northwestern quarter-section of the Reservation, and the ratio of new to recaptured individuals.

**Collard Lizard:** Over the six-year period that the colony on the Reservation survived there were on the average, 3.6 adults in the area occupied at the quarry, a little larger than half an acre.

**Slender Glass Lizard:** The population normally amounts to several per acre in the more favorable grassland areas.

**Six-lined Racerunner:** Over a four-year period population density averaged 56 per acre on a half-acre area of favorable habitat, the ditch in the headquarters area.

**Ground Skink:** The population density on the Reservation is low. Only a few are seen each season and it seems probable that there is only one to several acres of woodland.

**Five-lined Skink:** Population density was calculated as 67 per acre in an unusually favorable woodland area of 2¾ acres where this species was most intensively studied.

**Great Plains Skink:** Population density was calculated as 16 or 17 per acre on a four-acre area of rocky upper slope where these skinks were intensively studied.

**Brown Snake:** Density is probably only one to several acres over most wooded areas of the Reservation.
Common Garter Snake: Over the nine-year period of my study numbers caught annually averaged 23 (11 to 35) and relatively few marked snakes were recaptured. A population of one to many acres is indicated.

Ring-necked Snake: In 1950, 47 were collected on a study area of a little more than four acres. Populations exceeding ten per acre probably occur over extensive areas of the Reservation.

Worm Snake: In 1951, 51 worm snakes were collected on a study area of 2\% acres, and the ratio of recaptures indicated that this was only a part of the population. Such high concentrations, exceeding 20 per acre, are limited to relatively small areas of favorable habitat.

Yellow-bellied Racer: In 1957, 36 were collected in a grassland area of 25 acres, and these represented the majority of the population present. Populations of from one to two per acre for grassland habitats are indicated.

Black Rat Snake: The population density for the Reservation is calculated as perhaps one adult to ten acres.

Bull Snake: The number resident on the Reservation is normally fewer than ten.

Copperhead: A population of one to several acres is indicated.

Opossum: Population densities of from one in 20 acres to one in 40 acres are indicated.

Short-tailed Shrew: There may be several short-tailed shrews per acre in certain areas of favorable habitat in woodland or edge.

Little Short-tailed Shrew: Probably this shrew averages much less than one per acre in the grassland portions of the Reservation where it occurs.

Mole: No basis is known for estimating numbers; from the abundance of sign populations exceeding one per acre might be expected, at least for the wooded parts of the area.

Red Bat: Probably there is one bat to several acres.

Cottontail: In September, 1955, Janes (MS) recorded 33 cottontails on a 21-acre area of woodland.

Fox Squirrel and Gray Squirrel: Packard (1956: 17) found a population of 1.18 squirrels per acre in the better type of woodland; more than two-thirds of this total consisted of fox squirrels.

Plains Harvest Mouse: In December, 1957, on a partly barren formerly pastured 7.1-acre plot of the Rockefeller Tract, 65 plains harvest mice were caught, indicating a population density of 9.2 per acre, almost the same as for deer mice on the same plot.

Western Harvest Mouse: In late winter of 1951, on a hilltop grassland plot of 1.6 acres, dominated by brome grass, an exceptionally high population with a total of 80 adults was recorded but doubtless some were wanderers and others lived mostly outside the plot, having home ranges which merely overlapped it slightly. Populations as high as 50 per acre are rarely attained, but densities between one per acre and ten per acre are normal for most grassland areas of the Reservation.

Deer Mouse: In December, 1957, 66 were caught on a partly barren formerly pastured 7.1-acre plot on the Rockefeller Tract, indicating a population density of 9.3 per acre. On most areas where the deer mouse occurs, it is in lower population densities.
White-footed Mouse: In early spring of 1951, 16 adult white-footed mice were caught in a woodland study area of 12½ acres. Ordinarily the numbers probably exceed one per acre in edge or woodland habitat.

Hispid Cotton Rat: In November, 1957, 28 cotton rats were caught in a prairie plot of 3.1 acres on the Rockefeller Tract. The population of nine per acre represented is regarded as moderately high, but at certain times and places under favorable conditions it is much exceeded.

Eastern Woodrat: From a high population of several per acre in most wooded areas in 1948, this rat decreased to a low point of perhaps one per hundred acres in 1954.

Prairie Vole: Martin (1956: 378) found populations of from 25 to 140 per acre in the grassland areas where his studies were made.

Pine Vole: The population of the entire Reservation is estimated as consistently less than 100 adults, concentrated in a few highly localized colonies.

Norway Rat: For the entire Reservation the population of adults probably has never exceeded ten.

House Mouse: Population densities of several to many per acre are at times attained on limited areas, but ordinarily numbers are much lower.

Jumping Mouse: This species is poorly known on the area. It is doubtful whether population density exceeds one per acre except for brief periods in unusually favorable habitats.

Raccoon: Several family groups live on the area. Populations as high as one to 50 acres probably have been attained.

Spotted Skunk: Winter populations somewhat exceeding one to 50 acres are usual.

Striped Skunk: This species is slightly less numerous than the spotted skunk. In winter there is somewhat less than one striped skunk to 100 acres.

Bob-white: In the 1954 winter census 25 were recorded, but usually numbers are somewhat higher.

Mourning Dove: Probably at least 20 pairs breed on the Reservation.

Yellow-billed Cuckoo: The breeding population probably exceeds 20 pairs.

Whip-poor-will: A breeding population of perhaps ten pairs is present in summer.

Yellow-shafted Flicker: In the 1954 winter census seven were recorded, but often the population is much higher.

Red-bellied Woodpecker: In the 1954 winter census 21 were recorded, probably a typical number for that time of year.

Red-headed Woodpecker: The resident colony usually includes between 10 and 20 individuals.

Hairy Woodpecker: In the 1954 winter census 13 were recorded; probably this population is fairly stable.

Downy Woodpecker: In the 1954 winter census, 42 were recorded.

Crested Flycatcher: The normal breeding population is estimated as somewhat more than ten pairs.

Phoebe: The breeding population of the Reservation is usually from three to seven pairs.

Eastern Wood Peewee: Perhaps as many as 20 pairs nest on the area; no definite figures are available.

Horned Lark: In 1957 six pairs nested on a 72-acre area of formerly cultivated fields on the Rockefeller Tract.
**Barn Swallow:** Two pairs nested at the old barn on the Rockefeller Tract in 1957. In earlier years many more had nested there.

**Blue Jay:** In the 1954 winter census 12 were recorded but usually more are present.

**Crow:** In the 1954 winter census ten were recorded but this is probably near the minimum figure. In winter there are, at times, hundreds on the area, and in summer the breeding population may approach one to ten acres.

**Black-capped Chickadee:** In the 1954 winter census 214 were recorded, perhaps a typical figure for that time of year.

**Tufted Titmouse:** In the 1954 winter census 40 were recorded.

**Brown Creeper:** In the 1954 winter census two were recorded but usually a larger number winter on the Reservation.

**Carolina Wren:** In the 1954 winter census, nine were recorded, probably a typical number for that time of year.

**Brown Thrasher:** Probably there are never more than five pairs present in summer and sometimes none.

**Eastern Bluebird:** In winter, flocks of as many as 20 bluebirds use the Reservation regularly. In summer there are probably never more than five pairs on the area.

**Blue-gray Gnatcatcher:** It seems probable that more than 20 pairs live on the area, although no census figures are available.

**Bell Vireo:** With successional changes the number of breeding pairs has gradually increased since 1952, to perhaps as many as ten pairs.

**Red-eyed Vireo:** A 1955 census figure of one pair per 2.1 acres on a wooded north slope may apply for the better woodland habitats throughout much of the Reservation.

**White-eyed Vireo:** Usually the breeding population has varied from one to six pairs.

**Kentucky Warbler:** Probably not more than five pairs nest on the Reservation.

**English Sparrow:** A colony of more than 20 pairs bred in vicinity of the buildings on the Rockefeller Tract in 1957, but none has successfully nested on the Reservation.

**Eastern Meadowlark:** Approximately six pairs nested on the Rockefeller Tract in 1957. To my knowledge no more than one pair annually has ever nested on the Reservation.

**Cowbird:** The breeding population is estimated as the equivalent of at least 20 pairs. The majority of all passerine nests found on the area have been parasitized by cowbirds.

**Summer Tanager:** At least six pairs breed on the Reservation annually.

**Cardinal:** In the 1954 winter census 40 were recorded, but usually the winter population is somewhat higher. The breeding population also probably exceeds this number normally.

**Indigo Bunting:** Perhaps as many as 30 breeding pairs are present in summer.

**Dickcissel:** In recent years the breeding population has amounted to approximately ten pairs.

**Eastern Goldfinch:** In the 1954 winter census nine were recorded.

**Red-eyed Towhee:** The breeding population is estimated at ten pairs or a little less. The wintering population also normally approximates this number, but none was recorded in the 1954 census.
Junco: In the 1954 winter census 41 were recorded, but usually there are more.

Tree Sparrow: In the 1954 winter census 17 were recorded. Numbers are variable and sometimes greatly exceed this figure.

Field Sparrow: This is the commonest breeding bird; 58 pairs were recorded on a 300-acre area in 1950.

Harris Sparrow: The numbers of these sparrows wintering on the area are highly variable depending on the food supply. In the winter of 1956-57 a flock of more than 100 lived on the Rockefeller Tract and the adjacent part of the Reservation, feeding largely on waste grain from a sorghum crop.

Song Sparrow: In the 1954 winter census 18 were recorded, but probably the winter population is usually somewhat larger.

HABITATS

The habitats of the University of Kansas Natural History Reservation have been described in some detail by Fitch (1952, 1954), Fitch and McGregor (1956), Leonard and Goble (1952), and Packard (1956). These include not only descriptions of the Reservation as a whole, but detailed descriptions of small areas. The present brief discussion is intended merely to supplement these earlier descriptions, and to show the chief successional changes that took place from 1948 to 1957, while the study was in progress.

Fields in bottomland, cultivated until 1949, include Ditch Field and Coon Field in the small valley of the west-central part of the Reservation, and Oat Field, Square Field, Corn Field, Woods Field and Weed Field in the southern part. The pioneer vegetation of secondary succession in all these fields at first consisted chiefly of sunflower (Helianthus annuus) and giant ragweed (Ambrosia trifida), in a rank growth, with stems as much as two inches in diameter and plants as high as ten feet. After several seasons the sunflower had almost completely disappeared and the giant ragweed had become much stunted, and was absent from parts of the field. Many other weeds, including thistle (Cirsium sp.), horseweed (Erigeron canadensis), goldenrod (Solidago sp.), goosefoot (Chenopodium sp.), wild lettuce (Lactuca scariola), nightshade (Solanum sp.), spurge (Euphorbia sp.), velvetleaf (Abutilon theophrasti), smartweed (Polygonum sp.), aster (Aster sp.), Joe-Pye weed (Eupatorium alissimum), and false boneset (Kuhnia eupatoroides) dominated certain parts of the fields. Annual grasses, especially foxtail, became increasingly prominent, and dominated extensive patches. Saplings, especially those of American elm (Ulmus americana), also became increasingly prominent until by 1957 the edges of the fields bordering woodland had become dense thickets, with trees up to twelve feet high.

Throughout the woodland, in general, the trend was toward larger size in the second growth trees, and shading out of the understory layer including not only saplings of the climax species, but species such as red haw (Crataegus mollis), crab apple (Pyrus ioensis), redbud (Cercis canadensis), dogwood (Cornus drummondii) and wild plum (Prunus americana). Later, in 1953 and 1954, there was extensive mortality in trees of all sizes, particularly American elm and black oak (Quercus velutina), as a result of drought and disease. Large gaps in the leaf canopy opened up permitting the establishment of various weedy herbs, notably wild lettuce. The dead trees are in process of disinte-
gration, producing an abundance of rotting logs and hollow snags, such as has not existed before since the area first came under control of white immigrants.

While most of the woodland areas were fenced and were protected from livestock throughout the nineteen forties, the wooded hillsides of "Horse Woods," "Skink Woods," and "Rat Woods," were connecting strips between pastures and were exposed to grazing and browsing until 1949. At that time the three areas had little underbrush or herbaceous vegetation, and were relatively open as compared with adjoining parts of the woodland over the fence. By 1957 the reverse was true; the formerly browsed woodlands had dense thickets of elms, hackberries, and other young trees, up to six feet high, while in the adjoining areas the underbrush had grown taller and sparser.

Former pastures on the area, including a long flat hilltop from Angle Field on the southwest to Gate Field on the northeast, Top Field, Quarry Field, Tree Field and Point Field, also on hilltops, and Picnic Field, House Field, Dike Field, Gully Field and Cow Field in the two small valleys, have changed even more than the woodlands. Formerly these fields had only a few trees, which were of medium to large size, and the awnless brome grass (Bromus inermis) and bluegrass (Poa pratensis) which provided the chief forage were mixed with many weedy forbs, notably nightshades, spurge, vervains (Verbena sp.), milkweeds (Asclepias sp.), lespedeza (Lespedeza striata), germander (Teucrium canadense), and ironweed (Vernonia baldwini). In succeeding years since grazing was discontinued, the brome has made up an ever-increasing proportion of the herbaceous vegetation and all the weedy species have become

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**Fig. 3.** Map of an area in the northwestern quarter of the Reservation, where field work was most concentrated, showing ten-foot contour intervals, distribution of woodland (tree pattern) and grassland, roads and buildings, diversion ditch, hilltop outcrop of rock ledges (stippled), and other details. The maps in Figs. 4 to 10 and 16 to 24 include parts of this same area.
scarce. At the same time young trees have sprung up in profusion. These saplings are unevenly distributed, as in some parts of the fields, especially near the edges they form dense thickets, while in other areas, farther removed from seed sources, they are relatively sparse.

An area in the northwest corner of the Reservation was long maintained as bluestem prairie but by 1957, after approximately 20 years of protection from fire and mowing, encroachment of woody vegetation, including dogwood, sumac (Rhus glabra), blackberry (Rubus argutus), and saplings of various trees, had crowded out so much of the grassland vegetation that on the hill slope the area had assumed the aspect of a thicket. On the adjacent hilltop, encroachment proceeded much more slowly, and was temporarily halted in April, 1956, when a fire spread from neighboring land and burned over this small hilltop prairie patch. The fire killed most of the woody vegetation, including hundreds of young boxelders (Acer negundo). In 1956 and 1957, big bluestem (Andropogon gerardi) made up the bulk of the vegetation in this prairie plot. Other kinds of prairie vegetation including many kinds of legumes, and composites that were abundant on an adjacent plot to the north (on the Rockefeller Tract) were scarce or absent on the prairie of the Reservation.

An upland area under cultivation in the nineteen thirties, and so heavily eroded that most topsoil was lost, included Road Field and High Field which were sown to seeds of native grasses in May, 1949. By 1957 the perennial grasses were well established and dominated the area causing it to have, superficially, the aspect of a prairie, but only a few of the grasses and forbs typical of prairie were present on this area. Deep gullies cut by torrential rains when the area was cultivated, have become largely revegetated but there are still barren patches on the steep banks. The stand of perennial grasses is not continuous but there are intervening weedy patches, with goldenrod and aster dominating. Dry Field and Slope Field constituting the eastern part of this upland field area were not sown to native grasses, and revegetation has proceeded slowly. Erosion continues, with vegetation sparse, and many small areas of bare soil intervening. Goldenrods, aster, lespedeza and three-awn grass (Aristida oligantha) are the most prominent plants.

Aquatic and riparian habitats are not well represented on the Reservation. The pond near the headquarters was variable in extent, depending on weather trends, but never covered more than an acre. Originally constructed in 1936, this pond had been nearly filled with silt fifteen years later. It was deepened along the side adjacent to the dam and an outlet pipe was installed in 1953-1954. Although water has been present continuously since then, the level has fluctuated widely. Aquatic vegetation consists chiefly of pondweed (Potamogoton sp.), naiad (Najas guadalupensis), wapato (Sagittaria latifolia), and cattail (Typha sp.). The willow grove that has overgrown the silted portion of the pond has a dense understory vegetation with various hydrophytic plants. Some of the willow trees have grown to a trunk diameter of six inches, and many of them have died and fallen, creating a tangle of dead trunks amid the thick weedy vegetation.

The intermittent creeks that flow through the two small valleys have cut deep and narrow gullies. Their bottoms are gravelly. Hydroseral vegetation is scarce. At the upper ends of the small valleys the creeks emerge from steep rocky ravines on the wooded hillsides. After heavy rains these rocky stream beds are filled with torrents of muddy water, but ordinarily they are dry.
Vegetation adjacent to these channels differs little from that found elsewhere in the woodland, except that sycamore trees tend to be concentrated there.

In the spring of 1957, the Rockefeller Tract, a quarter-section adjoining the western half of the Reservation on the north (Fig. 2) was acquired by the University of Kansas as an adjunct to the Reservation itself. Unlike the Reservation, the Rockefeller Tract is not maintained rigidly as a natural area. Rather, it is manipulated in various ways with the object of restoring and maintaining a tall-grass prairie vegetation on the portions that are not woodland. Several species of vertebrates ordinarily absent or rare on the Reservation were common on the Rockefeller Tract and were studied there in 1957. This 160-acre area had an eight-acre virgin prairie (mowed annually for hay) in the southwest corner, and had blocks of woodland in the remaining three corners, but most of it was under cultivation. An 18-acre block in the east-central portion was overgrazed pasture, dominated by bluegrass but with many weedy annuals. A small artificial pond in this pasture had often been dry, but held water throughout 1957. The northwestern and northeastern parts were north slopes of oak-hickory woodland somewhat different from any on the Reservation, with a high proportion of red oak (*Quercus rubra*) and with linden (*Tilia americana*) and certain other species not found on the Reservation. The southwest corner consisted of a ravine and hilltop, with a few large elms and other trees, and with thickets of underbrush, especially blackberry, dogwood and young honey locusts. The cultivated parts of the Rockefeller Tract had been used for growing of milo, oats, wheat, barley and alfalfa for many years. Soil had become considerably impoverished through erosion and long continued cultivation. On the edge of the cultivated land the level is one to two feet lower than that on the adjoining prairie as a result of loss of topsoil through sheet erosion.

In April, 1957, the pasture and formerly cultivated portions of the Rockefeller Tract were disked as preparation for a seedbed, and were sown to seeds of native grasses, chiefly little bluestem (*Andropogon scoparius*), with smaller proportions of big bluestem (*Andropogon gerardi*), Indian grass (*Sorghastrum nutans*), switch grass (*Panicum virgatum*), and with some forbs characteristic of tall-grass prairie. By July, 1957, weedy vegetation, chiefly sunflower, ragweed (*Ambrosia artemisiifolia*), and dogbane (*Apocynum cannabinum*), had sprung up, shading the slow-growing perennial grasses. To reduce competition from these weedy species, the area was mowed. By late summer, annual grasses, notably foxtail (*Setaria sp.*), and crabgrass (*Digitaria sanguinalis*) made up a major portion of the vegetation.

As a result of the more open terrain and different vegetation, the Rockefeller Tract in 1957 provided favorable habitat for the sparrow hawk, kingbird, barn swallow, horned lark, loggerhead shrike, lark sparrow, English sparrow, chipping sparrow, and a few other kinds of vertebrates that likewise rarely or never visited the Reservation. Dickcissels, meadowlarks, and redwings were also common in the open areas. Field sparrows, indigo buntings, and cardinals were common along woodland edges. Birds of the woodland were not known to differ from those of the Reservation. In the pasture of the Rockefeller Tract the Plains harvest mouse was common. Otherwise mammals of this tract were not known to differ from those of the Reservation. Woodhouse's toad, common on the Rockefeller Tract, was the only species of cold-blooded vertebrate well represented on this tract but not regularly present on the Reservation.
Accounts of Species

Fishes

Pimephales promelas Rafinesque
Fathead Minnow

Status.—Irregular resident and wanderer on area whenever water supply is adequate.

Habitat.—Lakes, ponds, and slow flowing streams; on Reservation limited to small creek draining eastern part of area. At maximum occurs for approximately half a mile along course of this creek, living chiefly in small pools having clay and gravel bottoms. Creek channel is within gully 15 feet or more in depth.

Movements.—From 1948 through July 1952 these minnows, and probably other kinds also, were abundant along the creek's course. Subsequently, drying progressed in the late summer of 1952, until no water remained along the creek's channel and all fish had perished. Throughout the next four years the creek was dry almost continually and no fish were present on the Reservation. On July 29, 1957, several small adults and many young of various sizes were found to be present. Frequent heavy rains in May and June, culminating in a downpour of more than six inches near the end of June had restored the flow of water, creating favorable habitat conditions and had made possible upstream migration to the area.

These small minnows tend to be nomadic, and heavy summer rains stimulate them to migrate upstream into small tributaries and spawn. In the small pools where specimens of minnows were collected, it was noticed that each fish had certain niches or crevices beneath submerged rocks in which it sought shelter when too greatly disturbed.

Among many kinds of small fish which might conceivably reach the Reservation by migrating upstream from the Kansas River to the heads of the small tributaries, the fathead minnow is the only one known to have been present in 1957. In future cycles of wet weather perhaps other kinds of fish will reappear on the area. Nevertheless, it is certain that in the past one hundred years, habitat conditions for fishes in general have undergone progressive deterioration on the area. Before major portions of the drainage systems were subjected to cultivation, and to heavy grazing by livestock, run-off was much less rapid. The two small streams were then much different in character, meandering, with many pools and
sloughs, through their partly wooded valleys. The molluscan fauna, represented by numerous unfossilized shells in the deposited silt of the creeks, included several pond-living or semi-aquatic species which have either disappeared from the area altogether, or are now confined to the one small pond (Fitch and Lokke, 1956: 444). Severe erosion has occurred. Much topsoil has been washed away, especially in upland fields, and the creeks have incised their channels to form gullies that are as much as 20 feet deep, in places. With each heavy rain there is further gully-cutting, but the rate has been reduced. Protection of most of the watershed from grazing and cultivation probably has been instrumental in checking erosion. The water supply has become uncertain and fluctuating, often turbid and with occasional flash floods. The fathead minnow seems better adapted to survive under such unfavorable conditions than does any other species of fish.

**Ictalurus melas** (Rafinesque)

**Black Bullhead**

*Status.*—Occasional and temporary resident, at least formerly; none present in recent years.

*Habitat.*—Ponds, lakes, dams and sloughs, or slow-flowing streams.

*Movements.*—In 1951 and 1952, schools of young were seen in the small creek in the eastern part of the Reservation. In 1954 after exceptionally heavy rains in June, a small group was in the creek at the west boundary of the Reservation. All these were young less than an inch long which had moved upstream in schools, after heavy rains.

**Lepomis cyanellus** Rafinesque

**Green Sunfish**

*Status.*—Reaches area as an occasional wanderer, when water supply is sufficient.

*Habitat.*—Streams with slow moving water, or ponds and lakes.

*Movements.*—In late June, 1954, several days after heavy rains, three were collected in a pool at the west edge of the Reservation. From the behavior of these sunfish it appeared that they were preparing to breed. The heavy rains, following prolonged drought, had seemed to initiate a breeding cycle, and had caused the fish to run far upstream into this small tributary.
Amphibians
Ambystoma tigrinum Green
Tiger Salamander

Status.—Occasional wanderer; only two found in nine years of field work.

Habitat.—Both individuals recorded were in funnel traps in woodland along hilltop rock ledges, when the surface of the soil was still damp after rain. One was caught on October 24, 1951, the other on October 7, 1955.

Movements.—There is no evidence that the tiger salamander breeds on the Reservation. Both individuals recorded were immature and of approximately the same size, 140 mm. total length. They probably had travelled considerable distances after metamorphosis. The nearest known breeding place was a slough in the Kansas River Valley, approximately two miles farther south.

Scaphiopus bombifrons Cope
Plains Spadefoot

Status.—Few records have been obtained from the Reservation, and it is unlikely that this secretive toad is regularly present even in small numbers. Its voice has never been heard in the choruses of breeding salientians at the pond.

Habitat.—Breeding choruses of spadefoot toads have been heard at several places within a two-mile radius south and west of the Reservation. From the location of these choruses it seems that the spadefoots occur chiefly in the Kansas River flood plain and the fairly level land near its margins, although one small pond, on the tip of a spur of hilltop projecting out into the valley, was used. Burrows of small mammals are probably an essential feature of the habitat. Pocket gophers (Geomys bursarius) were abundant near the places where spadefoot choruses were heard.

Movements.—None was recorded on the Reservation until May 8, 1955, when an adult female was caught in a funnel trap in a ditch bottom near the headquarters approximately 3000 feet from the nearest pond where choruses had been heard, and a mile from places where other choruses had been heard to the south and west. On July 13, 1956, after a heavy rain, two recently metamorphosed young were found at points 1900 feet and 3000 feet from the hilltop pond near the south boundary of the Reservation, where a chorus
had been heard some nine weeks earlier. In the summer of 1957, ten spadefoots, including both adults and young, were caught in funnel traps in the western half of the Reservation.

**Bufo terrestris** Bonaterre

**Common American Toad**

**Status.**—Abundant resident.

**Habitat.**—Rocky situations in open woodland, or near woodland edge, perhaps provide optimum habitat. The shelter provided by flat rocks, with damp, loose soil underneath, is an important factor. This toad is not narrowly limited in its habitat requirements, and probably uses the entire area, but it is seldom found in open fields with high dense vegetation. It breeds in the pond and, when sufficient water is available, in the two small intermittent creeks, in marshy situations where the current is normally sluggish.

**Movements.**—In the breeding pond each trilling male shifts position frequently with no attachment to a specific location. Usually not more than a dozen males were calling at any one time, and they tended to be concentrated within an area perhaps 30 or 40 feet in diameter, but with a few well separated from the main aggregation. However, from night to night the location of the main aggregation shifted. An individual was often seen to swim for a distance of several yards to take up a new position, and occasionally a marked individual recaptured after a short interval was found to have crossed the pond from one shoreline to another. Males that were members of breeding choruses were recaptured after intervals of 53 days, 31 days, 24 days, 23 days and several shorter periods. It is uncertain whether these males had left and returned in the intervals.

Occasionally toads were found in their daytime retreats, in hollows beneath flat rocks excavated partly by their own efforts. Tenure of such shelters was found to be brief. For six immature toads whose shelters were checked from time to time, known occupancy averaged only 9.5 days. The longest known tenure was one of 26 days. Recorded shifts (in feet) from one shelter to another were: 150, 100, 65, 50, 30, 25. All the toads involved in these records were immature individuals several weeks or several months old.

Size of home range was suggested by successive captures of seven individuals all living in the headquarters area. The total of twelve movements averaged 47 feet, indicating a home range of approximately .16 acres. This figure is almost certainly too low for a typical
home range because the resident toads were most likely to be re-
captured when they were moving over the sidewalks or lawn ad-
jaacent to the buildings, and were least likely to be noticed when
they moved farther away. The longest movement recorded was one
of 150 feet, in two days.

The newly metamorphosed young, like those of other salientians,
disperse rapidly and wander widely in wet weather. On May 30,
1955, swarms of young were noticed at the edge of the water, many
still having tail stubs. Two days later the young were no longer
confined to the water's edge but were abundant on damp ground
near the pond. One had travelled 400 feet from water, but most
were still much nearer the pond. On June 8 one was found on a
wooded hilltop 700 feet from the pond and at an elevation 100
feet higher, and by the following week the young had dispersed to
every habitable situation.

Travel is undertaken at times when the humidity is high and the
soil is damp. The young toads soon become familiar with their
surroundings and each settles within a small area. Marked young
have been recaptured, after periods of days or weeks or even months,
near the original location. One marked on August 9, 1951, when it
was 39½ mm. in length, was recaptured 150 feet away on April 30,
1952.

Breeding choruses were heard at several farm ponds within a
half-mile radius of the single breeding pond on the Reservation.
Ponds and intermittent creeks are well distributed over the general
area; consequently individuals need not travel more than half a mile
to spawn. One male caught and marked as a well grown young
(51 mm.) on a wooded slope on May 7, 1953, was recaptured in a
breeding chorus at the pond some 1900 feet away, a little more than
a year later. A female marked when she was about half-grown was
recaptured 150 feet away, in the pond, as a breeding adult nearly
22 months later.

Bufo woodhousei Girard
Woodhouse's Toad

Status.—Scarce and irregular resident.

Habitat.—This toad is much more numerous on adjoining closely
grazed pasture and cultivated fields than it is on the Reservation,
where it has been found only in grossly disturbed situations, along
the road, on or near the lawn, and at the pond. It would seem that
the woodland, and the dense herbaceous vegetation present in
grassland, render conditions unfavorable for it over most of the
Reservation.
Movements.—Most records of this species on the area were obtained in 1955, 1956, and 1957. On July 4, 1956, for most of the day, two were calling at the pond where none had been heard before, although several other ponds within a mile of the Reservation were used regularly for breeding. In 1955 an adult female was seen on September 19, 21, and 23, and on October 10, within a 50-foot radius about the house. Another large adult female was recorded near the house on September 24, 1955, and again on August 21, 1956. Six young were found near the house, in late August and September 1955, and in July, August and September, 1956.

*Acris gryllus* Le Conte

**Cricket Frog**

Status.—Resident, and at times perhaps the most abundant of all species of vertebrate animals on the Reservation, although its numbers vary greatly in response to weather conditions, and time of year.

Habitat.—Water, either stagnant or running, is the chief requirement.

The cricket frog is present about the pond and along the two small creeks and their tributary gullies, wherever moisture is normally to be found. Shallow water, either stagnant or with sluggish current, along muddy banks supporting thick grass, provides the most favorable type of habitat. The proportion of the area habitable at any one time depends upon the humidity and moisture supply; at times when moisture conditions are favorable there is dispersal throughout the woodlands and parts of the open areas. In time of drought the population dwindles, and becomes restricted to the remaining limited area with a water supply.

Movements.—Cricket frogs tend to stay in damp places but may wander extensively along creek beds and pond edges in dry weather, and almost anywhere in wet weather. Available evidence, from direct observation on individuals, and from recapture of marked frogs, seems to show that there is but little tendency to remain within a familiar area.

In the spring of 1955 I made effort to mark those in a small area—a strip about 70 feet long along the pond edge at the northwest corner. At each successive visit most of the frogs taken were new, unmarked individuals, indicating a high rate of population turnover. The numbers of new and recaptured individuals taken on various dates were as follows:
April 22 2 males and 5 females marked.
June 12 8 males and 5 females marked; no recaptures from April 22.
June 13 5 males and 5 females caught, all new except 1 male from June 12.
June 16 2 males and 6 females caught; 1 male and 2 females from June 12.
June 20 3 males and 3 females caught; 1 male and 2 females from June 12, and 1 male from June 13.
June 21 1 male and 1 female caught, the female from June 20.
July 2 3 males and 8 females caught, including 1 male and 1 female from June 12 and 2 females from June 20.

The pond's circumference amounted to some 1100 feet and most of the frogs disappearing from the strip under observation probably remained somewhere along its borders. However, one adult female marked on April 11 was recaptured on May 29, 500 feet west of the pond on damp soil in a ditch bottom.

On many occasions, in rain or mist, cricket frogs have been seen travelling far from permanent water, in tall grass of fields, in undergrowth of wooded slopes, or crossing roads. Each heavy rain seems to trigger a mass migration from the normal habitat of marsh, streamside, or pond. The migrating frogs seem to wander at random until, presumably, they perish from lack of moisture as dry weather again sets in. Only a small percentage would be likely to find suitable conditions permitting them to survive. In the summer of 1951 the frequent heavy rains permitted extensive wandering. At an old quarry 600 feet from the pond and approximately 100 feet higher, a depression in the limestone, several inches deep and three feet in diameter nearly always contained water and several cricket frogs usually could be found in the vicinity.

The frequent dispersal and decimation of the population relieves overcrowding in the streamside or marshland habitat. Also, it ensures that any area of suitable habitat will be found and occupied. The frogs are able to travel far and rapidly, as they easily cover two or three feet at a leap. Hence, they are able to seek out remote and isolated areas of habitat at the times when they are wandering.

The larval and postlarval development is rapid, and the crop of young cricket frogs produced one year seemingly attains sexual maturity in time to participate in the next breeding season. The reproductive potential is therefore high, with normally an adequate surplus to repopulate all available habitats.
Hyla versicolor Le Conte
Gray Treefrog

Status.—Common resident.

Habitat.—For breeding evidently requires semi-permanent stagnant pools with mud bottoms and weedy vegetation; some occur in this type of situation throughout summer, but most adults disperse from breeding pool to woodland early in summer. Occurs throughout woodland preferring situations where trees are large and where there are low shrubs; least favorable woodland is open type on dry south slopes, consisting mainly of honey locust and osage orange. Occasionally found in woodland edge situations.

Movements.—Of 113 treefrogs marked in the course of eight seasons of field work, only five were ever recaptured. Most of the frogs marked were adults in breeding aggregations at the pond. One male marked at the edge of the pond on May 2, 1955, was recaptured 30 feet away on June 1. Each of two others recaptured after shorter intervals had moved approximately 30 feet.

An adult female was found in a niche in the vertical rock face at the old rock quarry on July 14, 1950. On August 18 she was recaptured 90 feet farther along the rock exposure. On August 26 she was recaptured a second time at an intermediate location. Another adult female found on the outside wall of the house on October 5, 1952, was recaptured there on October 18. The records of these two frogs suggest that an individual tends to settle in a limited area, for periods of weeks, at least. The adults are not commonly seen except at the breeding ponds, and information concerning their movements is difficult to obtain.

Newly metamorphosed treefrogs, unlike chorus frogs, toads, and narrow-mouthed toads, do not disperse rapidly from the breeding pond. By the time the treefrogs have metamorphosed, in middle or late summer, annual vegetation such as smartweed, giant ragweed and cattail, has grown tall and rank, providing shade and maintaining high humidity near the wet ground. The young treefrogs live on these broadleaved plants. In several different years they remained abundant near the pond up until the time when cold weather arrived.
Pseudacris nigrita Le Conte
Chorus Frog

Status.—Abundant resident, but with great variation in population level from year to year; wide fluctuations in numbers are affected by varying success of breeding season.

Habitat.—Grassland seems to be preferred, but some have been noted in woodland or at the edge of woodland. This frog is so secretive in its habits that it is rarely seen, and its abundance would scarcely be suspected, were it not for the attention attracted by breeding choruses. Impressions regarding habitat preferences have been gained chiefly by observations on the dispersal of the newly metamorphosed young, and the situations where calling adults have been heard, away from water, just before onset of the breeding season. Such bits of information indicate a wide choice of habitats. The frogs seem to be largely subterranean in their habits. Most of those found were under rocks. Probably burrows of the prairie vole, and other small mammals, are important in the chorus frog’s ecology.

Movements.—Chorus frogs are active above ground mainly while rain is falling, or afterward while soil and vegetation are still wet. The records are fairly uniformly distributed throughout the year except for December and January. Excluding those frogs that were found in or beside water, 38 of the 44 records for adults were in grassland or open weedy situations, and only six were in woodland. Similarly, 29 of the 36 records for young were in grassland and other open situations. Chorus frogs found in woodland were generally in the more open parts. Most of the frogs found at water were either breeding adults or newly metamorphosed young. A seeming exception was an adult male found at the edge of the pond with swarms of cricket frogs on October 20, 1955.

Chorus frogs found at times other than in rainy weather, or under extremely humid atmospheric conditions were in well protected situations, typically under flat rocks. Whether the frogs carry on all their activities underground for long periods or emerge regularly to forage by night, is uncertain. On the average, they breed well before other local salientians in spring, sometimes even in February, but rain is a necessity for migration to the breeding ponds. In 1956, when no spring rains occurred, breeding was much delayed at the pond on the Reservation, although the supply of water was adequate. Throughout April and early May, 1956, whenever there were warm days with high humidity, one was heard
Fig. 1. Eastern end of "House Field" in the headquarters area of the Reservation, August 4, 1951. The foreground vegetation consists of awnless brome grass, interspersed with various weeds, notably vervains, ironweed, milkweeds, and ragweeds. The prairie vole, cotton rat, western harvest mouse, glass lizard, and yellow-bellied racer were abundant in the area shown. When this picture was taken, herbaceous vegetation was especially luxuriant as a result of abundant summer rain. The area shown is included in all the maps, figs. 2 to 24.

Fig. 2. Another view of the eastern end of House Field with dam and willow grove in background, August 4, 1951. Brush and young trees encroaching into the field have created a typical "edge" habitat favorable to the cottontail, pine vole, cardinal, indigo bunting, and field sparrow.
Fig. 1. Site of old limestone quarry on southward projecting spur of hilltop, October 13, 1949. Limestone strata are prominently exposed with cracks and fissures, providing shelter for many kinds of small vertebrates. Level rocky area in foreground has a sparse vegetation of lespedeza and ragweed. The open, rocky area was especially favorable habitat for various reptiles including the box turtle, collared lizard, racerunner, Great Plains skink, slender-flat-headed snake, red milk snake, prairie king snake. The narrow-mouthed toad, striped skunk, woodrat, white-footed mouse, bob-white, and broad-winged hawk also frequented this place.

Fig. 2. Diversion ditch at edge of woodland near Reservation headquarters, June 21, 1949. The bare soil of the banks and rocky bottom provided favorable habitat for the six-lined racerunner. This ditch was a travelway for coyotes, foxes, opossums, various kinds of snakes, and in wet weather, amphibians including the spadefoot toad, American toad, cricket frog, bullfrog, leopard frog, and narrow-mouthed toad.
Fig. 1. Woodland of a rocky upper slope, dominated by chestnut oak, July 22, 1950. Many kinds of vertebrates prefer this habitat type. Some species that attained their maximum numbers here were the narrow-mouthed toad, American toad, worm snake, copperhead, short-tailed shrew, mole, gray squirrel, and white-footed mouse.

Fig. 2. Hilltop rock ledge in woodland dominated by American elm, November 7, 1951. The ledge provided shelter for many kinds of animals, notably the opossum, short-tailed shrew, woodrat, and cottontail. In autumn various species of snakes including the timber rattlesnake, copperhead, yellow-bellied racer, black rat snake, king snake, garter snake and water snake repair to such places to find shelter for hibernation.
Fig. 1. Eroded hilltop field at end of 6th growing season after sowing native grass seeds in April, 1949. Side-oats grama to left of gully, and switch grass to right. Deep gully choked with vegetation and erosion almost stopped. U. S. Soil Conservation Service photo, November 9, 1954.

Fig. 2. Another part of same field (shown in Fig. 1) without native grasses, eroded from cultivation in the 1930s. U. S. Soil Conservation Service photo, November 9, 1954.
Fig. 1. Pond 200 yards east-northeast of Reservation headquarters on November 1, 1951. Cattails, and other hydrophytic vegetation surround the open water. American toads, narrow-mouthed toads, treefrogs, chorus frogs, cricket frogs, leopard frogs and bullfrogs bred in abundance here. Water snakes and snapping turtles preyed upon them. Redwinged blackbirds nested in the marsh.

Fig. 2. Upland prairie in northwestern part of Reservation, October 13, 1951. Foreground was part of a farm (later purchased as the Rockefeller Tract) and was subjected to annual mowing and occasional burning. A rich flora of characteristic prairie plants remains. In background, on Reservation, is prairie area not subjected to burning or mowing for many years, dominated by big bluestem, but having fewer associated species than the mowed area. Trees in background are along rock ledge at top of brushy slope. Photo by Robert Rose.
Intermittent creek in deep gully in southeastern part of Reservation, November 7, 1949. The aquatic fauna here was meager, but fathead minnows were often present in the creek. American toads, cricket frogs, chorus frogs, and leopard frogs bred in the pools. Coyotes, opossums, raccoons, and skunks regularly hunted along this gully, and used it as a travelway.
calling, in a three-inch iron culvert beneath the sidewalk at the Reservation headquarters. It was not known to have emerged.

Rate of dispersal of the newly metamorphosed young was observed in 1951. On the night of June 6 there was a heavy rain and on the following morning there were swarms of young at the quarry, having migrated 200 yards overnight up a wooded slope from the pond at 100 feet lower elevation. Similar rapid dispersal of young has been noted on other occasions. Otherwise little is known concerning movements from day to day and over longer periods, because none of those marked was ever recaptured.

**Gastrophryne olivacea** (Hallowell)

**Great Plains Narrow-mouthed Toad**

*Status.*—Common resident.

*Habitat.*—Perhaps this species occurs throughout the entire area, but it prefers rocky situations in grassland or open woods, and is abundant along hilltop rock ledges, especially where there is open woodland. Less frequently these toads have been seen or trapped in open fields of the valleys or hilltops. They are secretive in habits and nocturnal in movements and finding them is difficult where there are no flat rocks to turn. In such situations they probably depend upon burrows of other animals for shelter. Breeding occurs at the pond and at a rain pool a few hundred feet from the south boundary of the Reservation. Several times, in summer, after periods of unusually heavy precipitation, when water had collected in small weedy depressions in hilltop fields, these toads were heard calling in them.

* Movements.*—Freiburg (1951: 384) published findings concerning movements of marked narrow-mouthed toads on the Reservation. More recently Fitch (1955) analyzed the findings concerning movements that have resulted from the capture and marking of 1215 individuals over a six-year period. Only eight percent of the toads marked were ever recaptured. The mean distance for movement for all individuals recaptured was 72 feet. The secretive habits of the toads render them difficult to study. Those that moved farthest from the places where they were marked were least likely to be recaptured, since most of the work was concentrated on small study areas.

Certain individuals were found in the same niche under a flat rock over periods of days or even weeks, but these individuals were exceptional. Of the relatively few that were recaptured, most were
not found at the same place on successive occasions. An individual seems to have no definite permanent home base, but the habits are sedentary. The toads ordinarily do not venture away from their protected shelters except when the soil and vegetation are wet, during or soon after heavy rains.

Of the 59 individuals recaptured after one or more hibernations, 47 were adults, many of which had made one or more round-trip migrations to the breeding ponds. Most of these toads were recaptured in the general vicinity of earlier captures, indicating a homing tendency. Of the toads that were recaptured at greatest distances (hundreds of feet) from the point of release, several were at the breeding pond or *en route* to it in heavy rains. One adult female was caught in the same funnel trap in both 1954 and 1955 while making the trip between the home range and the breeding pond, suggesting a tendency to follow a definite route on successive trips to water.

The concept of home range does not apply well to animals having habits like those of the narrow-mouthed toad, which does not range regularly over a definite area, but occupies in succession a series of subterranean niches in the same general vicinity. When weather conditions are favorable the toad migrates to a nearby niche and does not necessarily ever return to the one it has left. The niche occupied provides protection from enemies, and from extremes of the hostile outside environment; also it provides a regular food supply (chiefly ants of the genus *Crematogaster*).

Narrow-mouthed toads that were recaptured even after intervals of weeks, months, or years, were most often less than 50 feet from the site of original capture. For greater distances, up to 400 feet, there was gradual decrease in the numbers of individuals. Several individuals recaptured at distances in the neighborhood of 400 feet from an original location were later recorded to have moved back near the original site. Therefore it seems that some “home ranges” may have a maximum diameter as great as 400 feet although certainly the usual diameter is much less.

**Rana catesbeiana Shaw**

**Bullfrog**

*Status.*—Resident, with a large population at the pond.

*Habitat.*—The pond, normally having a surface area of about one-half acre, and adjoining marshy areas of somewhat greater extent, provide the habitat to which this frog is normally limited on the Reservation. Although this small area is normally such favor-
able habitat that it supports hundreds of adult and partly grown bullfrogs, the population often has been decimated by drying in late summer.

**Movements.**—When drying is in progress, dispersal of frogs occurs mainly at night, or at other times when humidity is high. At such times the frogs are frequently seen in high grass, often along the creek bed and sometimes hundreds of feet from it, in the bottomland valleys. They have seldom been found on wooded hillsides. Their dispersal is less random than that of leopard frogs, and they tend to keep to low ground where the chances of finding water are better.

Bullfrogs were abundant at the pond in 1952, but in mid-July the pond dried and all were eliminated either by death from desiccation or migration down the creek bed ¼ mile or more to places where water remained. On the afternoon of July 10 when humidity was high, a large adult was found in high grass more than 100 yards from the pond. It did not attempt to escape when disturbed, but stood high off the ground and inflated its body to assume a threatening posture.

The pond held water in late spring and early summer of 1953. On May 18 a bullfrog was calling there. It must have travelled at least half a mile—farther if it followed the creek bed. Others reached the pond in the next few weeks but the population remained low and was again eliminated when the pond dried in late summer. In 1954 the pond did not dry, and by early 1955 several adults had become established.

In late May and early June, 1952, 24 bullfrogs were marked with colored tags. A total of 14 recaptures and sight records were recorded; in five instances no measurable movement had occurred; two had moved approximately 10 feet, 3 approximately 20 feet, 2 approximately 30 feet, and one approximately 40 feet. Each individual kept to its own small area within the pond. However, over periods of weeks there was a reshuffling of individuals. Home ranges, if they existed at all, were ephemeral.

**Rana pipiens** Schreber

**Leopard Frog**

**Status.**—Resident, with high population at pond, and occurring throughout entire area, population density and extent of area occupied varying greatly according to season and weather conditions.

**Habitat.**—Largely dependent on stagnant or sluggish water, at pond and to lesser extent, along two small creeks.
In moisture laden vegetation, when humidity is high, after rain or heavy dew, the population may disperse to every habitat of the Reservation. The frogs, especially the partly grown juveniles, are commonly found in woodland throughout the summer.

**Movements.**—Leopard frogs commence breeding in early spring, and by early summer the tadpoles are completing their metamorphosis. In dry weather large numbers accumulate in the moist areas along margins of creeks and ponds, but during and just after heavy rains there is a mass dispersal, with relatively few remaining behind. The breeding season may continue from early March until mid-summer or even later, and successive waves of migrants emanate from the breeding ponds throughout the summer. Presumably most of them perish without finding a suitable water supply. However, if drought conditions are not severe, they may survive for days or weeks, staying in protected shelters under rocks, logs, or boards, when humidity is low, and moving about at night. Adults as well as young participate in the mass migrations from the breeding ponds. Travel is fairly rapid on the overland migrations. On rainy nights the frogs have been seen in the glare of automobile headlights hopping across roads. Within a few hours after heavy rains, frogs have been caught in funnel traps on slopes and hilltops hundreds of yards from the pond, where probably the trip was begun.

No evidence of home range nor tendency to keep within a familiar area has been found in the leopard frog. Of several dozen marked and released at different times, none has been recaptured.

**Reptiles**

*Chelydra serpentina* Linnaeus

**Snapping Turtle**

**Status.**—Moderately common as a resident or transient.

**Habitat.**—Confined to pond and two small streams on area, so far as has been observed.

**Movements.**—Over a seven year period 18 snapping turtles have been captured and marked on the Reservation but none has ever been recaptured. Twelve of those marked were hatchlings; the remaining six were large adults. Several other large ones were seen that were not caught. The evidence thus far obtained suggests that these turtles wander more or less indefinitely following up and down the small intermittent creeks according to the water supply.
Terrapene carolina Linnaeus

Eastern Box Turtle

Status.—This species is tentatively classed as an occasional transient or resident, on the basis of one record. The Reservation is slightly outside the known range, which extends from the east into nearby Wyandotte and Franklin counties, Kansas. However, there is an old (and somewhat doubtful) record for Manhattan, Riley County (Smith, 1956: 137).

Habitat.—Deciduous forest and edge.

Movements.—The only record is of a large adult found by Donna Fitz Roy on May 29, 1958, 250 feet south-southwest of the Reservation headquarters. It is almost certain that this individual had recently come to the area; otherwise it would have been seen as frequently as the other box turtles having ranges in this vicinity.

Terrapene ornata Agassiz

Western Box Turtle

Status.—Resident on area, but in sparse population as compared with numbers in more favorable habitat elsewhere.

Habitat.—Probably this terrestrial turtle occurs throughout the area but it has not been found in the fallow fields that have rank growths of weeds so tall as giant ragweed and sunflower. Grazed pastureland provides the most favorable habitat, woodland next, open fields with undisturbed prairie vegetation or with brome grass and weed mixture are less preferred, and the rank weed habitat of recently fallowed fields seems to be least favorable.

Movements.—Because box turtles were scarce on the Reservation, the information obtained concerning their movements was meager. However, in the closely related Terrapene c. carolina, movements have been studied more thoroughly than in any other kind of animal (Stickel, 1950). Probably T. ornata is similar to T. carolina in the extent and pattern of its movements. Stickel found that in T. carolina the average range of adult males was 330 feet and that of adult females, 370 feet; the difference was not statistically significant. Home ranges are maintained from year to year, but overlap widely with no indication of territoriality. Within the area of its home range a turtle seems to wander in an aimless manner, making numerous turns, criss-crossings and detours. However, there seems to be a tendency to return to certain places and to travel repeatedly over certain relatively short preferred routes; "One turtle walked
over a single short stretch of path seven times in eight days, travelling over diverse areas between times.” (Stickel, op. cit.: 367).

Fourteen box turtles marked on the Reservation were recaptured from one to nine times. Seven were adult females, six were adult males and one was a juvenile of undetermined sex. The time span involved was within a single season for three; two seasons for four; three seasons for two; and four, six, and seven seasons for the other three. In 30 instances distances between successive sites of capture averaged 325 feet. One exceptionally long movement of 1830 feet was made by a female in a 53-day interval. This movement probably represented wandering well outside the usual range, and there-

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**Fig. 4.** Range of an adult female box turtle recorded 17 times from June 17, 1954, to July 31, 1957.

**Fig. 5.** Range of an adult female box turtle recorded 11 times from July 11, 1949, to May 25, 1957. The area of activity for this individual probably is much larger than for the one shown in Fig. 4; in the interval of nearly eight years the one concerned in Fig. 5 altered her home range extensively.
fore is best eliminated from the figures used to estimate size of home range. For the remaining 29 movements, the average was 274, and there was but little difference between the sexes (average for seven males, 282 feet; for 22 females, 270 feet).

Assuming random movement over the home range (although Stickel's findings suggest that the movements are not entirely random), and assuming that captures recorded were within the regular home range of the individual involved (except for that of the individual that had moved 1830 feet), the radius of the home range, in the neighborhood of 274 feet, indicates that an area of approximately 5.4 acres is covered.

One turtle was brought to the Reservation headquarters and released approximately half a mile from its original location. Nearly a year later it was found only 210 feet from the point of release. This single observation suggests that homing tendencies are either totally lacking or weak in the box turtle.

On several occasions box turtles were equipped with trailers, a spool of thread rotating on a spindle and unwinding as the turtle travelled. Such turtles usually travelled several hundred feet in the course of a day. Several individuals equipped with such trailers were kept under observation for periods of a week or more by John M. Legler, who also has made much more extensive studies of the box turtle's natural history and ecology in grazed pasture habitat west of Lawrence.

Chrysemys picta Schneider
Painted Turtle

Status.—Recorded just once in fall of 1951, at pond.

Habitat.—The one individual seen was basking in the sunshine on a floating board in the pond. The species is known to occur in lakes, large ponds, and sluggish streams where the water supply is sufficiently extensive and permanent to provide shelter and to support an aquatic fauna upon which the turtle depends for food.

Movements.—No definite records of movements have been obtained, but the abrupt appearance of the single adult individual at the pond, perhaps 1½ miles from the nearest suitable habitat, indicates that it must have made an overland journey of this distance; or it might have followed up the creek from a larger stream, which would have involved an even longer trip.
Crotaphytus collaris Say
Collared Lizard

Status.—Permanently resident, 1949 to 1956, but with few individuals, and limited to small area, at quarry.

Habitat.—Requires open, sunny situations, with loose rocks; habitat represented on Reservation only at old rock quarry.

Movements.—Suitable habitat on the Reservation over the period of study was limited to an area at an old rock quarry approximately 400 feet long and 100 feet wide. The colony under observation was small; 56 individuals, in all, were recorded over a seven-year period, but these represented several successive generations. Although there was territorial pressure, the colony showed no tendency to expand into adjacent habitats. They filled the quarry area to the extent of its carrying capacity, and so far as known, those that were eliminated were taken by predators without having left the area. At times when the population was crowded, as a result of successful reproduction, incidence of mortality was notably increased because of intraspecific friction. Recently hatched young, partly grown young that are attaining sexual maturity, and adult males that are dominated by others are especially susceptible to elimination.

Hatchling collared lizards, escaping from the nest burrow in broods of two to a dozen or more, tend to disperse immediately and wander for at least a day or two, to distances up to a hundred feet, or perhaps more; consequently they are not concentrated where they would compete with each other or where several at once would be captured by a predator. Hatchlings recently emerged have been noted to run in a random and aimless manner when attempting to escape. Others, still less than a week old, have been noted at each alarm to run to a regular place of shelter, a burrow or crevice providing security. Such young obviously had already become familiar with their immediate surroundings, and in their day to day activities they tend to stay in home ranges only a few yards across, consisting of one or several look-out rocks for perching and basking, and as escape shelter. Over periods of days or weeks, nevertheless, the juvenile may gradually shift its activities to a place many rods removed from its original home range. Also, the size of its home range is gradually increased.

From the time they are about a quarter-grown in bulk (75 to 80 mm. in snout-vent length), males are territorial. On September 30,
1953, when no adult males were present, the eight young males all approximately seven weeks old, were almost uniformly spaced along the 400-foot stretch of ledge at the quarry. Pursuit and fighting resulted immediately when any one of the young males was chased into the area dominated by another.

Ordinarily no more than two adult males were present at the quarry, and they divided the 400-foot stretch of ledge between them. A break in the outcrop near its middle separated the two territories, each of which was dominated by a succession of different males.

Territories tended to be linearly arranged along the 400-foot stretch of the quarry, as the lizards usually stayed close to the rock outcrop. They perched and travelled mainly along the bare rock at the top of the ledge and the shallow layer of bare soil adjacent to it. As a result of quarrying operations some years before, there was an exposed vertical rock face four to six feet high below the ledge, and a taluslike accumulation of sloping rock and soil with weeds and saplings which the lizards also used. The width of the outcrop and the rocky area below it averaged about twenty feet, and the lizards' activities ordinarily were confined chiefly to this width. Occasionally they ventured out on the adjacent flat, almost barren, limestone area. Grasshoppers, which constituted the lizards' main food supply, were abundant on this flat, but shelter was lacking, and at any alarm the lizards would rush back to the ledge.

Because of such occasional use of areas outside the usual sphere of activity, the extent of home ranges or territories cannot be stated with precision. One female that was recorded more than 100 times over a six year period was always within an area of approximately 300 feet x 40 feet. She was known to have shifted her headquarters several times, and the area covered in any daily or weekly period would have amounted to only a small part of the total area of 12,000 square feet covered in her lifetime. Individuals differ notably in the extent of their ranges. A female from the same brood as the one mentioned above, early became established at the opposite end of the quarry area. She was remarkably sedentary in her habits, and it is estimated that she spent at least half of her time within an area of only a square yard. Nearly always she was seen within a few yards of the same crevice, into which she quickly retired at any alarm. But to lay her eggs, she moved along the ledge some 150 feet from her home base. The adult and nearly adult females present at the quarry at any one time usually arranged themselves in territories that were mutually exclusive, or nearly so. The females
are much less aggressive than the males, but occasionally pursuit and attack of one individual by another has been observed. Individuals of the opposite sex, so far as observed, were never objects of territorial hostility. Males and females were often associated in pairs even at times when there was no breeding activity. The males have territories that average several times as large as those of females. In August, 1950, the four adult females present occupied stretches of ledge from west to east, 100 feet, 70 feet, 60 feet and 25 feet long. At times when only one adult male was present, he would range along the entire 400-foot length of ledge. The adult males were generally tolerant of partly grown males and, even though the latter were sexually mature, did not pursue or attack them. The small males were wary of the adults and did not challenge their dominance.

**Ophisaurus attenuatus** Baird

**Slender Glass Lizard**

**Status.**—Common resident.

**Habitat.**—This species occurs in grassland portions of the area; also in woodland edge situations and in open woodland or parkland with a herbaceous ground cover. It was seen only a few times in 1948 and 1949, when the pasture areas were grazed. The lack of adequate cover under these conditions was unfavorable, and probably the lizard was able to persist only because of the cover provided by marginal situations, along edges of fenced woodlands and edges of thorn thickets where herbaceous vegetation was at least partly protected from livestock. In later years glass lizards have been seen more frequently, and a high proportion of those seen were young, suggesting successful reproduction and steady increase with amelioration of habitat conditions after grazing was discontinued and by 1957 they had become moderately abundant.

**Movements.**—Over a seven-year period a total of 108 glass lizards have been captured, marked and released, and 31 have been recaptured from one to eight times. For most, the records extended over periods of months. Eighteen were caught in only one year, six over two years, three were caught over a four-year period, and four over three years.

These lizards are secretive and seem to travel but little, relying to a large extent on dense cover and concealing coloration to escape notice of both prey and predators. Most time is spent underground, or at least beneath the surface mat of dead vegetation. Many glass
lizards, including all of those that were recaptured, were known to live in the field within 300 yards of the Reservation headquarters where my field work was concentrated. Yet seeing a glass lizard in this area was a rare occurrence. Even when conditions of temperature and humidity seemed near optimum for them to be in the open, the area might be traversed several times by a person without his seeing one.

Glass lizards were usually found in tall grass and were remarkably elusive. One that was startled would dart away with rapid lateral undulations of its body, usually permitting no more than a glimpse of it. In this initial spurt the lizard rarely traversed more than ten feet but it was always difficult to relocate, as its dark brown color blended well with the background of old dead vegetation of the surface mat. Relying on concealment the lizard might permit close approach before moving again. Or it might move away slowly and stealthily with none of the commotion of its initial spurt. Occasionally in stalking a glass lizard in high grass I have “flushed” it four or five times in succession before finally catching or losing it. Working alone I have most often failed to make a capture, but when accompanied by one or more other persons, I have often been able to direct their movements in such a way that the glass lizard was driven toward me, came within easy reach, and was secured with a sudden grab. This maneuvering involved in flushing, stalking and capture of a glass lizard was generally within an area not more than 20 feet in diameter. If not caught within a minute or two, the glass lizard invariably found shelter and disappeared. In some instances it may have merely wriggled beneath the surface mat of dead vegetation. In other instances, however, glass lizards were seen to escape into burrow entrances of the prairie vole. The extensive underground runway systems of the voles may provide the retreats where the glass lizards spend the greater part of their time when they are not active on the surface.

In 36 instances the intervals between successive captures ranged from 280 feet to 10 feet, and averaged 88 feet, indicating home ranges in the neighborhood of .55 acres. The records are not sufficiently numerous to show conclusively the differences between the sexes, and between young and adults, but they do suggest that such differences exist. For adult males (20) the average was 98 feet, for immature males (11) 90 feet, and for adult females (5) 43 feet. Those that hibernated one or more times between captures are not included in these figures. For 15 such intervals the average
movement was 282 feet (850 to 20), indicating that there is some tendency to shift the home ranges over long periods. However, only one individual had moved more than 500 feet.

_Cnemidophorus sexlineatus_ Linnaeus

_Six-lined Racerunner_

_Status._—Locally abundant on several small areas of Reservation until 1956; much reduced in numbers since then.

_Habitat._—Patches of barren soil seem to be the essential habitat requirement; therefore the species has been confined to relatively small areas on the Reservation. Habitat deterioration has progressed as luxuriant vegetation encroached on sites that formerly had a sparse vegetation or were largely barren. The quarry formerly supported the largest number. A hilltop field formerly cultivated, and heavily eroded, with topsoil washed away and subsoil dissected by a system of gullies, supported a moderate population in 1948. At that time the area was partly barren with sparse vegetation of bindweed, three-awn grass, and lespedeza. In the following years as grass and weedy vegetation encroached, bare areas were increasingly restricted to the bottoms and steep sides of the gullies, and the lizards became correspondingly scarcer. By late 1952 few remained but in the following four years of drought they partially regained their numbers. A diversion ditch carrying water from the pond about 1000 feet along the base of a hillside, between woods and an open field, was usually dry except after heavy rains when the pond overflowed. In 1952 the dry channel of this ditch was occupied by a colony of these lizards, which found the bare soil of the ditch bottom and banks a favorable habitat, and thrived there for the next five years.

_Movements._—The racerunner is far more active than any other species of reptile on the area. Individuals move about almost constantly when they are active, and are capable of great speed. In its normal foraging this lizard moves over areas of bare soil with a brisk, jerky gait that seems to be half running and half walking. Individuals foraging in this way have often been followed for as much as 200 feet in the same general direction.

The racerunner shows a strong tendency to stay in a familiar area. Many of those marked were recaptured frequently, up to as many as 25 times, and successive captures were nearly always in the same general area. On the Reservation the individual areas of the lizards tended to be long and narrow, probably because barren ground occurred in strips along the hilltop ledges, gully banks,
ditch and road. In a more typical habitat of sand dune or open field, a home range probably would be more nearly circular or oval. For the entire group a total of 290 movements between successive captures were recorded and the average movement was 141 feet, but with notable disparity between the sexes, and between young and adults. For 102 movements of females the distance was greatest, 171.3 feet; for 188 movements of males average was 125 feet, and 42 movements of young averaged 99 feet.

The young were of both sexes and various sizes, from hatchlings to subadults. Observations on hatchlings indicate that at first they stay within an area of only a few yards, and that as a lizard grows, becoming fleeter of foot and more familiar with its surroundings, the sphere of activity gradually enlarges to the size of the adult’s home range.

The partly barren area of the ditch banks and bottom, providing favorable foraging grounds for racerunners, averaged approximately 25 feet in width. If the lizard wandered at random along the length of the territory, it is calculated that any two records of an individual would, on the average, be separated by a distance 35 per cent of the range’s full length. On this basis the figures already cited would represent home ranges of .25 acre for all race-
runners, .28 acre for adult females, .20 acre for adult males, and .16 acre for young.

Frequently, both on the Reservation and elsewhere, racerunners have been seen in locations familiar to me, where none had been observed previously. Obviously, at times they leave the areas habitually frequented and make movements of an exploratory nature. Exceptionally long movements recorded for the marked individuals recaptured in the course of my field work were 1100, 700, and 600 feet (and back again) for adult males; 900, 750, and 750 feet (and back again) for adult females, and 650 feet for a young male. The previously mentioned hilltop quarry, and the ditch in the field near the headquarters of the Reservation were separated by a wooded slope 600 feet across at its narrowest. The woods were thick, with tangled undergrowth, and seemed entirely untenable as habitat for the racerunners. Nevertheless, several that were first caught and marked at the quarry were later recaptured along the ditch bank. Also, on several occasions, lizards that were not individually identified, were seen in the woods. Most of these were on a man-made trail where ground vegetation was sparse and trampled, making running easier for them. Probably this trail served as an avenue of travel and permitted the racerunners to cross the wooded slope more easily than they could have otherwise.

Having large feet and powerful claws, racerunners are efficient burrowers, and excavate underground retreats into which they retire at night and in periods of inclement weather. On many occasions racerunners have been found in small nest cavities beneath flat rocks. Such cavities do not constitute permanent home bases, as an individual has rarely been found more than once in any one nest cavity.

The temporary nest cavities seem to be defended. On several occasions lizards, even young less than one-third grown, have been seen to dart out of burrows in pursuit of others that had started to enter, and chase the intruder for several yards. Chasing has been noted frequently, but it is usually sexual pursuit or masculine hostility not involving the defense of a definite territory. Individuals overlap extensively in their ranges. In favorable habitat a given situation may be used by several or many individuals of both sexes.
Lygosoma laterale (Say)

Ground Skink

Status.—Uncommon resident.

Habitat.—Woodland and woodland edge are preferred; the records of this species on the Reservation are perhaps too few to define its habitat requirements with precision, but seem to indicate that it occurs in all types of woodland, and ordinarily does not invade open fields beyond the shade of adjacent woodland. It is usually found in ground litter of fallen leaves and has been found most often in situations dominated by oak or hickory. One was at a board pile in the edge of a field of brome grass a few feet from the edge of hickory woods. Several were taken at a rock pile near the pond, adjacent to woodland. Several were found in grass in a parklike situation beneath large elms near the headquarters. One was found in bluestem prairie about 40 feet from trees and brush near its border.

Movements.—No records of movements were obtained; of a dozen individuals marked and released none has been recaptured.

Eumeces fasciatus Linnaeus

Five-lined Skink

Status.—Resident throughout the wooded parts of the Reservation.

Habitat.—Occurs in all types of woodland but in varying abundance; most numerous in hilltop ledge situations in open woods, and least numerous on heavily wooded north slopes where thick canopy permits little penetration of sunlight to forest floor. Flat rocks for shelter are an important requirement and where they are scarce or absent skinks are correspondingly scarce.

Movements.—In a recent publication (Fitch, 1954:99-115) I have discussed in some detail the data concerning movements of five-lined skinks accumulated over a four-year period. Several hundred skinks were marked and released, mostly on study areas of only a few acres. A total of 323 marked skinks were recaptured, many after one or more hibernation periods. None was captured frequently. Seven captures were the maximum recorded for any individual, and
these were spread over a period of nearly four years. In almost every instance of recapture of a marked skink, the actual distance of travel and the time, frequency and motivation were unknown. Although the records were inadequate to show the home range of any one individual, they were sufficiently numerous to show the trends according to sex, age, and lapse of time. Five-lined skinks are secretive, living where there is abundant shelter in the form of leaf litter, decaying wood and rocks. They stay under cover most of the time, and when travelling, they move furtively, always keeping near cover. The home range usually centers about a decaying log or comparable shelter, and the size and shape of the range is altered accordingly. Home ranges averaging approximately 90 feet in greatest diameter are indicated both for adult males and young. These skinks seem to have no regular home base, but use any convenient shelter within the area when they are inactive, or escaping from enemies. The adult females, however, have regular nest burrows in which they usually stay, except for occasional brief emergences to find food, from the time they become pregnant in early May until after the eggs hatch in July or August. On their brief forays for food these nesting females usually venture only a few yards from their burrows. Although they occasionally leave the nest burrow and eggs to forage, they then range much less widely than at other times. Several male skinks that were recaptured repeatedly were shown to have moved back and forth within areas 200 to 275 feet in greatest diameters, which constituted their home ranges. Others were limited to much smaller areas. A rock pile of approximately 70 x 30 feet harbored many skinks of both sexes and various sizes because food and shelter were abundant there. The rock pile was bordered on three sides by areas unsuitable as habitat, and on the fourth side the habitat also was much less favorable than in the rock pile itself. The rock pile or parts of it constituted the entire home range for all the skinks present there. These skinks are not territorial but males are hostile and fight on sight in the breeding season.

**Eumeces obsoletus** Baird and Girard

**Great Plains Skink**

**Status.**—Confined to relatively small parts of area where its habitat is present; there moderately common.

**Habitat.**—This large skink typically lives in open grassy situations with large flat rocks. Hundreds of captures have been recorded, mostly within four small areas totalling only a few acres
in extent. Perhaps not much more than one percent of the area is regularly occupied, and the habitable area steadily diminished as ecological succession proceeded with woody vegetation steadily encroaching. Under original conditions, with the area mostly prairie, the hilltop rock ledges several miles long, must have supported a large population of these skinks. By 1955 they dwindled to four separate relict colonies, one at the quarry, and the other three along stretches of rock ledge and adjacent woodland that were grazed by livestock until 1949 (the remainder of the rock ledge and woodland was fenced and protected from livestock beginning in the 1930's).

_Movements._—"The usual concept of a home range does not apply well to the Great Plains skink despite its tendency to remain within a small area. One skink may spend many days in its small burrow system under the same rock, or else if it does emerge at all it makes only short trips and then returns. But such shelters and burrow systems are temporary, generally occupied for only a few days, or, at the most, a few weeks. Then the skink moves on to another site, often only a few yards away. Later as it shifts to still other successive locations, it ordinarily does not move farther in the same direction, but tends to keep within a small area, probably using the same travel routes and depending on the same landmarks. The 'home range' encompassing the area to which normal movements are confined, is, however, ill-defined, because it is covered infrequently and has no definite boundaries, and its size, shape and position are ephemeral." (Fitch, 1955: 69.)

Great Plains skinks were much less numerous than five-lined skinks on the Reservation, but, for individuals, records of recapture were more frequent. Over a four-year period 634 captures were recorded for 208 individuals. In general, individuals tended to stay within areas more than 50 feet but less than 150 feet in greatest diameter. Males are more vagile than females and adults are more vagile than young. For twelve adult males each recorded in at least four locations, the average distance between most remote points of capture was 125 feet; for six adult females and seven juveniles comparable figures were 75 feet and 60 feet respectively. All these were selected individuals that moved back and forth without making long shifts. For 226 recorded movements of marked individuals; between successive captures, mean distances were as follows: adult males (80), 70 feet; adult females (51), 31 feet; young (95), 39 feet. The higher figure for adult males is influenced by the
fact that they are more inclined to shift. Eliminating the few movements of more than 200 feet, which are obviously shifts in most instances, average movements are: adult males, 51 feet; adult females, 19 feet; young, 30 feet. On this basis it is estimated that home ranges are .2 acre or less in adult males and of even smaller size in the females and young. Not included in these figures are the 45 movements in the intervals that included one or more hibernation periods, 121 feet for 16 adult males, 119 feet for 10 adult females, and 81 feet for 19 young. These figures suggest that the lapse in day to day routine and the seasonal change in habitat associated with hibernation often induce individuals to shift to new home ranges. These skinks often do shift away from an original home range to a new area more or less remote from it. Over periods of months or years many of the skinks on the study areas turned up at locations hundreds of feet from the areas encompassed by a series of early capture records. After such a long movement a skink never returned to an original home range. The longest record of movement was one of 500 feet (830 feet if the skink kept to the usual rock ledge habitat) in an individual whose records extended over 47½ months.

On many occasions skinks seemed to appear abruptly on study areas that had long been under intensive observation. After an original capture some such individuals were often recorded regularly over periods of weeks or months, indicating that they had settled in the new location after immigrating from a more or less remote location.

Unlike most other kinds of reptiles occurring on the Reservation, Great Plains skinks dig well in soil that is loose and moist, and they spend most of their time in the burrows that they have excavated. The burrows may be several inches or several feet in length and usually they are under rocks. A skink may stay in such a burrow for periods of days, then may emerge, wander briefly, and begin a new burrow a few yards away. In the breeding season, May and June, adults are often found in pairs in their burrows under large, flat rocks. Such burrow systems may be thought of as temporary small breeding territories because they are never occupied by more than the pair of adults, and the male will viciously attack intruding males.

Although these skinks seemed to be disappearing from the Reservation by 1955, they made surprising gains in numbers in 1956 and 1957, and even appeared in several areas where they had not been recorded previously.
**Eumeces septentrionalis** Baird

**Prairie Skink**

**Status.**—Only three recorded on Reservation, perhaps survivors of relict colony.

**Habitat.**—All three skinks were found on lower slopes of hillsides having southern exposures, in grassy places sparsely wooded with osage orange, honey locust, dogwood and haw, grazed by livestock until 1949. As compared with most other places in northeastern Kansas where the species has been collected, these sites differed in having encroaching woody vegetation, and more rank herbaceous cover. Discontinuance of grazing is resulting in the elimination of this skink's habitat.

**Movements.**—In the summer of 1953 one was caught twice, at stations 100 feet apart in funnel traps set in a ditch between woodland and grassland. Breckenridge's (1943) study of marked individuals of a local colony of these skinks suggests that the species is at least as sedentary in habits as is *E. fasciatus* or *E. obsoletus*.

**Natrix sipedon** Linnaeus

**Common Water Snake**

**Status.**—Uncommon, and probably irregular, resident, its number influenced by uncertain water supply.

**Habitat.**—Mainly in vicinity of permanent water supply, either stagnant or running; in spring and autumn has been found along hilltop rock ledges far from water, and evidently seeks such situations to hibernate.

**Movements.**—Of 23 water snakes marked and released, four have been recaptured. A large adult female caught twice in 1949 was recaptured in 1952 and 1953. All captures were at the pond or near it, with the exception of the second 1949 record, which was some 450 feet farther west along a diversion ditch. Of two young females recaptured, one was taken in early September and again the following May in the same rock pile near the pond. The other was recaptured after a three-month interval less than 100 feet from the original location, beside the pond. A juvenile was recorded three times within a 15-foot radius, at the Reservation headquarters in September 1953. The records of these several marked individuals that were recaptured demonstrate that individuals may live for periods of months or years where there is a limited and isolated water supply. The other records suggest that individuals occasionally wander long
distances to find such habitat. Stickel and Cope (1947:129) recorded one recaptured at a distance of 380 feet after a lapse of two years.

Storeria deayi Holbrook

Brown Snake

Status.—Uncommon resident; actually may be more numerous than some of larger snakes that are considered moderately common, but is seldom seen because of small size, secretive habits, inconspicuous dull coloration, and preference for situations with dense ground cover.

Habitat.—Woodland in damp, well-shaded situations where leaf canopy is dense; also in wet situations near stagnant or running water.

Brown snakes are most commonly found in late March or April, under flat rocks, often associated with ring-necked snakes and worm snakes.

Movements.—No information has been obtained; none of several brown snakes marked and released has been recaptured.

Thamnophis sirtalis Linnaeus

Common Garter Snake

Status.—Common resident.

Habitat.—Damp situations wherever its prey, earthworms and amphibians, are available. The pond and the two small creeks provide the most preferred habitat, but this garter snake also ranges far and wide through moist fields and woodlands. Garter snakes have been caught in greatest numbers in October, in funnel traps set along hilltop rock ledges, which are preferred hibernation sites. The ledges chosen are those in warm and dry situations, with south-facing exposures.

Movements.—A total of 150 garter snakes had been marked and released on the area and 22 had been recaptured by the end of 1956. Twelve of these records were of snakes recaptured after one or more hibernation periods. In eleven instances the distances between successive capture locations averaged 688 feet (777 feet for seven males and 532 feet for four females) indicating home range areas in the neighborhood of 34 acres (or 43 acres in males and 20 acres in females, if the differences between the sexes in this small sample are representative). Movements to or from hilltop rock ledges, where hibernation dens usually are located, were not
included in the computation of average movement between captures. In most instances travel to or from the hibernation den must have taken the snake well beyond the limits of the usual range. The longest movement recorded was one of 2300 feet, in a female first caught as a juvenile at a hilltop ledge on October 25, 1950. An adult male recorded at a hilltop ledge twice in November was recaptured 1040 feet from there in a bottomland meadow the following May. No garter snake was recaptured in the same denning area after an intervening summer, although in several instances a snake was recorded more than once in a denning area in the same autumn, or in autumn and again in spring. From the trend of the records, it seems that garter snakes have some attachment to definite areas, but tend to range more widely than most other snakes, and, over periods of months or years may wander into new areas. Of 97 records on the area, 49 were at hilltop ledges, 30 were in the vicinity of water including several at a rock pile near the pond which was also used for hibernation, 13 were in grassland and five were in woodland. Double or multiple catches were made in funnel traps much more often than might have been expected from chance. The catch might consist of three males (once), two males and a female (twice), two males (twice), two females (twice), male and female (five times). Most of these catches were made along hibernation ledges, and it seems probable that trailing by scent of one snake by another was responsible for the double or multiple captures. This idea is borne out by the fact that when a garter snake was removed from a trap on one day, a second was often caught on the day following.

Carpenter (1952:250) studying a population of this species in Michigan found the average “activity range” to be about 600 feet in length and 150 feet in width, thus having an area of 2.07 acres.

**Haldea valeriae** (Baird and Girard)

Smooth Earth Snake

**Status.**—Rare and seldom seen (only two records) because of secretive habits, but probably resident on Reservation in small relict population.

**Habitat.**—This small, burrowing snake lives chiefly in deciduous forest. Here, in the northwestern corner of its range, it seems to prefer open woodland with rocks and brush but not a continuous leaf canopy. The species is known from only five localities in Kansas (Smith, 1956:287), these clustered in or near Douglas County, where the Reservation is situated.
Diadophis punctatus Linnaeus
Eastern Ring-necked Snake

Status.—Abundant resident; at times this snake probably outnumbers, in individuals, all other kinds of vertebrates on the Reservation.

Habitat.—Optimum habitat seems to be in open woodland with abundant flat rocks. Ring-necked snakes do not often bask in direct sunlight, but regulate their body temperatures by maintaining contact with the undersides of rocks warmed by sunshine. They are largely subterranean in habits. They are relatively scarce in woodland with a continuous leaf canopy shading the ground. In meadow habitat, where rocks are absent, the snakes are difficult to find, but have been seen on many occasions crawling through the grass or crossing roads. On several occasions they have been found in underground tunnels of the prairie vole. Several have been found in the humus and litter beneath the stick houses of woodrats.

Movements.—The ring-necked snake is probably the most abundant reptile of the Reservation, but because of its secretive tendencies, attempts to study it were remarkably unproductive. A total of 333 have been marked and released, mostly in 1950 and 1951, but only 11 recaptures for ten individuals have been recorded. Most of the individuals marked were in small areas of favorable habitat where intensive field studies were in progress, which should have greatly increased the chances of recoveries. However, of the ten individuals recaptured, seven were taken after intervals of less than a month, and perhaps had not had time to wander far from the original location. An eighth was a juvenile caught and marked shortly before going into hibernation (October 2) and recaptured the following spring at the same place soon after emergence (April 26). Of these eight, two had moved 60 feet, one 30 feet, and the remaining five had made no measurable movement. An adult male caught and marked on April 26, 1950, was recaptured 90 feet away on May 1, 1951. An adult male marked on April 27, 1951, was recaptured 350 feet away on May 22, 1954.

These small snakes may not have regular home ranges as they seem to wander widely. Each year in April and May, ring-necked snakes were found in large numbers in certain rocky places that were evidently optimum habitat at that time of year or served as hibernation sites. Most of the individuals marked were those found in such places, which had an almost complete turnover of the
population from year to year. Evidence of wandering was obtained frequently. The grassy field where the Reservation headquarters are situated was much less favorable habitat than the rocky slope where the snakes were more often found. However, on many occasions, when temperature and humidity were favorable, the snakes were seen crossing the road or crawling through high grass. Strips of tarpaper were placed on the ground in many places in the field. When weather was moderately cool and soil was moist, ring-necked snakes usually could be found under these strips, but none of these was ever recaptured.

Carphophis amoenus Say
Worm Snake

Status.—Common resident.

Habitat.—This snake occurs throughout the wooded portions of the Reservation and along woodland edges. Most individuals have been found in open rocky woods. Nearly all were uncovered in loose soil beneath large flat rocks. These snakes have been found chiefly in the rock-strewn portions of the woodland, but perhaps are not actually concentrated in such situations to the extent that my records would suggest, since it would be far more difficult to find them in the absence of rock cover. Isolated large rocks in woodland often have worm snakes hiding under them. Loose damp soil is a necessity. The snakes are found mainly in April and May, and are little in evidence later in the season, when evidently they retreat deep underground. In periods of rainy weather when the soil is unusually damp, they may be found occasionally in the types of situations frequented in spring, while in periods of dry weather, they cannot be found at all.

Movements.—Worm snakes usually stay beneath the surface of the soil. They are more specialized for fossorial life than any other species of reptile occurring in the area. The head is small and flattened, with snout spade-like, lower jaw counter-sunk, eyes minute, and cephalic plates reduced. The neck is especially thick and muscular, adapted for driving the head through soft soil. I have never found a worm snake travelling above ground in the open. Such travel is indicated by occasional individuals caught in pitfalls or funnel traps, but probably they emerge only under cover of darkness.

Of 137 worm snakes marked and released, nine have been recaptured. One was recaptured four times, another twice and the others
only once each. Seven were recaptured only in the same season they were marked; the other two were recaptured in the following season after lapses of 12 months and 10½ months. A large adult female had moved 410 feet between May 19 and June 7, 1951, but all other individuals were much more sedentary. An adult male had moved 50 feet between May 30, 1949, and April 14, 1950. An adult female had also moved 50 feet between April 30 and May 25, 1951, but on May 29, May 31, and September 14, she was found within five feet of the second location. An adult male had moved 20 feet in 38 days. Each of the other individuals either was recaptured under the same rock where the snake was captured originally or had moved no more than five feet. Span of records between first and last captures for these individuals were: 352, 5 (with three captures), 5, 4, and 2 days.

The trends of these meager data seem to suggest that worm snakes have no home range in the usual sense, but tend to stay for long periods in the soil at the same place, moving mainly in vertical planes in response to changes in temperature and moisture. Occasionally individuals may make relatively long shifts, perhaps wandering at random, and then may settle in new locations. There is no evidence that the snakes ever return from such wanderings.

**Coluber constrictor** Linnaeus

Yellow-bellied Racer

*Status.*—Common resident.

*Habitat.*—Occurs throughout the entire area with seasonal shifts.

In summer it ranges over grassy fields, especially those of the two small valleys, also in bluestem prairie, along woodland edge thickets, and in open woodland where some herbaceous ground cover is present. In fall most of the population or all of it resorts to hilltop ledges for hibernation, after moving across wooded areas to reach these sites, in some instances.

* Movements.*—By July 15, 1955, a total of 337 yellow-bellied racers had been marked and released on the Reservation and 74 had been recaptured, mostly after substantial intervals. Forty-two were recaptured after lapse of a year or more. Four was the maximum number of captures for any one individual.

In the area of the Reservation, yellow-bellied racers spend most of the active season in prairie, pasture, or hay field habitat or occasionally can be found in glades of open woodland. However,
in autumn there is a general shift to hilltop rock outcrops, where clefts and fissures provide dens for hibernation. After moving to the rock outcrops the population is much more concentrated than it is on the summer range. As a result, most of the individuals re-captured (48 of the 74 total) were taken only along hilltop rock outcrops. These were classed as follows: 8 adult males, 11 adult females, 17 yearling males, 7 yearling females, 4 hatchling males, and one hatchling female. Although these groups are too small for statistical comparison, the trends do not appear to be significantly different. Excluding several that shifted from one hilltop ledge to another distant one, the mean movement for 48 was 210 feet, ranging from 0 to 875. For the 26 recaptured after intervals of a year or more, the mean distance was 174 feet. Individuals may return year after year to the same part of the hilltop rock outcrop. After 55 months a large female was found 300 feet from the original site of capture. Another was found at 390 feet after 43 months.

Eleven individuals were caught both at a hilltop rock outcrop, where presumably they had come to hibernate, and in a bottomland valley where presumably they spent the summer, providing some idea of the distance of travel to and from the hibernation ledges. Distances ranged from 500 to 1360 feet and averaged 770. The tendency seems to be for the racers to seek the nearest suitable stretch of ledge rather than to make an unnecessarily long trip to one that is farther away. Hilltop fields near or adjacent to the ledges where snakes hibernated also provided suitable habitat. Two individuals were caught both at a ledge and in a hilltop field, and they had moved distances of 230 feet and 1350 feet.

Twenty-three individuals were recorded and then recaptured away from outcrops in the areas where, presumably, they live during the summer. One of these was caught as a hatchling and recaptured 19 months later at a distance of 1500 feet. This long movement probably represents one or several shifts rather than normal use of a home range. Another hatchling male had moved 470 feet in 18 months. The remaining 21 movements were all of adults. For 13 records of males the average was 567 feet, indicating an average home range of 23 acres, and for nine records of females the average was 367, indicating home ranges of 9.7 acres.

Eight of the individuals captured at hilltop ledges had made relatively long movements, probably having shifted permanently away from the original site of capture. These movements were:
Fig. 8. (A) Capture locations of an adult male yellow-bellied racer (6 records, October 21, 1953, to July 15, 1957); and (B) capture locations of an adult female. In each instance summer records were in a grassy bottomland field, but fall records were at hilltop rock ledges where the snakes came to hibernate after moving 138 to 200 yards up a wooded slope.

3150 feet in six months, hatchling female; 3000 feet in two months, yearling female; 2950 feet in 31 months, adult female; 2900 feet in three months, yearling male; 2700 feet in two months, subadult female; 2430 feet in two months, adult female; 2250 feet in twelve months, yearling female; 1250 feet in six months, yearling male. Because field work was mostly limited to a square mile area, and was concentrated to a large extent on relatively small parts of it, the chances of recapturing individuals that made long movements were poor. The number of long movements actually recorded therefore seems high. Possibly much longer movements may be made occasionally. Much more information is needed concerning the vagility of the species. With the information available at present it can be said that individuals have a strong tendency to stay within the same home range, and to traverse an area that may be several times the diameter of the home range to return to the same hibernation shelter each autumn, but that some, of both sexes and various ages, may shift permanently for half a mile or more beyond the original range of activities.
Elaphe obsoleta Say
Black Rat Snake

Status.—Moderately common resident, evidently utilizing all parts of area.

Habitat.—This snake is characteristic of deciduous forests; on the Reservation it has been found most often along hilltop rock ledges. It is notorious as a climber and raider of birds' nests. It often has been found along woodland edge and even in open fields. The open field situations are utilized chiefly in summer, when there is high grass.

Movements.—Of 159 black rat snakes marked and released on the Reservation 22 were recaptured. Many of those marked were small young which probably had a short life expectancy and, in some instances, perhaps had not yet established themselves in definite areas. Some adults were caught in outlying areas that were seldom visited in the course of routine field work, and the opportunities for recapturing them were limited. For the adults captured within the area where field work was concentrated, the incidence of recaptures was relatively high. Span of records, in months, for the 22 individuals were: 49, 48, 48, 44, 42, 32, 25, 24, 22, 21, 20, 20, 17, 15, 12, 12, 12, 10, 8, 1, 1, 1, and 0. From the trend of these records it is evident that adults and well grown young remain in familiar areas for periods of years, or perhaps for life. Greatest distances recorded as covered by black rat snakes were: 2200 feet (adult male in 44 months), 1650 feet (adult male in 49 months), 1650 feet (adult male in 21 months), 1600 feet (hatchling in 32 months), 1560 feet (adult male in 42 months), 1450 feet (half-grown male in 24 months), 1200 feet (adult male in 24 months), 1100 feet (hatchling male in 22 months). Thirteen others had moved distances of less than 1000 feet.

Several of those that made long movements were recaptured later, back nearer the original capture point, suggesting that they were still within a home range. For example, an adult male first recorded on October 5, 1949, was recaptured 1900 feet away on June 12, 1950. On April 21, 1953, he was captured a third time 2200 feet from the second location but only 300 feet from the first location. Another adult male was caught on July 16, 1950, September 19, 1950, October 3, 1950, May 15, 1951, June 12, 1952, June 17, 1954,
and July 19, 1954. The second and third captures were at approximately the same place on a hilltop ledge more than 1000 feet from the other six capture points, which were all within a hundred-foot radius near the Reservation headquarters. Another adult male caught on June 6, 1950, June 2, 1952, April 27, 1953, May 9, 1954, June 6, 1954, and July 27, 1954, was found at four places in the headquarters field, over a distance of 1380 feet, and shifted back and forth between this field and a hilltop ledge three different times, covering distances of 850 to 1350 feet in doing so.

![Fig. 9. Capture locations of an adult female black rat snake recorded eight times in a six-year period.](image)

For the total of 38 movements between successive captures, the average distance was 817 feet. Stickel and Cope (1947: 129) recorded ten movements of black rat snakes, ranging from 130 feet to 1760 feet and averaging 767, on the Patuxent Research Refuge in Maryland. Marked disparity between the sexes in vagility was evident in the trend of my records. For the 29 movements of males the average was 897 feet, indicating a home range of 57.6 acres, while for nine movements of females the average distance was 559 feet, indicating a home range of 17.9 acres.

**Pituophis catenifer** Blainville

**Bullsnake**

*Status.*—A few individuals are permanent residents on the Reservation, but others from adjacent cultivated land resort to the area to find hibernation shelters along hilltop rock ledges.
**Habitat.**—Bullsnales live primarily in grassland but also in open woodland. Fields of alfalfa and other hay crops in nearby farmlands provide a habitat more favorable than any to be found on the Reservation itself, perhaps because of the abundance in them of pocket gophers, which constitute the chief food of the bullsnales. On the Reservation bullsnales have been found from time to time in brome grass fields and also have been found in summer in open rocky woods on south-facing slopes. The majority of those seen were individuals caught in funnel traps along hibernation ledges in October.

**Movements.**—Eighteen bullsnales have been marked and released on the area. Of the 23 captures 17 were made in late September or October, or in early spring, along rock ledges where presumably the snakes had come to hibernate. One large female was caught on September 22, 1951, crossing a county road at the edge of an alfalfa field. Nine days later she was caught 2700 feet away at a hilltop rock ledge on the Reservation. Another adult female was caught at sites along the ledge 310 feet apart on October 17, 1950, and September 1, 1953.

Some of the records suggest that these snakes trail each other by scent to the hibernation dens. On “Sugarloaf,” a hilltop overlooking an expanse of cultivated fields to the west, three large adults were caught within a few days in the autumn of 1950. In October of 1949, 1950 and 1951, an adult female was found along a 200-foot stretch of ledge where evidently she returned each year to hibernate. She was found 420 feet farther along the same ledge in June, indicating that her summer range also extended into this same area.

Imler (1945:273) recaptured 12 marked bullsnales in Nebraska and found that 11 had moved distances less than 300 yards, while the twelfth had moved 1 1/2 miles. Fitch (1949:556) working with the subspecies *catenifer* in California, recorded movements of less than 1000 feet in 25 of the 28 snakes recaptured.

**Lampropeltis calligaster** Harlan

**Prairie King Snake**

**Status.**—Scarce, but seems to be regular resident on Reservation.

**Habitat.**—Open grassy situations with flat rocks seem to be preferred. Several have been trapped in fall along old rock walls, and rock ledges in thick woods of oak, hickory and elm. Several have been found in brushy pastures of brome and bluegrass.

**Movements.**—Over a seven-year period, 16 have been marked
and released on the Reservation, but none has ever been recaptured. The secretive and partly subterranean habits would account, in part, for this lack of success, but it also seems probable that the snakes wander widely.

Stickel and Cope (1947:129) recorded two recaptures of this species (subspecies rhombomaculata); one was recaptured at the same place after one day; the other had moved 600 feet in six weeks.

**Lampropeltis doliata Linnaeus**

**Milk Snake**

*Status.*—Rare, probably with small permanent population tending to be localized in few small areas that satisfy habitat requirements.

*Habitat.*—Grassy, rock-strewn areas, usually in open woodland or at woodland edge.

*Movements.*—Over an eight-year period ten milk snakes have been marked and released, and two have been recaptured. A small juvenile marked and released on June 16, 1951, was found again after 31 days, beneath the same piece of rusty sheet metal where it was originally discovered. A half-grown individual marked and released on May 26, 1955, was recaptured 12½ months later at a distance of 1320 feet from the original location, and had grown to small adult size.

**Tantilla gracilis Baird and Girard**

**Slender Flat-headed Snake**

*Status.*—Rare and seldom seen (only three records) because of secretive habits, but probably resident in small relict populations.

*Habitat.*—The three found on the Reservation and a few found at other places in northeastern Kansas were all on sparsely wooded, rocky hilltop edges of southward exposure. Of those found on the Reservation, one was at the old quarry, the other two were found in 1950 and 1956 at almost the same spot of “Rat Ledge.”

**Agkistrodon contortrix Linnaeus**

**Copperhead**

*Status.*—Common resident.

*Habitat.*—Living chiefly in woodland, the copperhead is one of the species most characteristic of the deciduous forest climax. It ranges throughout all parts of the woodland, but with some change in preference according to weather and season. Rocky upper slopes
near hilltop ledges in woods of chestnut, oak, hickory and elm perhaps provide the optimum habitat, and provide hibernation sites where there is some concentration in fall.

Shelter is provided by crevices in the ledge, and by loose flat rocks. The rocks selected for hiding places are often massive slabs several inches thick and several feet wide. In summer the snakes undergo some dispersal from these ledges throughout the woodland, woodland edge, creekside and roadside thickets, grassy fields, both in the bottom lands and on hilltops, and even to hay fields adjacent to the Reservation.

Movements.—Copperheads are sluggish by nature and seem to obtain their prey by ambush rather than by active search. Their movements are therefore usually short and leisurely, and are governed to a large extent by changes in temperature and humidity during the daily cycle. The fact that activity is largely nocturnal makes observation difficult.

A total of 94 individuals caught and marked on the area have been recaptured, after intervals of from a few days to five years. Two (both adult females) were released at distances from their capture points and they had made unusually long movements 2870 feet and 660 feet when recaptured after intervals of four months and six months. The remaining 92 individuals averaged a distance of 455 feet between capture points. The significance of this average figure is lessened by the fact that trends differed notably between the sexes and in different age groups. For 31 adult males the average of 717 feet is approximately twice that in the 25 females—353 feet. Probably difference in vagility between the sexes is even greater than these figures suggest, because of the 11 males that had moved less than 100 feet nine were recaptured after relatively short intervals of about a month, or less. Restlessness and frequent activity caused these males to be recaptured in traps or found in the open before they had moved far from the sites of original captures. However, of the six females that had moved less than 100 feet only three were captured in intervals of less than a month; others were recaptured after intervals of 45 months, 21 months, 20 months, 11 months, one month, and one month. For 36 other copperheads that were marked as young of various sizes, and recaptured, average distance was 298 feet. Thus it seems that adults of either sex are somewhat more vagile than the young. Among the juveniles, females had moved somewhat farther on the average than had males.

Difference in vagility between the sexes in adults is best demon-
strated by eliminating from consideration all those individuals re-
captured after less than six months. For the 15 males distances 
ranged from 205 to 3040 feet and averaged 1323; for the 15 females 
distances ranged from 0 to 1950 feet and averaged 292.

Of the 25 adult females two had made outstandingly long move-
ments: 1950 feet and 1350 feet. These probably represent shifts 
from one home range to another, and therefore should not be in-
cluded in a computation of home range size. The remaining 23 
movements are rather evenly distributed from zero up to 500 feet 
(with one of 655 feet), and they average 246 feet. Most probable 
home range diameter is, then, approximately 500 feet, representing 
an area of roughly 6.5 acres.

Sedentary nature of the adult females is demonstrated also by the 
frequency with which individuals were recaptured as compared 
with males and young. Of the individuals captured three times, 
seven were adult (or subadult) females, one was an adult male, 
two were immature females, and one was an immature male. Of 
individuals caught four times, two were adult females and one was 
a half-grown male. The only individual caught five times was an 
adult female. She was caught on June 27, 1951, July 17, 1951, 
August 3, 1951, August 6, 1953, and September 26, 1953, all within 
a one hundred-foot diameter.

The nature of long-time movements in adult males remains some-
what obscure. Of the 31 recaptured, 8 made movements of 1000 
feet or more as follows: 3040 feet in 12 months, 2750 feet in 12 
months, 2250 feet in 32 months, 2250 feet in 26 months, 2250 feet in 
11 months, 1300 feet in 12 months, 1120 feet in 8 months, and 
1000 feet in 19 months. On the other hand prolonged occupancy 
of a relatively small area is suggested by the following records: 
700 feet in 57 months, 650 feet in 21 months, 300 feet in 17 months, 
270 feet in 39 months, 210 feet in 20 months, 205 feet in 37 months, 
90 feet in 6 months, 60 feet in 6 months.

Available observations suggest that newborn copperheads are 
remarkably sedentary and that they extend their spheres of activity 
slowly over periods of weeks, as they gradually become familiar 
with their surroundings. On September 17, 1948, in a deep crevice 
of a limestone outcrop I found shed skins of several young copper-
heads entwined in the same mass of sticks, dry leaves, and cobwebs. 
Obviously these were snakes of the same litter, which had all shed 
about the same time, before they dispersed. According to my own 
findings and those of Gloyd (1934:600) young born in captivity
most often do not shed their skins for a number of days after birth. On September 24, 1950, a litter of young copperheads born in captivity was released at the spot where the female was originally found. On the afternoon of September 26 all seven were found again at the same place. The day was cloudy and humid, about 72° F., and all the young were in tight circular resting coils in the open. Four were within a ten-inch radius just where they had been dumped from the sack 48 hours earlier, under a skunkbush (*Rhus trilobata*). Some two hours later, when the temperature was falling rapidly, the spot was checked again. One snake had disappeared and another had begun to move toward shelter of the rock cleft. On September 28 four of the litter were again found at the same place, but a little more scattered, all within a ten-foot space. On September 30 five of the litter were found at the same place, and four were found again on the following day. Two were found there again on October 3 after a minimum night temperature of approximately 40° F.

Gloyd (1934:592) on three occasions found associations of gravid females, and found other reports in the literature. He speculated that the gravid females tend to assemble in places where conditions provide favorable shelter. On August 3, 1950, I turned a flat rock two feet in diameter and two to three inches thick and found two gravid females. They were coiled in a nestlike depression which had the damp earth of its sides packed and smooth as if the snakes had been there for a long time. While I was catching these two a third gravid female was heard gliding through the grass toward the rock, and it also was captured.

I found a second aggregation on August 9, 1950, about 400 feet from where the first group was found, under a large flat rock that was exposed to sunshine for several hours during the middle of the day. Four gravid females were lying in resting coils in contact with each other. When uncovered, they began to move about restlessly but seemed reluctant to leave the depression. While I was catching three, the fourth escaped into thick brush nearby. On the following day the fourth female was found within a few feet of the rock where the group had been, in a resting coil on the sticks of an old woodrat house beneath a bush and partly in the sunshine.

On the Reservation copperheads are too scarce to be seen frequently, and rarely is more than one found in a day, even though intensive search is made, and many rocks suitable for shelter are turned. Shelter is abundant, and similar conditions of temperature
and humidity can be found under hundreds of different rocks within a small area. Therefore it seems that the aggregations of females found are not due to chance meetings at sites where physical conditions are favorable but that the females have a definite affinity for each other causing them to seek others and remain associated with them, in suitable shelters, for extended periods.

**Crotalus horridus** Linnaeus

**Status.**—Rare resident.

**Habitat.**—This rattlesnake prefers deciduous forest, especially along hilltop rock outcrops in thick woods. Individuals range widely and may temporarily invade other habitats. One was found in brome grass at the edge of a field a few yards from edge of the woods, near the pond. One was killed in a hayfield adjoining the Reservation. The few records on the Reservation are well scattered.

**Movements.**—On September 25, 1950, an adult female was caught at a hilltop rock ledge. On October 4 she was caught only 40 feet from the first location. In the period September 30 to October 17, seven newborn young were caught within 50 feet of the female’s second location. One young was caught at the same place on September 30 and October 7; two others each moved approximately 10 feet between October 7 and October 13, and another moved approximately 10 feet between October 13 and October 17. These young were obviously litter mates. For each only a “prebutton” was recorded in the nine captures made up to October 13. On the night of October 15 one underwent its first molt while confined in a sack, and the one recaptured on October 17 also had molted. In mid-October, an estimated three weeks after their birth, these young had scarcely begun to disperse and they were probably still near their birth place when they hibernated.

A half-grown female was caught on October 14 and October 26, 1952, at the same place on a hilltop rock outcrop. These several recaptures near the original location, after short intervals show little regarding extent of home range, but emphasize the sluggish nature of rattlesnakes, which ordinarily hunt by awaiting the approach of their prey in strategic locations. After approximately 3½ years an adult female was recaptured on the same ledge 280 feet from the original location. This is the only instance of a rattlesnake re-captured near the same place after a long interval, and it seems
clear that these snakes wander widely. A large adult male marked in the autumn of 1948 was reported killed in a hay field more than half a mile away in the early summer of 1950. It was recognized by the wire marker attached to one rattle. On June 2, 1953, a large adult male was marked in a hilltop woods, and on October 16, 1954, it was recaptured at a ledge 2100 feet away. Another large male was marked in November, 1950, and almost five years later its recently cast skin was found 2940 feet from the original location. The fact that these individuals made movements among the longest for any snakes of the hundreds recaptured over a nine-year period, and that none of the 26 other rattlesnakes marked was ever recaptured after intervals of more than a few days, indicate that timber rattlesnakes travel extensively. The wandering tendency probably has been an important factor in reducing the population of rattlesnakes locally and throughout much of the range. According to written and verbal testimony of longtime residents in Douglas County, rattlesnakes were abundant on the area that is now the Reservation in the late eighteen hundreds, and even up into the nineteen twenties. Under modern conditions, with heavy motor traffic on county roads, each rattlesnake in its wanderings is liable sooner or later to be run over and killed. Copperheads, being less vagile, tend to stay on the rough wooded slopes where habitat conditions are most favorable and therefore remain common locally, holding their own against encroaching civilization even within the city limits of Kansas City and other urban communities.

Mammals

Didelphis marsupialis Linnaeus

Opossum

Status.—Common resident.

Habitat.—Primarily woodland, woodland edge, and along margins of pond and creeks; also, to lesser extent, utilizes open fields.

Movements.—Home range and movements of the opossum on the Reservation have already been discussed in a recent publication (Fitch and Sandidge, 1953). To summarize the findings of this study: Individual opossums have home ranges of irregular size and shape over which the animal roams more or less at random in the course of its nocturnal prowling. Home ranges tend to be circular or oval, with an average radius somewhere in the neighborhood of 800 feet. There is no territoriality and several or many individuals may use the same area simultaneously. Two or perhaps
more may even use the same den. The animal may shift frequently from one den to another. Home range boundaries are fluid, and the ranges are constantly altered, partly in opportunistic exploitation of new food sources that become available, and also perhaps as a result of innate wandering tendency. The tendency to wander and shift the range is much more apparent in the male, and normally results in complete replacement of the individuals on any small area within a year. After attaining independent status, young males are especially likely to shift to new areas, while young females are likely to remain on or near the area occupied by the mother. In actual size of range no difference is discernible between males and females or between old adults and yearlings.

**Blarina brevicauda (Say)**

**Short-tailed Shrew**

*Status.*—One of commoner small mammals of Reservation.

*Habitat.*—This shrew occupies most of the area, occurring in a variety of habitat subdivisions. Woodland is its main habitat. It has been taken most often in wire funnel-traps set for reptiles along hilltop rock ledges. Often it has been taken in rainy weather in mouse traps set in brome grass fields, especially near woodland edge. Also it has been taken at the quarry rock ledge, the rock pile near the pond, and in brush along fence rows at field edges.

*Movements.*—Although shrews are fairly common on the Reservation, the information regarding their movements remains meager because of the lack of a satisfactory method of catching them alive in good condition. All captures were made in traps set for rodents, reptiles or amphibians. Because the shrews were always caught in relatively small numbers, it was not practical to run trap lines for them specifically. The shrews, being much more delicate than the other animals trapped, were subject to heavy mortality while in the traps, and their numbers would have been decimated on the study areas but for the fact that they entered the traps so seldom. The box traps set for small mammals were normally tended at 24 hour intervals, but shrews caught usually exhausted the food supply and starved within this time. Pitfalls and funnel traps set for amphibians and reptiles were checked less frequently since these animals were not harmed by going unfed for periods of days. The shrews caught by chance in traps of these types usually died before they were found.
When grids of one hundred or more mouse traps were maintained, capture of one or more short-tailed shrews could be expected on days when there was heavy rainfall. Such captures were made both by day and by night. Occasional captures were made on days following a heavy rain, when the ground was still soaked, but in most instances the shrew was caught while rain was still falling. Similarly, in the pitfalls and funnel traps, which were unbaited except with insects and other small animals that happened to wander into them, captures of shrews were almost invariably made in heavy rains. During dry weather the same trap lines might be maintained for weeks, or even months, without a single capture of a short-tailed shrew. The implication is that, ordinarily, these shrews venture forth on the soil surface only in wet weather, and spend the remainder of their time under shelter in burrows and runways. When there is snow on the ground, they are perhaps more inclined to wander than at other times. On several occasions their tracks have been noticed in snow on the frozen surface of the pond, extending for 100 feet or more away from cover, in a meandering course.

Although shrews dig burrows and make runways of their own, the tunnels and runways of voles seem to play an important part in their ecology. On various occasions the tracks of the shrews or the animals themselves have been seen entering burrows of voles.

Whether shrews are to any extent territorial has not been determined, but they are quarrelsome and pugnacious. On various occasions their high, trilling squeaks have been heard in dense vegetation, but usually the sound ceased abruptly when attempt was made to locate the source. On November 3, 1951, a shrew was heard squeaking in a thicket, and then was glimpsed thrashing and darting about among dead leaves on the ground, but its supposed antagonist was not seen. After a few seconds the shrew darted into a burrow entrance which appeared to be that of a pine vole.

Although the shrew is known to be an important predator on voles, it may not be able to cope with an adult pine vole. On April 18, 1951, while checking a trap line, I heard the shrill squeaking of a shrew and traced it to a live-trap some 50 feet away. The shrew was in the trap huddled against the door. A large pine vole was also in the trap, and it was standing menacingly, with its head held high, at the entrance to the nest box. From time to time the vole would dart forward and strike the shrew a sharp body blow, forcing it back, and eliciting the protesting squeaks.
Only 14 of the short-tailed shrews marked were recaptured. Two were each caught five times, two others were each caught four times, one was caught three times and the remaining nine were each recaptured just once. Records of these are summarized below: 570 feet in 18 days, 2 captures (adult female); 490 feet in 215 days, 2 captures; 340 feet in 97 days, 4 captures (twice near the same place in December, 100 yards away in February, and had moved back to near the original location in March); 180 feet in 18 days, 4 captures (first and second capture sites were 150 feet apart, the third was the same as the second, and the fourth was back near the starting point); 95 feet in 8 months (first four captures within a 40-foot space and a 17-day period). The other nine shrews had moved distances of 75 feet, 60 feet, 60 feet, 32 feet, 30 feet, 22 feet, 20 feet, 0 feet, and 0 feet in periods of from one day to three months. From the trend of these few records it appears that shrews temporarily at least may carry on their activities in small areas of not much more than 100 feet across, but that they may also shift their activities for distances of hundreds of feet and return.

The two longest movements probably represent shifts beyond the limits of a home range. The remaining 12 movements probably are all within home ranges, as indicated by return movements of 300 feet and 150 feet. These 12 movements average 110 feet, indicating home ranges of .87 acres. Manville (1949:65) recorded 38 movements of short-tailed shrews, which averaged 91.5 feet (30 to 315). He found no significant difference between the sexes in the 13 males and 15 females that he was able to sex with certainty. Burt (1940:50) concluded, on the basis of movements made by twelve shrews that he had marked and recaptured in Michigan that a normal home range is probably about 50 yards in diameter and covers about .4 acre.

\textit{Cryptotis parva} (Say)

\textit{Little Short-tailed Shrew}

\textit{Status.}—Common resident.

\textit{Habitat.}—This species inhabits grassland and open woods. Most of the little short-tailed shrews recorded have been taken in pitfalls as they are small enough to squeeze out of most of the live-traps used, and are little attracted by bait. Most habitats have not been thoroughly sampled for these shrews and pitfalls are limited to a small part of the area. The shrews have been caught most often along the dry, exposed ledge at the quarry, and many have been caught at the ledge at "Skink Woods," in open grassy woodland.
Others have been found in various parts of the woodland. Several were caught in mouse traps in open fields.

Movements.—Little short-tailed shrews seem to be somewhat less common than *Blarina* on the Reservation. At any rate they are caught in traps set for small mammals much less frequently. Because of their minute size they are sometimes able to enter and leave such traps without tripping them, and are also able to squeeze through small openings to escape. The majority of those caught in pitfalls were found dead, and those that were marked and released were never recaptured.

Captures of *Cryptotis* in pitfalls, like those of *Blarina*, were almost invariably made in heavy rains. At other times the shrews seem to stay beneath ground litter. One shrew caught in a mouse trap had killed and eaten a harvest mouse larger than itself, which was in the trap with it.

On several occasions two adults of the little short-tailed shrew, male and female, were caught together in the same pitfall trap. In these instances it seemed probable that the pair had been travelling together when they were caught, although this could not be definitely determined.

*Scalopus aquaticus* (Linnaeus)

**Eastern Mole**

*Status.*—Common resident.

*Habitat.*—Most typically, woodland, but also present in parklands, pasture, prairie, and fallow fields.

Movements.—No suitable live-trap was available for the capture of moles; therefore nothing was learned concerning the movements of individuals. Moles were rarely seen, and the only basis for judging their activity was provided by the mounds and ridges of earth thrown up by them. Activity was noted to differ greatly from time to time and from place to place. During times of drought, as during most of 1953, and for shorter periods in other years, mole workings were seldom seen. However, after heavy rains had softened the soil, there was always a surge of activity and evidence of burrowing was conspicuous. For example, on February 15, 1954, there was a rain of 1.35 inches, and within three days many new mounds and ridges had appeared. Groups of such workings were concentrated, each in a small area, and each presumably originating from a different mole. Within a 20-foot radius of a large elm in the headquarters area, the ground was criss-crossed with a network of mole ridges.
Branches extended out in several directions and one was traced for more than 100 feet.

After prolonged drought, moles were noticeably less common than at other times. Difficulty in digging through the hard dry soil presumably restricted their movements and limited their food supply.

In the spring of 1957 after soaking rains, new mole ridges were noted to be numerous along the edges of formerly cultivated fields on the Rockefeller Tract. Several runways that were followed extended out into the fields for 200 feet or more in meandering courses, as if the moles were finding some kind of subterranean insect prey. No deep burrows or mounds were noted in the fields, and obviously the moles were not living in the fields, but entered them temporarily from adjacent woodland. Brumwell (1951:208) mentioned similar exploratory tunneling in recently deposited sandbars along the Missouri River, with digging concentrated about patches of smartweed, sedge, grass, or willows where insect prey was abundant.

Lasiurus borealis (Muller)

Red Bat

Status.—Common resident in summer; evidently migrates to more southern regions in winter.

Habitat.—Primarily woodland; often noticed flying at dusk near woodland edge or through parklike open stands of large elms, or near pond.

Movements.—Red bats often were observed at dusk flying over a regular beat. Most often the bat was 30 to 50 feet above ground and kept to a fairly straight course, in the open but in the vicinity of trees. For example, on July 27, 1951, at twilight, one was coursing back and forth over an open stretch about 100 feet long, between large elms just east of the headquarters area. On other occasions, the beat covered was somewhat longer and less regular.

On August 18, 1949, a red bat was found hanging on a bush three feet from the ground, at a hilltop rock ledge in thick woods.

Sylvilagus floridanus (J. A. Allen)

Eastern Cottontail

Status.—Abundant resident.

Habitat.—The cottontail uses every part of the Reservation. It is seen frequently in both grassland and woodland. Actually it is concentrated along the line of contact or transition from woodland to grassland, in "edge" habitat. Blackberry thickets provide the
most preferred type of refuge, and the rabbits are especially numerous where such thickets are well developed. Other types of shelter that are used are: thorny clumps of gooseberry; rock crevices along ledges; deserted and partly collapsed old houses of woodrats; dead brush from crowns of fallen trees; grass clumps in open fields; among dead leaves in woodland. Under cover of darkness the rabbits forage out from these shelters and may visit relatively exposed situations. In summer, when fields are covered with high grass, rabbits are much less closely limited to situations with woody vegetation for protection, and may shift their headquarters out into the fields.

**Movements.**—From September 1954 to March 1956 Donald W. Janes carried on a program of live-trapping and marking cottontails on part of the Reservation. A total of 89 were caught and marked; 54 were recorded repeatedly and yielded data permitting computation of home range areas. These cottontails were equipped with colored markers attached to their ears, serving for sight identification, and many were trailed from the stain left in the snow after the feet had been soaked in liquid dye of a bright color. The data were hence far more complete than they would have been if based on live-trapping alone. Janes computed the average home range as 8.34 acres (2.42 to 12.62). For males the average was 8.92 acres, and for females 7.76. Janes found that when records of an individual were sufficiently numerous to form a pattern with nine marginal points, the area encompassed was fairly representative of the entire home range, and was ordinarily increased little or none by additional records. Computation of the home range area from distances between successive (random) points of capture, assumed to represent a home range diameter, yielded a figure of 8.40 acres, approximately the same as the 8.34 acres obtained from actual measurements. In several cottontails Janes noted increase of the home range area in summer five to fifteen per cent beyond the size of the area covered in winter.

Young cottontails that are old enough to forage increase their ranges gradually. For one female Janes recorded the following: age three weeks (July 1954), range approximately .25 acre; age 11 weeks, range 1.5 acres; age 23 weeks, range 8 acres; age 75 weeks, range 11 acres.

In Michigan Haugen (1942:366) found that adult females occupied an average home range of 14.0 acres during the winter, and that the size increased to 22.5 acres during the breeding season. He found that adult males wandered much more extensively.
Spermophilus franklinii (Sabine)
Franklin's Ground Squirrel

Status.—Rare wanderer.

Habitat.—Situations with tall grass or other rank herbaceous vegetation are preferred.

Movements.—On June 27, 1958, Robert L. Packard saw one on the Rockefeller Tract east of the buildings in a field having low grass and weedy vegetation. It escaped into woodland and could not be found again on subsequent days, when search was made.

Marmota monax (Linnaeus)
Woodchuck

Status.—Uncommon transient.

Habitat.—Woodchucks have been observed at well-scattered points, both in woodland and in grassland. In foraging, the species prefers situations with lush grass, at edges of fields near thickets of woodland edge or fence rows. It has not been seen in eroded field areas having scant weedy vegetation.

Movements.—Over the nine-year period covered by my work on the Reservation woodchucks were noted approximately a dozen times. However, no two records were in the same place, and none was associated with a burrow. In each instance the animal was a wanderer. No permanently occupied burrows were known nearer than a mile to the Reservation. The woodchucks noted on the area were all adults and were mostly in brushy and wooded situations. One found on April 18, 1951, was in a small elm tree 20 feet above the ground. It remained "frozen" motionless as persons walked beneath it and tossed sticks at it. On June 13, 1951, one was seen three times at about the same place on the road between an alfalfa field and a brushy hillside.

Sciurus carolinensis Gmelin
Gray Squirrel

Status.—Moderately common resident.

Habitat.—Dense woodland of mesic aspect, typically oak-hickory, where trees are large and have a thick leaf canopy.

Movements.—Packard (1956: 29) presented figures showing the average movements of the squirrels marked by him and recaptured, both on the Reservation and on the Dillon Farm some eleven miles south, classified according to sex and age groups.
Packard kindly made available his original records for the Reservation. For 26 intervals between successive captures in gray squirrels on the Reservation the average distance was 513 feet. However, it is questionable whether all movements recorded were within the home range of the animals. Of four movements of more than 1000 feet recorded (1350, 1250, 1110, 1110), each of three was made in a single day, supporting the supposition that it was within the individual's normal range. For ten movements of males the average of 626 feet was higher than the average of 472 feet for the 15 movements of females.

Packard (op. cit.:117) found a population of nine gray squirrels and 15 fox squirrels on a 27.1-acre tract of woodland where his study was concentrated. No interspecific strife was observed. Obviously the gray squirrel does not maintain large individual territories, although the nest and its surroundings are defended against other individuals.

*Sciurus niger* Linnaeus

**Fox Squirrel**

**Status.**—Abundant resident throughout wooded portions of area.

**Habitat.**—Woodlands of all types are utilized, most notably where there are large trees of oak and hickory, and especially walnut. These squirrels sometimes live in parklike situations where trees are well scattered. Even isolated lone trees that are productive of food are visited regularly. Some such trees may be 100 yards or more from the edge of woodland. Extensive treeless areas are avoided.

**Movements.**—Packard (op. cit.:28) presented figures concerning the average movements of fox squirrels and gray squirrels trapped by him on the Reservation. These figures are well adapted to show differences between the species, and within a species according to age and sex. However, they give little idea of the normal movements of an individual, because different kinds of movements are combined. Packard has kindly permitted me to examine and rearrange his original data. Fifty-five movements are rather evenly distributed for distances up to 1000 feet. Ten longer movements (1600 and 1600 feet for adult males; 3400, 2175, 1550 and 1050 feet for adult females; 2850, 2175, 2050 and 1450 feet for young males) seem to represent shifts of range, in most instances at least, and they are therefore excluded from computations of home range. For the 55 movements of less than 1000 feet, the average is 436 feet,
representing a home range 13.7 acres in area. This figure may be representative for the species in a woodland habitat. Significant differences in the average movement were evident according to age and sex, as follows: 22 adult males, 450 feet (14.5 acres); 14 adult females, 364 feet (9.5 acres); 11 young males, 500 feet (18.0 acres); 8 young females, 439 feet (13.7 acres).

**Geomys bursarius** (Shaw)

Plains Pocket Gopher

**Status.**—Occasional on the Reservation; abundant on adjacent cultivated land.

**Habitat.**—Locally this gopher is found mainly in hay fields, especially those that are used for growing alfalfa. The population of an extensive agricultural area of the Kansas River flood plain was largely eliminated in the flood of July, 1951, and the area has been re-occupied gradually. Gently sloping land along the edges of the valley, like the farm lands adjoining the Reservation on the west and south, provided retreat where a population was able to survive the flood. Individual gophers have shifted onto the Reservation from time to time. Their workings have been found in bottomland of each of the two small valleys, in brome grass fields.

**Movements.**—When field work was begun on the Reservation in 1948, the whole area was searched thoroughly for sign of gopher, but none was found. Subsequently, on several occasions gopher mounds appeared in situations remote from any known colonies, and the individual (or individuals) involved were known to have remained in the same small area for periods of months. Isolated individuals, such as those that appeared on the Reservation, offered unusual opportunity for determining the extent of a burrow system and the changes that occurred in it with time. Ordinarily, where gophers occur the burrow systems of individuals overlap and inter-communicate so extensively that the limits of any one system cannot readily be determined.

On the Reservation gopher mounds were found first in September, 1948. Several were noticed on a gentle slope in the pasture a short distance north of the headquarters area. On October 12, a week after a heavy rain, there were many more mounds at this place; 22 fresh ones were counted, all within a space of 40 feet. On October 25 there were many new mounds within the same area. The
most remote were 50 feet apart, with freshly deposited mounds at each edge and at several intermediate locations. By this time the loose earth of the mounds covered a substantial portion of the area encompassed by the burrow system. By November 2, a linear series of mounds extended out from the former limits of the system, up the gentle slope some 50 feet to a ditch bank. For the next 17 months this burrow system was continuously occupied, and new mounds were thrown up from time to time, all either within the limits of the area occupied in September and October, 1948, or within a few yards of its edges. This burrow system was in a former pasture dominated by brome grass, 1450 feet from the nearest boundary of the reservation and hundreds of yards farther from any area that was permanently occupied by gophers. In early October, 1949, a second group of mounds was noticed in the same field 950 feet farther east southeast. The extent of this burrow system was checked from time to time and in the next three months it was steadily extended north northwest 160 feet up a gentle slope to the edge of woodland. From the trend of the lines of mounds, it was evident that several times in the course of extending its burrows up the slope, the gopher had divided its efforts between two more or less parallel or diverging branches.

In the summer of 1953 a group of large mounds was noticed beneath a locust grove in the large pasture in the southeastern part of the Reservation. This burrow system may have been present for a long time before it was noticed. On December 21, 1953, most of the mounds were within a span of 40 feet, but several fresh mounds were more than 100 feet from the main group. Soil was deep and rich at this place, and the mounds were exceptionally large; some were estimated to contain as much as 100 pounds of earth. Throughout the winter, the burrow system was almost co-extensive with a grove of locusts and osage orange, about two dozen trees in all, covering an area approximately 150 by 100 feet. For most of the next winter the burrow system was limited to the same area, but by April 1 a linear series of 35 new mounds extended the system for 100 yards east southeast, in an almost straight line. This temporary extension of the burrow system was probably soon abandoned, but activity continued in the burrow at least into the spring of 1958, indicating more than 4½ years of continuous occupancy.

In each instance when a gopher appeared on the Reservation,
the animal probably had wandered on the surface for hundreds of yards, from an established colony. An immature male, probably a wanderer, was found dead on the road near the Reservation headquarters. It appeared to have been attacked by a predator.

Reithrodontomys montanus (Baird)

Plains Harvest Mouse

Status.—Uncommon resident.

Habitat.—This mouse is confined to grassland, especially where the grass is short. The habitat requirements are more restrictive than those of the western harvest mouse, which is common and widely distributed on the area. One Plains harvest mouse was caught at the headquarters, where grass had been cut several times annually. Others were caught in the large hilltop field where prairie grasses had been restored, but their records were concentrated at a few trap stations where grass was short. In the spring of 1957 a colony was discovered in the blue-grass pasture on the Rockefeller Tract. A few weeks later, when this pasture, no longer grazed, had become overgrown with high weeds, none could be caught in live-traps.

Movements.—Twenty-five of the Plains harvest mice recorded were recaptured only at the site of the original record. One of these was recaptured four times; three, three times; five, twice; the others only once each. Twenty-nine movements were recorded, and averaged 83 feet, a figure remarkably close to that obtained for the western harvest mouse, with more than twenty times as many records. Therefore, I conclude that in this species also, the home range averages approximately half an acre.

Most captures were made on the Rockefeller Tract in November and December 1957, especially in the more barren parts of the pasture, where vegetation was chiefly lespedeza and three-awn grass. Because of minute size and delicate touch, these mice were often able to enter the traps without springing them, and after traps had been set for periods of days, individuals or pairs might take over as residences the nest boxes attached to some of the traps. The harvest mice released from live-traps were easily followed in their open habitat, but attempts to trail them to a hole or nest were invariably unsuccessful. The mouse followed wandered slowly and furtively in an irregular course, often stopping to crouch in a depression attempting to conceal itself, but never entering a burrow.
Reithrodontomys megalotis (Baird)
Western Harvest Mouse

Status.—Abundant resident.

Habitat.—Grassland of various types. Especially high concentrations were present along the weedy margins of the pond where there were dense mats of rice cutgrass (Leersia oryzoides) mixed with other grasses and forbs; and in tall-grass prairie. In the latter there were more harvest mice in mixed stands and those of switch grass, Indian grass and side-oats grama than there were in stands of little bluestem or big bluestem. In fallow fields, patches of foxtail grass supported colonies. When the Reservation was first established, in 1948, the pastured areas, consisting of brome grass with a mixture of many weedy species, were closely grazed, and did not provide suitable habitat for harvest mice. In subsequent years, after discontinuance of grazing, the rank vegetation provided a favorable habitat, and by late 1949 all these formerly pastured areas were well populated with harvest mice. The mice continued to thrive in 1950 and 1951, but subsequently as various kinds of herbaceous plants were crowded out, and succession progressed toward a pure stand of brome, the numbers of harvest mice dwindled to a low level.

Movements.—Harvest mice were trapped in large numbers in several habitats, and a large amount of data was obtained concerning their movements from day to day and over longer periods. In the months of June, July, August and September harvest mice were trapped in much smaller numbers than at other times of year. They seemed to be less attracted to bait in summer, probably because of the abundance of preferred natural foods. The June-to-September period therefore constitutes a gap in the records of many individuals that were marked and recaptured over periods of months.

Harvest mice that were released from traps most often hid in dense ground vegetation, but sometimes they moved off in unhurried fashion, seemingly unconcerned by the presence of an observer. Occasionally such a mouse was followed for 100 feet or more, but none was ever followed to its nest. Such mice progressed through tall grass by alternately walking and making long bounds, gripping the stems in all four feet, and more often climbing than walking on the ground surface.

One harvest mouse was trapped 16 times, and many others were caught five times or more, permitting some idea of the extent of
their normal movements. For one the span of records covered 20 months, and for a dozen others the records covered a year or more. No movements of hundreds of yards, from one study area to another, were recorded. It seemed that each individual was restricted to a limited area and there was but little tendency to wander. For individuals that were caught many times there was a disproportionately large number of captures at one or two stations and other captures were more scattered at several other sites. Outlying stations were most often represented by just one capture each.

For 106 harvest mice each caught at four or more locations, the "minimum home ranges" (areas encompassed by the capture sites) averaged .29 acres. For the 30 that were each captured at four locations, the average area was .16 acres; for 26 each captured at five locations the average area was .29 acres, and for those captured at seven locations, .24 acres. For 18 each caught at more than seven locations, the average area was .53 acres. Corroborative evidence of home ranges approximately half an acre in extent was obtained from many other individuals recaptured too few times to permit plotting their separate ranges. For 327 intervals between successive captures in males, the distance averaged 85 feet, indicating home ranges of approximately .52 acres. For 261 intervals between successive captures in females, the distance averaged 84 feet, indicating that there is no significant difference between the sexes. In each instance those movements of more than 300 feet (5.5 per cent in males and 5.1 per cent in females) were arbitrarily eliminated from the computation, as such long movements were considered to represent shifts in home range or wandering beyond the usual boundaries. The relatively few movements recorded in summer did not differ in their trend from the year-around movements, and it seems that the same home range may have been maintained throughout the year.

The extent of movement does not seem to differ much in males and females. For 37 females each caught at four or more locations the "minimum home ranges" plotted averaged .26 acres, while for 67 males the comparable figure was .29.

On many occasions nests of harvest mice have been found, mostly on the surface of the soil in dense vegetation. Some were partly underground in shallow depressions or in cracks of eroded banks. Others were fixed in plant stems above the ground surface, and one was three feet above ground in a dense Osage orange thicket. The harvest mice found in such nests were mostly litters of young, but pairs of adults also have been found occupying nests.
The nest found above ground in the osage orange was occupied by five harvest mice that seemed to be of adult size but may have all belonged to the same litter. On many other occasions, in walking through grass, I have flushed harvest mice without being able to find a nest. Individuals may spend a good deal of time away from their nests resting or feeding in sheltered places. Each individual probably has a nest to which it returns regularly. Those kept in captivity always made nests of cotton, shredded grass, or any other available material.

Live-trapping records seem to indicate complete lack of territoriality in harvest mice. The home ranges plotted show extensive overlap with several or many adults of both sexes using the same area. Frequently more than one harvest mouse was caught in a trap. Most often the mice caught together consisted of pairs, adult male and female. In many instances the females of such pairs were not in breeding condition. Therefore it seems that the members of a pair live together more or less permanently in the same nest and forage together. Not all multiple captures involved a pair; some consisted of a female and her well-grown young, and other captures were of two adults of the same sex, either male or female. On many occasions mixed groups of adults have been caged together without any fighting, and they were generally tolerant of other individuals.

**Peromyscus maniculatus** (Wagner)

**Deer Mouse**

*Status.*—Moderately common resident in more open situations.

*Habitat.*—Grassland, especially where grass cover is low and sparse because of heavy grazing, or erosion, or poor soil, or combinations of these factors and others.

As compared with the white-footed mouse this species occurs in much lower populations on the area. Habitat separation between the two species is almost complete; overlapping occurs only in grossly disturbed situations where vegetation is in an early seral stage: margin of the pond, talus at base of rock quarry, and along cut banks of gullies. Most captures of deer mice were made in a field which had been stripped of sod, eroded and covered with a thin stand of lespedeza and poverty grass, which was gradually being replaced by brome grass. None was ever caught in the woods.

*Movements.*—Deer mice were persistent repeaters where live-traps were available to them. One was caught 43 times, and eleven
were caught 12 times or more. Those individuals caught frequently were usually taken time after time at one or two stations, and were caught much less frequently at outlying stations. The female caught 43 times was taken 12 times in 6 different months at the most favored station, and 5 times in 3 different months at a second station 75 feet from the first. She was taken 4 times at another station and 3 times at each of two others and twice at one station. At each of the remaining fourteen stations she was caught only once.

One individual was caught seven times in succession at the same station, and was not caught elsewhere, although the station was within a 50-foot trap grid. Another individual was caught eight times in succession at the same place, but subsequently it made shifts of 50, 100, 50 and 70 feet. Of the individuals recaptured, 52 had too few records to show extent of home ranges. For these, however, 149 recaptures do show something of the average trend of movements. In 48.3 per cent of the recaptures the animal was at the same station as at its preceding capture; in 18.8 per cent the animal had moved from 10 to 50 feet; in 20.1 per cent it had moved from 51 to 100 feet; in 12.4 per cent it had moved from 101 to 200 feet, and in 5.4 per cent it had moved more than 200 feet. The longest movement recorded was 525 feet, and other notably long movements were: 500, 350, 310, 300, and 275 feet.

"Minimum home ranges" were plotted, by drawing a line around all capture stations (except those involving obvious shifts) for 18 individuals. The average area was .74 acres, but with a wide range, from 2.24 to .27 acres. The two with only four capture stations had the smallest areas, .27 and .28 acres; the eight with six or seven stations each had areas from .34 to .50 acres (average .39), and those with 8 or more stations ranged from .53 to 2.24 acres, averaging .96. Only the one individual covered more than an acre. If this one notably large area is excluded, the average for the seven others caught eight or more times is .78 acres. Corroborative evidence concerning size of home range is provided by a total of 84 intervals between successive points of capture. These intervals (excluding two that were exceptionally long and were thought to represent shifts in range) averaged 107 feet, representing areas of .8 acres. The ranges of males are, on the average, larger than those of females; for 43 movements of males the average was 120 feet, indicating a home range of one acre, while for 41 movements of females the average was 92 feet indicating a home range of .6 acres.

On many occasions deer mice released from live-traps were trailed to hiding places which may or may not have been their
regular home bases. Several times individuals trapped near the edge of a road ran rapidly along the open area of the wheel track for distances up to 200 feet, turning off sharply into thick grass in a manner suggesting that they were following routes familiar to them and frequently travelled. Released individuals, unless startled by sudden movements of the observer, usually moved slowly and cautiously slinking through dense vegetation, and occasionally crossing open areas with a series of brisk bounds.

Deer mice were caught at all seasons, but records tended to be concentrated in cold weather, November through March. Presumably preferred natural foods available in quantity during the warmer months caused the mice to be less tempted then by trap bait. Seasonal change in food supply and cover may result in small scale shifts in range. One adult female, caught four times within a 75-foot radius in February and March, was caught in May at a station 1000 feet from her original range. This was by far the longest movement recorded. In several other instances much shorter movements were recorded to stations that seemed to be outside the main home range of the animal involved.

Blair (1942:29) estimated that home ranges of adult male prairie deer mice in Michigan average .77 acre and those of adult females .63 acre. He found that the woodland deer mouse (subspecies gracilis) in northern Michigan has a home range considerably larger than that of the prairie subspecies. He calculated average home ranges of 2.31 ± .27 acre for adult males and 1.39 ± .16 acre for adult females. Manville (1949:14) reported home ranges for P. m. gracilis in northern Michigan, of .11 acre to .31 acre in adult males and .12 acre to .25 acre in adult females. Manville's calculations were based on a grid of live-traps spaced at ten yard intervals, and he considered each trap to cover effectively and to represent the 100-square yard area nearest it. Trap stations where an animal was not recorded were not considered to be within the home range and their areas were not included even though they were surrounded by other capture sites. Blair's calculations included such areas and therefore the home ranges indicated were larger. Nevertheless, the possibility was mentioned by Blair, and by Dice and Howard (1951:6) that the method used would result in too small an estimate of home-range area, because each individual tends to be trapped each night before he has travelled from his homesite to the outer limits of his range. Dice and Howard presented many instances of deer mice that, in the course of their normal activities, moved distances considerably greater than would be expected if
their movements were confined to a 2.29 acre area (the maximum home range area recorded by Blair). Dice and Howard found that dispersal occurs in many young deer mice when litters are nearing maturity, with a mean dispersal distance of 188 feet for females and 339 feet for males.

**Peromyscus leucopus** (Rafinesque)

**White-footed Mouse**

**Status.**—Abundant resident throughout woodlands and woodland edge situations of the Reservation.

**Habitat.**—Though present in all types of woodland this mouse occurs in varying populations depending on availability of shelter, and on the food, especially at critical seasons. Relatively few have been taken in deep woods having a thick canopy. In open woods having a ground layer of grass and other herbaceous vegetation, the mouse tends to be more numerous and probably attains highest populations in woodland edge habitat, and in parkland situations. Coralberry bushes, bearing abundant crops of berries, where they are not too heavily shaded, provide one of the main food sources. Some favorite types of shelter used as nesting sites are: holes and crevices in hilltop rock ledges; spaces beneath loose flat rocks; hollows of dead logs, stumps and snags; stick heaps of deserted woodrat houses and low squirrel houses; and root tangles of overhanging banks. This mouse usually does not venture more than a few yards out into open fields, but has been trapped, hundreds of feet from woodland, along brushy fence rows, and in patches of sumac (*Rhus glabra*).

**Movements.**—White-footed mice were caught in almost every kind of trap line that was maintained on the Reservation. In autumn they were often caught in wire funnel traps set for snakes along hilltop rock ledges. The traps set for reptiles were not checked daily and the incidence of mortality was high among the mice trapped. Traps set in trees and bushes, for birds, at times when ground was snow-covered, caught white-footed mice consistently if left overnight. Lines of mouse traps baited with grain, caught white-footed mice in a variety of habitat situations, but these mice were rarely taken in open fields more than a few yards from the edges.

In extremely cold weather these mice rarely were caught. Sudden warming after such cold spells may induce the mice to emerge and forage in daylight, providing unusually favorable opportunity for observing them. On the afternoon of January 3, 1952, after two
days and nights of temperatures mostly below 15° F., weather had warmed to slightly more than 40° F., the sun was shining and the two-foot snow was melting. Several sets of recent tracks of the mice were noted. Each set followed a meandering and aimless course. One set was followed to a distance of more than 100 feet from the starting place, the mouse having travelled several times as far in actual distance. Another set led to a clump of coralberry bushes where the mouse itself was found, feeding on the seeds two feet above the surface of the snow, which was littered with the discarded hulls of the berries. The mouse dropped onto the snow when I approached, but after moving only a few inches, it resumed its search for food, burrowing in the snow to reach a honey locust pod on which it began to feed. In snow, trails are often short and direct, leading from one shelter to another, sometimes only a few yards apart. After snow has been on the ground for several days, such a route may become worn to a well-beaten trail with numerous sets of tracks superimposed. White-footed mice released from live-traps often returned to shelter by an indirect but convenient and presumably familiar route. For example, one followed beneath one edge of a log, turned sharply to run up an inclined stick, through a bush along horizontal branches, and then passed into the side of a rotten stump. On December 23, 1953, I noticed tracks of a mouse in snow on a wooded slope. The mouse had made many trips of approximately 100 feet up and down the slope, tending to follow the same route, but often deviating from it for part of the distance, so that there was one main trail with several parallel to it, frequently merging and separating.

Each mouse maintains a home base, a shelter where it is insulated from extremes of weather and relatively safe from predators. Dry leaves, straw and fur may be brought to the nest cavity. Unless there are dependent young, material is scanty in the summer, but may be abundant in cold weather. The mouse may use several such shelters, alternating between them. In late July, 1951, mice of this species were found in unusually large numbers beneath large flat rocks on wooded slopes. Excessive rainfall in the preceding month probably had saturated many of the nests in burrows, rotten logs and stumps, rendering them untenable. On many occasions, females with young have been found in nests under flat rocks. Pairs of adults have been found together in nests at all times of year, and have often been caught together in traps of various types.

Territoriality seems to be only weakly developed; several or many
white-footed mice inhabit the same area. A trap set beside a
deserted woodrat house caught five adult mice simultaneously.
Probably all were occupants of the rat house.

Of the white-footed mice live-trapped and marked, 249 were
recaptured one or more times providing information concerning
movements. Each of 16 mice was caught a dozen times or more,
over periods of up to 15 months. The longest distances recorded
were, in feet: 1760, 850, 660, 620, 600, 580, 520, 480, 440, 420, 380,
330, 330, 330, 330, 320, 320, 305, 300. These few relatively long
movements involved only 2.1 per cent of the total. Even after
periods of months any individual mouse was usually caught within
the same small area. Numbers of records representing various
distances were as follows: 0-20 feet, 449; 21-40 feet, 139; 41-60 feet,
77; 61-80 feet, 46; 81-100 feet, 46; 101-120 feet, 24; 121-140 feet, 26;
141-160 feet, 17; 161-180 feet, 12; 181-200 feet, 12; 201-220 feet, 7;
221-240 feet, 5; 241-260 feet, 6; 261-280 feet, 5; 281-300 feet, 3.

Twenty individuals each caught at six or more different places
provided information concerning size of home range. Minimum
home ranges were plotted by drawing lines on a map between
capture points and measuring with a planimeter the enclosed area.
The areas ranged in size from .03 up to .36 acre (average .16 acre).
Better information concerning the usual extent of home range is
available from the 637 intervals between successive points of
capture. These intervals averaged 74.4 feet, indicating home
ranges of approximately .4 acre (.35 for 341 movements of males
and .42 for 295 movements of females).

Burt (1940: 26) found an average “minimum home range” of
.27 acre for 58 adult males and .21 acre for 65 adult females. In my
study a large adult male was caught at six places linearly arranged
within a 425-foot stretch along the edge of a gully in an open field.
The gully was fringed with trees and bushes, and presumably the
mouse kept to the gully and the adjacent thicket, within a space
only a few yards wide. On one occasion when the mouse was
released it was followed for more than 100 feet. It stopped once
beneath a flat rock where quantities of discarded seed hulls showed
that the shelter had been frequently used for feeding, and finally
took refuge in a deep vertical crack where soil of the cut bank
was sloughing away. Social wasps (Polistes sp.) were wintering
in large numbers in this and other cracks of the gully bank, and
quantities of their discarded remains showed that small predators,
probably Peromyscus, fed upon them frequently. In an adult
female captured at nine different places the records were also linearly arranged and they encompassed a distance of approximately 320 feet. Other home ranges plotted tended toward triangular, circular, or oval shapes. The data suggest that males and females differ little or none in extent of area covered; that the individual tends to stay in the same home range throughout the year but makes minor seasonal adjustments according to changing availability of food and shelter. Records were obtained in greater numbers in cold weather when bait seemed more attractive.

**Sigmodon hispidus** Say and Ord

**Hispid Cotton Rat**

*Status.*—Common resident at times, but subject to such drastic population reductions that at other times it virtually disappears from the Reservation. Probably in each instance small breeding stock has remained, although for periods of months none was noted.

*Habitat.*—Grassland, in situations with rank weedy vegetation, as at edge of pond, and near brushy margins of fields.

*Movements.*—Cotton rats are diurnal, but are rarely seen because of their tendency to keep to situations where dense grass and other vegetation provide cover. Because of their timidity and rapid movements, they were usually only glimpsed as they darted through the grass. Information concerning their movements was obtained almost entirely from individuals marked and retrapped. In the course of their feeding and trampling, cotton rats make runways through the grass that are less well defined than the runways of the prairie vole. In the course of their normal movements, cotton rats seem to be much less closely confined to runways than are voles. A cotton rat released from a live-trap, or flushed, dashes through the grass in an almost straight course, with long bounds, often crashing into grass stems and other obstacles. After it is lost to view its course may be followed for many yards by the sound and the waving grass stems, as it runs without seeking out a runway, making much more rapid progress than a vole would make in its runway.

In cotton rats trap habit was often strongly developed. Each of several individuals was caught several times in the same trap without visiting any of several nearby traps. Some individuals were caught repeatedly at traps that were well separated, but were caught only occasionally or not at all in traps that were more or less intermediate in position.

Most records of cotton rats on the Reservation were obtained in
the summer and autumn of 1951, and in the following winter and early spring of 1952. By the end of April, 1952, few remained.

Many of those recorded were originally caught as partly grown young. After its initial capture a cotton rat might be recaptured almost daily, when the trap line was operated, over periods of weeks. The maximum number of captures recorded for any individual was 46. Many of the rats were caught in only one, two or three locations; each of 42 others was caught four or more times (average 11.7). In each of these instances the records were scattered and seemed to indicate the general size and position of the home range in each instance. These records show that the home range is small, and that its size varies widely. One adult male had ranged over an area of 2.03 acres (8 captures in 23 days) and another had ranged over 1.16 acres (20 captures in 43 days). An adult female had ranged over 1.11 acres (with 46 captures in 295 days).

Table 1.—Average Sizes of Minimum Home Ranges in Cotton Rats, Showing Increasing Size with Number of Marginal Points in Minimum Home Range.

<table>
<thead>
<tr>
<th>Number of marginal points</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average minimum home range</td>
<td>.14</td>
<td>.16</td>
<td>.29</td>
<td>.72</td>
<td>.72</td>
</tr>
<tr>
<td>Number in sample</td>
<td>10</td>
<td>20</td>
<td>10</td>
<td>6</td>
<td>4</td>
</tr>
</tbody>
</table>

Minimum home ranges of 50 cotton rats were plotted. A trend toward larger areas in those with more numerous records was evident, as shown in Table 1. Hayne (1949:14) questioned whether the apparent levelling off in size of minimum home range, with further captures, after a rapid increase with the first few captures, can be assumed to show accurately the size of the actual home range. He suggested that the tendency toward such levelling off might be due to the mechanics of trapping instead. His suggestion is particularly apropos for such small mammals as the cotton rat which quickly acquire a trap habit and an addiction for the bait. An individual’s preoccupation with the traps and bait available nearest its “home base” or “activity center” might on most occasions prevent it from reaching the outlying parts of its home range where it could be caught in other traps. Disregarding this unmeasurable factor, the following average distances between successive captures and
home ranges were indicated for the different categories of cotton rats that I trapped.

Adult and nearly adult males (129) ... 95 feet (.65 acre)
Adult and nearly adult females (67) ... 79 feet (.45 acre)
Young males (77) ... 62 feet (.26 acre)
Young females (73) ... 55 feet (.22 acre)

Neotoma floridana (Ord)

Eastern Woodrat

Status.—Woodrats occur in varying abundance, chiefly in woodland areas. From a peak population of several per acre in favorable tracts of woodland in 1947, woodrats dwindled to only a few individuals on the entire 590-acre Reservation in 1953 and 1954. Extremes of weather in the winters of 1947-1948 and 1948-1949 were probably responsible in part for this drastic reduction. By 1958 numbers had increased to a level somewhat intermediate between the high point of 1947 and the low point of 1953.

Habitat.—Primarily woodland, but extending also into various marginal situations. Since 1949 the reduced surviving population has been confined mainly to hilltop rock outcrops in woodland edge. Those outcrops with south exposures are favored. Most houses are built where a loose boulder, a deep crevice, or a tree or large shrub along the outcrop provides support and additional protection. Projecting spurs of the hilltop where the outcropping ledge of exposed limestone is especially prominent and several feet thick were used more than parts of the hilltop where the outcropping was less prominent. Osage orange trees were often used as house sites, the house being built either at the base (especially in those where the trunk forked at the ground level or near it) or in crotches a few feet off the ground. Other favorite situations included hollow trees and logs, blackberry thickets, exposed tree roots along cut-banks of gullies, among dense, interlaced branches of tops of fallen trees, in brush and weed thickets along fence rows and at the edge of woodland. As the population dwindled, such sites were gradually deserted, until the rats were almost confined to hilltop rock ledges.

Movements.—Each woodrat is normally the possessor of one or more stick houses, shelters within which its nests are located. Such a home base is the focal point for the rat's activities. The rat may maintain two or several such shelters at well separated points, especially if it is a dominant individual, or if the population is low
and effective competition is lacking. When an individual controls several houses, it alternates between them, using each in succession for periods of days or weeks. In sorties from the house, the rat ordinarily keeps to beaten trails, and its activity is most concentrated within a 30-foot radius. Most foraging for food is less than 75 feet in any direction from the house. Because the woodrat usually chooses a residence where there is dense low woody vegetation and feeds upon such abundant materials as the foliage and bark, the food supply within its small range is adequate. The home range cannot be effectively measured as a two-dimensional area because of the rat's climbing tendencies. Much of the food is obtained in trees and bushes, and travelways are often above the ground level, typically along logs and horizontal or gently inclined branches. Over periods of months, rats often shift into new areas, deserting their former houses and home ranges permanently. Although various factors may motivate such shifts, search for a mate is probably the most common cause. Males wander farther and more frequently than females, and large old males are more inclined to shift than are younger individuals. The longest shift recorded was 1080 feet for an adult male; 650 feet was the maximum recorded for a female.

Woodrats are intolerant of each other, and ordinarily when an individual occupies a stick house, others are excluded. Pairs are associated only during a brief period when the female is in oestrus. Ordinarily an intruder is quickly routed when it ventures into an occupied house. The house itself may be thought of as constituting a small territory. The area about the house, in the rat's usual foraging range, is likewise defended. However there is no evidence that territorial boundaries are sharply defined. Intruders may often venture within the territory undetected since each rat spends a major portion of its time in the nest.

Along an osage orange hedge row which offered favorable habitat conditions, a series of twelve occupied woodrat houses were linearly arranged at almost regular intervals averaging approximately 60 feet (minimum 42 feet), but with three longer gaps which probably represented unoccupied potential nest sites (Fitch and Rainey, 1956: 522).

**Microtus ochrogaster** (Wagner)

Prairie Vole

*Status.*—Abundant resident in grassland.

*Habitat.*—Mainly fields dominated by brome.

In this habitat type the voles thrive best where the grass is rank and lush; they tend to be correspondingly scarce where grass is short
and sparse. Consequently they are less numerous in hilltop fields where soil is shallower and drier than in the bottomland fields. In time of drought in the bottomland fields they tended to retreat to marginal situations, such as edge of the road, and disturbed soil of ditch banks where the vegetation was most luxuriant. Coralberry thickets at the edges of fields provided favorable habitat. In some instances weedy fallow fields were occupied, after several successive crops of weeds had produced a protective cover of horizontal stems. Voles were found in such old-field situations where there was scarcely any grass but they were more numerous where there were patches of foxtail grass forming a ground mat. In almost pure stands of big bluestem and other perennial tall grasses the voles were relatively scarce.

Movements.—The prairie vole, like other members of its genus, makes runways through or beneath herbaceous vegetation on the soil surface, and excavates subterranean tunnels. The activities of an individual are largely within these surface and underground runway systems. The pattern of surface runways especially is in a state of constant change as older trails are abandoned and new ones are established. Those runways leading to the most used burrow entrances are well worn and are much more permanent than the runways in outlying areas. The voles are somewhat social in habits, and ordinarily a small group or colony inhabits each system of burrows and runways. Such a group may include several adults of both sexes, as well as young of various sizes. Well situated burrow systems may be occupied over long periods of years by successive generations, although individual occupancy is only a few months at most. Unless the population is unusually low, each colony is in contact with others, the anastomosing surface runways merging in such a way that no boundaries can be identified. The normal range of an individual may include two burrow systems, and the vole may alternate frequently from one to the other. Over periods of weeks or months a vole may gradually alter its range, withdrawing from one portion and extending its activities in another until it occupies a range entirely separate from that in which it lived originally. More rarely, an individual venturing farther than usual may become disoriented, losing contact with its home range, and after a period of wandering may settle in a new location. In a few instances, such shifts, involving distances of hundreds of feet, were recorded in marked voles.

For the prairie vole more data have been obtained concerning movements than for all other kinds of mammals combined. The
excessive bulk of these data have presented a serious obstacle to their analysis. Thorough analysis has therefore been postponed. It may be expected that a detailed study of the available records will show the extent of differences between the sexes, and differences arising because of season, vegetation type, and age of individual in the normal range, and the frequency of shifts. Even without such analysis, the trends are evident.

The female vole usually leaves her young in the nest when she emerges to forage, but occasionally, on short expeditions, she may drag the entire litter behind her, each young clinging to a teat. When the young are approximately nine days old, their eyes open and thenceforth they become more active, emerging from the nest burrow either on their own or following the female, and gradually extending their areas of surface activity, from a radius of only a few inches at first, as they become familiar with their surroundings. The young may remain after they have grown to adults, continuing to use the same burrow system and surface runways which the female parent occupied. However, there is some tendency for dispersal in those that have attained the age of independence. Over periods of years many prairie voles have been caught in funnel

![Fig. 10. Typical home ranges of several small mammals: (A) adult male western harvest mouse recorded seven times from November 16, 1950, to August 12, 1951; (B) adult female western harvest mouse recorded five times from April 21, 1953, to September 10, 1953; (C) male hispid cotton rat recorded 20 times from July 24, 1951, to September 5, 1951, both as a juvenile and as an adult; (D) adult female prairie vole captured 52 times from August 3, 1954, to June 30, 1955; (E) adult male pine vole captured 65 times from March 7, 1951, to March 20, 1952. Note small sizes of ranges in the voles.]
traps placed for snakes in a woodland habitat where the voles ordinarily do not occur. Nearly all the voles so trapped were within the weight range 20 to 30 grams, a little more than half-grown, and they included a disproportionately high ratio of males.

As a result of extensive live-trapping on the Reservation, Martin (1956:381) found that in both males and females the mean size of home range was .09 acre. He found that over periods of months the total area encompassed by a vole's movements expanded, to a maximum of .26 acre in nine months.

**Microtus pinetorum (Le Conte)**

**Pine Vole**

*Status.*—Common resident, localized in small colonies where habitat conditions are favorable, and subject to drastic fluctuations in population density.

*Habitat.*—Chiefly parklike areas of woodland edge, where ground is usually shaded and has dense, low herbaceous vegetation. In the bottomland field where the house was located, a strip several hundred yards long and 50 to 150 feet wide, at the edge of woodland, was occupied by the voles. This was in an area shaded by large elms. There was a ground mat of muhly grass and bluegrass, with patches of coralberry, and with giant ragweed and various other coarse weeds. These voles have been taken also along hilltop edges at scattered locations. They have never been taken either in deep woods or in open fields more than a few yards from trees.

*Movements.*—Each pine vole ordinarily stays within an established system of runways and burrows. Territoriality seems to be entirely lacking. A small group including several adults of both sexes and young of various sizes usually occupies each burrow system. Presumably such social groups live together in the same nest chamber. Often two or even three adults are caught simultaneously in the same live-trap. Frequently such associations involve two males or two females. There is complete lack of hostility between such voles, both while they are in the traps, and when they are kept in cages.

The runway systems of these voles are situated mainly along the line of contact between woodland and pasture. The majority of records obtained in the present study were within the 1000-foot strip of woodland edge in the small valley where the Reservation headquarters are located.
Runways pass through and beneath the ground litter of dead vegetation, usually a mixture of old leaves and remains of herbaceous vegetation. Runways in current use are so well roofed over that their presence may be unsuspected. Runways may pass to greater depths by imperceptible stages, and the runway system may include extensive tunnels three to four inches beneath the surface, or occasionally deeper. Usually the tunnels pass through mats of roots, making excavation difficult, either for a predator or for an investigator. Abandoned burrows of moles (Scalopus aquaticus) are often taken over by the voles and incorporated in a runway system.

In general, both the underground tunnels and the runways in surface litter consist of one main axis and numerous lateral branches, most of which have blind ends. Occasionally, however, the secondary runways loop back to join the main tunnel, or anastomose in a complex pattern. The runway system has no well defined limits. Whereas the main runway in the vicinity of the nest is heavily used and well worn, outlying ends of the main runway and numerous branches may be faintly defined, with but little evidence of use.

Presumably the home range of each pine vole is more or less co-extensive with the runway system it occupies. It travels mainly on well established runways, but some of those used earlier may be abandoned, and replaced by other extensions elsewhere as season and food sources undergo changes. Short exploratory trips away from the runway sytems are made frequently, and the route taken on such a trip may be retraced until it is incorporated in the runway system.

Seventy per cent of the recapture records were within 30 feet of the vole's last capture site. It seems that most of an individual vole's foraging is confined to a 30-foot radius, and within this small area is confined to the established runway system or its immediate vicinity.

Pine voles were more difficult to catch than were most of the other small mammals occurring on the Reservation. Over a seven-year period approximately a half dozen individuals have been caught in wire funnel traps set for reptiles along hilltop rock outcrops. In these situations no signs of activity of the voles were noted and the voles caught were all more than half-grown but less than full adult size. I suspect that they were recently independent young dispersing from the parents' runway systems and invading unoccupied situations. Other voles live-trapped and marked and
released while they were still less than half-grown have been known to stay in the same location and use the same runway system until adult size was attained and afterward. Dispersal may involve only a small percentage of the young, or may occur only under unusual conditions.

Although the majority of recorded movements were short, marked pine voles occasionally were retrapped hundreds of feet from an earlier location. In every instance these individuals were trapped in well established runway systems. In a large proportion of such instances the same vole was soon retrapped back at its original location. Just why and how such relatively long movements are occasionally made is not altogether clear. It does seem evident that the vole remembers its route and returns by it. Runway systems that are a hundred feet or more apart and appear to be well separated may be connected by little used outlying runways facilitating visiting between them. There is little or no difference between the sexes in vagility. Of the 62 males and 69 females for which movements were recorded, nine males and ten females had made relatively long movements of 200 feet or more. Several of them shifted repeatedly, some as many as six times. Even though individuals may from time to time visit and explore a neighboring runway system, the latter does not constitute a part of the regular home range as it is not used regularly. Ordinarily, shifts in home range are gradual, and usually they involve use of a succession of nest burrows within an area familiar to the animal.

Table 2.—Recorded Movements of Pine Voles, Grouped According to Distance.

<table>
<thead>
<tr>
<th>Distances between recorded capture sites in feet</th>
<th>Percentage of total movements</th>
<th>Distances between recorded capture sites in feet</th>
<th>Percentage of total movements</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 5</td>
<td>35.5</td>
<td>96 to 105</td>
<td>1.3</td>
</tr>
<tr>
<td>6 to 15</td>
<td>23.5</td>
<td>106 to 115</td>
<td>.3</td>
</tr>
<tr>
<td>16 to 25</td>
<td>11.9</td>
<td>116 to 125</td>
<td>.7</td>
</tr>
<tr>
<td>26 to 35</td>
<td>7.3</td>
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<td>36 to 45</td>
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<td>.3</td>
</tr>
<tr>
<td>46 to 55</td>
<td>3.2</td>
<td>146 to 155</td>
<td>.5</td>
</tr>
<tr>
<td>56 to 65</td>
<td>2.4</td>
<td>156 to 165</td>
<td>0</td>
</tr>
<tr>
<td>66 to 75</td>
<td>2.2</td>
<td>166 to 175</td>
<td>.1</td>
</tr>
<tr>
<td>76 to 85</td>
<td>1.3</td>
<td>176 to 185</td>
<td>0</td>
</tr>
<tr>
<td>86 to 95</td>
<td>.5</td>
<td>186 to 195</td>
<td>.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>200 or more</td>
<td>1.5</td>
</tr>
</tbody>
</table>
Burt (1940:51) stated that the normal home range of the species (subspecies scalapoides) is about one-fourth of an acre. This figure was based on recapture records of 17 individuals which indicated an average range-diameter of 38 yards.

**Ondatra zibethicus** (Linnaeus)

**Muskrat**

**Status.**—A permanent population is lacking because of insufficient aquatic habitat. Nomadic individuals stray over the area from time to time and some of these have established themselves at the pond and resided there for periods of months when conditions remained favorable.

**Habitat.**—Marshland is required; the shallow pond with marshy margins, and with stands of Typha latifolia and Typha angustifolia, provides favorable habitat when the water supply is sufficient, but on such a limited scale that only a few individuals can be supported.

**Movements.**—The small amount of information gathered concerning muskrats on the Reservation serves to illustrate: 1. long movements by immigrants, and 2. repeated occupancy of a small and isolated area of favorable habitat by such wanderers.

The pond, when filled to capacity, covers approximately an acre. On the upstream side a silt flat slopes off gradually to the pond bottom, and supports a dense stand of cattails that provide food for muskrats. In the spring of 1948 an old, deserted muskrat house was noticed in the pond, and evidently there was at least brief occupancy in 1949 and again in 1950. In the spring of 1951 trails and cuttings were noticed, but there were no houses and the animals must have been living in bank burrows. High water may have driven these rats from their burrows and exposed them to predation. In any case no more sign was seen until November, when two adults were present. Occupancy, perhaps by these same two, continued through June 1952. At this time the pond was rapidly drying and the water was so shallow over most of it that the rats were unable to submerge completely in swimming. In late June the stand of cattails showed heavy use by the rats, but with lowering of the water level this food source had become inaccessible to the rats unless they exposed themselves crossing the open mud flats to reach it. The rats had, in part at least, turned to a variety of herbaceous vegetation growing on the pond dike nearer their burrows. On July 5 the fresh half-eaten carcass of an adult female was found on the dike a few yards from the burrows. Judging from the man-
ner in which the carcass had been attacked, a red-tailed hawk was the most probable predator. On July 9, at 4:00 P. M. another adult was foraging for green vegetation on the dike near the spot where the female had been killed. It was unselective, gathering Japanese chess (*Bromus japonicus*), prickly lettuce, thistle, and giant ragweed, and carrying them back to the burrow. It made half a dozen trips while I watched, coming within a few feet each time without seeming to notice my presence. On July 14 remains, probably of this same individual, were found on the dike. The remains consisted of scraps of entrails and fragments of skin, and a scat nearby implicated a fox or coyote as the predator.

On March 25, muskrat remains were found beside the small creek in the east part of the Reservation. The carcass had been partly skinned out and the bones picked, in a manner suggesting the red-tailed hawk as the predator.

The muskrats that appear on the Reservation from time to time are wanderers that reach the area from the Kansas River Valley. The nearest known colony, in an old slough cut off by a shift of the river channel, was a little more than two miles air line from the places where the animals were found on the Reservation. In most instances, wanderers probably follow up stream courses.

**Rattus norvegicus** (*Berkenhout*)

**Norway Rat**

*Status.*—Irregular resident, reaching the area from nearby farms.

*Habitat.*—Most typically the Norway rat lives in urban situations and about barns, corncribs and occasionally along creeks adjacent to grain fields. A quantity of corn ruined in the 1951 flood was dumped on the edge of the Reservation, and several months later rats were found to be living in the vicinity. They may have been transported there with the loads of corn, or may have been attracted there from a nearby farm. They were living in rock clefts that had been occupied by woodrats until a short time before. Also, several Norway rats were trapped about the laboratory building approximately 900 feet from the corn pile and probably twice as far from any other colony. In this situation they were subsisting largely on natural foods, perhaps supplemented by occasional access to the grain used as bait.

*Movements.*—The Norway rats that lived beneath the laboratory building at the Reservation headquarters restricted most of their activities to a radius of a few yards. There were several burrow
entrances beside the foundations of the building, and there were trails leading from these burrows into nearby clumps of high weeds and dense patches of foxtail grass (*Setaria viridis*). The rats seemed to be living on this vegetation and on waste grain. The animals of this colony may have originated from those at the pile of waste corn 900 feet north on the hilltop, or they may have made their way up a small creek from cornfields adjoining the Reservation to the west; in the latter case they must have travelled at least half a mile.

**Mus musculus** Linnaeus

**House Mouse**

*Status.*—Common resident in vicinity of buildings, and other favorable situations.

*Habitat.*—Most numerous and persistently present in buildings. Elsewhere the house mouse prefers disturbed situations with rank weedy growth, as on silty soil at pond margin, and among roadside weeds. It may occur in brome fields in the same habitat occupied by the prairie vole, harvest mouse, and cotton rat. It has been taken also in wooded hilltop rock ledge situations where the white-footed mouse is the most common small rodent.

* Movements.*—House mice were not trapped with any degree of regularity. In certain locations they were caught frequently over periods of days and weeks. In view of the low incidence of captures, the frequency of double captures was especially high, suggesting that these mice often live and travel in family groups. Because of their agility, house mice often escaped as the investigator opened the live-trap to remove them.

Occasionally in unusually cold weather of winter, house mice were found dead in a variety of situations. It seemed they had died of exposure, while searching for food in open situations away from shelter. With the advent of cold weather each autumn, house mice became increasingly troublesome in a small building at the Reservation headquarters. Often a dozen or more adults have been trapped within a few days, after the population of nearby areas had converged on this building to find shelter from the cold. On one occasion an adult male live-trapped in the building was carried in a box 860 feet west on the road and released. On the following day it was re-trapped in the building, demonstrating homing ability.

Twenty-five of the house mice live-trapped, marked, and released were subsequently recaptured a total of 36 times. Movements ranged up to 300 feet. Two-thirds of the total were within the range
20 feet to 100 feet. Movements, 33 in all, averaged 73.6 feet. Several of the mice were marked and recaptured on a quarter-acre area that was intensively live-trapped with a grid of traps at 20-foot intervals. All the movements recorded on this trap grid were relatively short, and they lower the average. Exclusive of the movements recorded on this quarter-acre grid, only eleven movements were recorded and these averaged 143.6 feet indicating a home range of 1.48 acres. The minimum home range of an adult male plotted from five successive captures was measured as .44 acre.

**Zapus hudsonius (Zimmermann)**

**Meadow Jumping Mouse**

**Status.**—Moderately common resident.

**Habitat.**—Mainly high grass, such as in bluestem prairie or brome, especially near woodland edge, where coralberry and various weedy plants occur; also in woodland, at least along its edges.

Jumping mice have been caught in open woods of honey locust and elm on south facing slopes, where a ground layer of muhly grass and low brush was present.

**Movements.**—In the course of live-trapping for small mammals, jumping mice proved to be particularly elusive—so much so that scarcely any information on movements was obtained from recapture of marked individuals. Most captures in mouse traps have been made in late April and early May, soon after emergence from hibernation. At other times the mice seem not to be interested in bait. However, more than a dozen have been caught in unbaited wire funnel traps set for reptiles along hilltop rock outcrops in October. Traps set in the same situations at other times of year have not caught jumping mice; therefore it seems that some of these mice move to the outcrops from adjacent grassland to find places favorable for hibernation. A young male jumping mouse trapped on April 24, 1952, had perhaps recently emerged from hibernation. He was re-trapped 100 feet farther south on April 29, and again 50 feet farther in the same direction on April 30. This is the only individual that has been re-trapped.

Blair (1940:244) on the basis of live-trapping in southern Michigan, arrived at a figure of .89 ± .11 acre as the average home range of a male jumping mouse, and .92 ± .11 acre as the home range of a female. Manville (1949:69) recorded an adult female on suc-
cessive days in live-traps set 180 feet apart. Quimby (1951:87) recorded an average home range of .38 acre (.19 to .57) for four females, and .43 acre (.14 to 1.10) for five males, near Itasca, Minnesota. Corresponding figures for a larger series obtained near Centerville, Minnesota, were 1.57 ± .22 of an acre for 17 females and 2.70 ± .50 of an acre for nine males. Quimby attributed the much higher figures at Centerville to the more open habitat there, with more scattered food and cover. He concluded that the range of an individual jumping mouse is relatively unstable.

**Canis latrans** Say

**Coyote**

*Status.*—Frequent transient and irregular resident.

In the summer and fall of 1948 a pair of coyotes probably denned on the area and made it their headquarters, and from time to time others may have lived on the area temporarily. However, it is believed that most often the coyotes on the Reservation were merely crossing the area.

*Habitat.*—The entire area of the Reservation is used by coyotes. In daytime they tend to keep to brush and thick woods, and have been flushed from such situations on a few occasions. While travelling or hunting at night they seem to prefer grassland.

*Movements.*—Several travelways were present on the Reservation. One followed the middle of the long narrow hilltop field, leading from the northeastern part of the Reservation almost to the southwest corner of the section. A similar path crossed the large bottomland field in the southeastern part of the area. When the intermittent creek in the eastern part of the area was dry, the bottom of the ravine, walled by steep banks on either side, was used as a travelway. The coyotes that left sign on the Reservation mostly came from rough, wooded areas in the sections to the north in Jefferson County, and were travelling to or from the edge of the Kansas River Valley. Of 118 scats collected on the Reservation and analyzed, several contained remains of animals—such as sheep, pig, domestic chicken, and jack rabbit—that must have been found elsewhere, demonstrating the wide range of the individual coyote. Several times coyote tracks in fresh snow were followed a mile or more, and led beyond the boundaries of the Reservation, bearing out the supposition that the individual animals range widely.

Packs of hounds sometimes crossed the Reservation, baying in pursuit of quarry, which was assumed to be a coyote in most in-
stances, although raccoons, deer, and other animals were sometimes chased. The route followed by the pursued animal could be traced by the baying of the dogs. On one such occasion the owners were intercepted as they were attempting to retrieve the dogs, and they claimed that the chase had begun more than three miles northeast.

In 1948, when the newly created Reservation was still used for pasturing livestock, tracks and scats of coyotes were noticed in much greater numbers than at any time subsequently. Scats collected in 1948 contained a high proportion of carrion from the carcasses of cattle, whereas in later years when livestock were no longer present on the area, rabbits and cotton rats made up most of the food (Fitch and Packard, 1955).

Young and Jackson (1951:59) state that the runway used by a group of coyotes may be no more than ten miles in length, and that it may be used throughout the life span of the individual. Assuming such a route to be circular, and bounding the edge of the home range, the range would have a radius of approximately 1.59 miles, and would cover 7.85 square miles.

**Vulpes fulva** (Desmarest)

**Red Fox**

*Status.*—Irregular resident; sign seen less frequently than that of coyote.

*Habitat.*—In the winter of 1951-1952 one lived in the northwestern part of the Reservation, having a den in a cleft of the rock ledge on a southwest slope in oak woodland. Its hunting was done mainly in the vicinity of the pond, and in the field near the house.

*Movements.*—The fox mentioned above was tracked to its den, in a rock cleft along the hilltop outcrop, when snow was on the ground. Subsequently in the winter and spring the den was checked frequently, and it always showed evidence of recent use. Whenever the ground was snow-covered, tracks were seen in great abundance about the upper end of the small valley where the pond was situated, approximately 700 feet southeast from the den. The fox regularly ranged at least 500 feet farther in this direction, and at least 2000 feet south from the den site. Although it probably covered at least half a square mile, its hunting tended to be concentrated in a much smaller area. On March 5, 1952, following the tracks in the snow, I found where the fox had approached a cottontail crouching in a clump of big bluestem. The cottontail, flushing from the clump, had dodged once, avoiding the fox's rush,
and had escaped to the nearby brushy slope, with the fox in pursuit.

In the winters of 1954-55 and 1957-58 fox tracks were again abundant in the same area, and the rock cleft den showed signs of occupancy.

**Urocyon cinereoargenteus** (Schreber)

**Gray Fox**

*Status.*—Uncommon resident or transient.

*Habitat.*—Woodland or brushy areas.

* Movements. *—On April 7, 1958, Phillip Ogilvie saw one in the northwestern acre of the Rockefeller Tract. On September 7, 1958, one (possibly the same) was seen to cross a county road headed east onto the Reservation 100 yards north of the entrance gate.

**Procyon lotor** (Linnaeus)

**Raccoon**

*Status.*—Common resident.

*Habitat.*—The raccoon is primarily a woodland inhabitant and it is notorious for its habit of foraging along edges of streams or ponds. On the Reservation this tendency was well defined, and sign was most frequently noticed at the pond, and along the creek flowing through the eastern part of the area. However tracks and other sign, and experience in trapping raccoons suggested that these animals range throughout all parts of the area, including grassland, woodland, hilltops, and stream courses.

* Movements. *—Raccoons range over relatively large areas as compared with the smaller mammals on the Reservation. Few individuals were live-trapped and the meager data available do not show the extent of home range. Raccoons probably use every part of the Reservation but change their activities according to seasonal shifts in food sources. Wide expanses of open fields are generally avoided.

In 1948 corn was cultivated on several bottomland fields of the Reservation. Tracks and dropping of raccoons were conspicuous along the margins of these fields adjacent to woodland. It was evident that the animals were utilizing waste corn as a food supply.

The two small creeks on the Reservation were favorite routes of travel for raccoons, whose tracks could be found in wet streamside soil at all seasons. In autumn each year the pond on the Reservation either went dry entirely, or underwent partial drying, leaving mud flats uncovered. Leopard frogs, cricket frogs, and bullfrogs were then partly exposed to predation by raccoons, and the pond
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became a focal point for raccoon activity. In late September, 1948, the pond had dried completely and there were deep cracks in the mud. These cracks and the dense stands of cattails provided refuge for swarms of young leopard frogs and cricket frogs, and raccoon tracks were especially numerous. In April, 1954, frogs and toads had begun breeding when there was scarcely more than a puddle of water in the bed of the pond. The water was in the center of an area of open mud with no protective vegetation. Amphibians therefore had no adequate escape shelter. Under these conditions the raccoons made heavy inroads on the breeding populations of American toads and chorus frogs. A large sycamore with a hollow at the base was used for a den in 1953 and perhaps in other years. Sign of raccoon was especially concentrated at the pond in autumn at the time of drying, when swarms of newly metamorphosed frogs and toads were leaving the water, and in spring when breeding aggregations were present.

Sign of raccoon also was often noticed along hilltop rock outcrops. Deep crevices in the rock provided the best den sites, as large hollow trees were scarce on the area. On May 7, 1952, hounds were heard baying, coming from the west probably off the Reservation. Quarry was chased in an almost straight course approximately 1/3 mile to a hilltop rock crevice where it escaped. An hour later, investigating, I found that the dogs had done much digging but had not been able to reach the raccoon except to tear a few tufts of hair from its partly exposed rump. The raccoon was an immature one.

The raccoon's tendency to shift to any readily available food source was demonstrated on many occasions when these animals formed the habit of following trap lines and systematically raiding them, eating either the bait, the trapped animals, or both. Because of these activities raccoons became a major pest to persons attempting to study populations of small mammals or reptiles. They would follow along the lines of mouse traps, arranged in a grid with a 50-foot interval, and would overturn each trap and eat the grain beneath it. On a few occasions sign indicated that the voles or other small mammals in the traps likewise were eaten. The raccoons showed dexterity in removing the covers of the metal nest boxes attached to the wire live-traps. The nest boxes were constructed with the metal sprung so that these covers snapped into place, and ordinarily the operator removed them with pliers. Once raiding had begun on a trap line, it usually continued with increasing severity until trapping had to be abandoned. In April, 1954, after such raids had forced abandonment of mouse trapping near
the Reservation headquarters, the family of raccoons raidied the bait supply kept on the porch of a building, and they learned to unlatch and remove the heavy metal top of a large garbage can in which grain was stored. The raccoons also frequently raidied wire funnel traps set along hilltop outcrops, breaking open the traps and eating the insects, reptiles or mammals caught in them.

For most of the year, at least, raccoons seem to travel in family groups. On September 19, 1955, at 1:00 A. M. after a brief shower, a group of four or more young raccoons moving along a nearby dry creek bed, attracted my attention by their peculiar low trilling calls. These calls served to keep members of the group informed of the others' whereabouts as they moved along in the same direction strung out over a distance of 100 feet or more. When the group had travelled approximately 100 yards down the creek channel, they came to a road where I was standing. One, coming within a few feet, suddenly took alarm at my presence and climbed a tree, where it stayed for five minutes, frequently answering the calls of other members of the group. Two others appeared, one keeping close behind the other. They were attracted by the calls of the treed individual, and almost brushed against me, then shied away upon noticing my presence.

Stuewer (1943:226) stated that the normal feeding range includes distances up to one mile from the home base but that raccoons will travel even farther, if necessary, to obtain a preferred food. Whitney and Underwood (1952:118) state that a hungry raccoon may travel several miles, in a meandering course, in one night, and they cite an instance of a female and her three young that travelled 2½ miles to a cornfield for their nightly foraging. Summarizing 459 records, for 87 animals, Stuewer found the average range to be 503 acres for adult males (maximum 2012 acres), 268 acres for adult females and juvenile males, and 111 acres for juvenile females.

**Mustela frenata** Lichtenstein

Long-tailed Weasel

*Status.*—Scarce and seldom seen; it is not known whether a permanent populations is present.

*Habitat.*—No definite preference has been noted; probably it ranges over the entire area. One was seen in March hunting in the daytime at the edge of a fallow field overgrown with giant ragweed and sunflower. Two were caught at different times and places but in similar situations in wire funnel traps set for snakes along hilltop
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rock ledges in oak-hickory woods. Another was seen in this same type of habitat.

 Movements.—No information has been obtained. The fact that no weasel or sign has been seen more than once in any one place seems to suggest that these secretive small predators wander extensively.

 Spilogale putorius (Linnaeus)

 Spotted Skunk

 Status.—Common resident.

 Habitat.—Records of the spotted skunk on the Reservation are so well scattered in both woodland and grassland situations, that no definite preference for any habitat subdivision is detectable.

 Movements.—In 1950 during the colder months a line of 50 or more live-traps were kept in operation and were moved from time to time. These traps were set primarily for opossums, but spotted skunks were caught frequently. In the course of a year 18 individuals were caught within an area of approximately half a square mile. All of these were marked by toe-clipping and released, but the data from recaptures are so scanty that little can be learned from them concerning movements. Only two marked skunks were recaptured. One of these was caught at the same place on January 3, January 15, and March 27. An adult female was trapped and marked on October 16, 1950; she was recaptured on March 8, 1951, at a point 900 feet southeast, and on April 4, 1951, she was caught approximately 3300 feet south of the original location. These records, together with the fact that most individuals marked were not recaptured at all, indicate that an individual skunk ranges over an area considerably larger than the area live-trapped.

 Crabb (1948:232) in southeastern Iowa found that in winter a spotted skunk has a home range of about .25 square mile with two or three separate dens. He found that in spring the range was similar to that of late winter for the females, but the male’s range was greatly expanded, to an area of two to four square miles.

 Mephitis mephitis (Schreber)

 Striped Skunk

 Status.—Common resident.

 Habitat.—This skunk prefers grassland, especially in woodland edge situations, for hunting its prey. The captures recorded (mostly in wire live-traps set for opossums) were nearly all in grassland within a few yards of woodland edge, or near margins of streams or
the pond. So far as has been observed dens are usually situated in rock clefts along hilltop ledges in woodland.

** Movements.**—Eleven striped skunks were live-trapped in a six-months period and within an area of approximately one-third of a square mile. Only two of the eleven were recaptured. One of these was caught at the same place on March 30 and April 4, but was caught at a second location 750 feet away on April 8. Another skunk, caught within a few yards of a currently used den on November 26, 1949, was recaptured 1700 feet away on April 12, 1950. Most captures of skunks were made along edges of fields of brome grass, formerly pastured. Several captures were made along the channel of a small creek draining the eastern half of the Reservation. Skunks released from live-traps did not, like most other animals, make for the nearest shelter, but struck out with seeming fixity of purpose and slight deviation from a straight line course, on relatively long treks, with the home burrow as the obvious objective. Several times attempt was made to follow such skunks, but usually they eluded pursuit by scrambling through thicket or tangles. One such individual, caught at the head of a small valley, travelled 700 feet uphill in its homeward dash to shelter in a fissure at the hilltop rock outcrop.

**Dama virginiana** (Boddart)

** White-tailed Deer **

** Status.**—Irregular resident.

**Habitat.**—Chiefly woodland, especially where there is an under-story of dense brush; on many occasions seen crossing open fields, or feeding along their edges.

** Movements.**—Twelve occurrences of deer were recorded from August 18, 1949, to May 25, 1951. All these records probably pertained to the same two individuals, which were usually seen together, a doe and her yearling fawn. However, none was seen from October, 1949, to August, 1950. From May, 1951, to March, 1956, no deer or sign of them were recorded on the Reservation, but subsequently in 1956 and 1957 at least one individual was present on the area and was recorded frequently.

The records of 1949 through 1951 were well distributed over an area of a little more than a quarter of a square mile, rhomboidal in shape and including a narrow hilltop field, the wooded slopes on either side of it, and the meadows at the heads of two small valleys approximately half a mile apart. The area seemed to provide favor-
able habitat conditions. It included approximately two miles of woodland edge thickets, and the meadow portions were being invaded by many kinds of woody vegetation. The area was just over $\frac{3}{4}$ mile in greatest diameter from the southwestern edge to the northeastern, and $\frac{3}{4}$ mile from the southeastern limit to the northwestern. This entire area was not covered uniformly by the deer. The two northwesternmost records were near the Reservation headquarters. Deer or their sign would have been readily noticed in this vicinity and it seems obvious that the animals rarely ventured so far in this direction. In their normal daily activity the animals must have been limited to a smaller home range, from which they wandered occasionally for a variety of reasons.

The deer seen on August 18, 1949, was in the center of a hilltop field late in the afternoon. It seemed nervous but was little alarmed by the nearness of the observer. It stood watching curiously, from time to time giving a snort, or walking a few steps in one direction or another. A few minutes before this deer was seen, coyotes were heard yapping excitedly a few hundred yards farther east, and this disturbance probably had caused the deer to move into the open. It finally moved off into the woods on the opposite side of the field from that where the coyotes had been heard. On May 9, 1951, near the central part of the Reservation, tracks of a running deer and a running coyote were seen. Probably the coyote had been chasing the deer, but their courses could be followed for only a few yards because of the rocky nature of the soil. In late November, 1950, after the pond had dried, deer tracks were extremely numerous in the muddy bottom. One or more deer were visiting the area frequently to feed upon the succulent vegetation.

In the period of this study the Reservation offered habitat conditions favorable to deer. Dense cover was abundant, with a variety of shrubby and herbaceous vegetation for food, freedom from disturbance by humans and from competition with livestock. The 590-acre area would undoubtedly support a large number of deer. The fact that the species still, in 1957, has not become well established in the area can be attributed almost entirely to domestic dogs. In the course of a year many individual dogs hunt on the area, usually in twos or threes, or sometimes in larger packs. Some have been recognized as residents of nearby farms; others perhaps travel many miles to reach the area. Their quarry includes raccoons, coyotes, opossums, squirrels, and rabbits. Hunting is limited almost entirely to the colder half of the year. In summer, because of the abundance of insect pests, dense thorny vegetation, heat and
humidity, the dogs' hunting activity is much reduced. Were it not for this respite during late pregnancy and the period when small young require care, deer probably would be unable to survive at all in this part of eastern Kansas. As it is, the population is kept sparse and scattered. Deer are still sufficiently uncommon that notice of them by farmers or other individuals are frequently reported in local newspapers. In such accounts there is often mention of chasing by dogs, and such incidents as the chasing of a nearly exhausted deer into a farmyard or into the edge of town are common. If chasing by feral and free-ranging dogs could be partially controlled, a rapid rise in the deer population of eastern Kansas might be expected.

**Birds**

*Podilymbus podiceps* (Linnaeus)

**Pied-billed Grebe**

*Status.*—Occasional migrant.

*Habitat.*—Sizable bodies of water are required for existence of a permanent population.

*Movements.*—On at least one occasion a pied-billed grebe was seen in the pond at the Reservation, and on several other occasions lone individuals have been seen on a small pond several hundred yards south of the Reservation. In each instance the grebe was present on only one day. No specific dates were recorded.

*Pelecanus erythrorhynchos* Gmelin

**White Pelican**

*Status.*—Uncommon migrant.

*Habitat.*—Large lakes, or bays and inlets of the sea coast.

*Movements.*—On an afternoon in late May, 1949, pelicans in a large flock were seen flying north, high over the Reservation. On June 11, 1953, at 8:45 A. M., a flock of approximately 25 were seen flying slightly above the level of the tree tops, headed north and a little west.

*Ardea herodias* Linnaeus

**Great Blue Heron**

*Status.*—Occasional visitant, especially in April and May.

*Habitat.*—Normally limited to vicinity of lakes, ponds and streams.

*Movements.*—These large herons pass over the Reservation frequently but irregularly, usually without stopping. They have been
seen or heard passing over most often around dusk. Usually such herons were flying high, on what appeared to be long overland trips. From time to time a lone individual or a pair has stopped temporarily at the pond, or at one of the small intermittent creeks on the area, attracted by an abundant food supply of frogs and tadpoles. In most instances the leopard frog or the cricket frog, or the tadpoles and young of the bullfrog seemed to be the chief prey. In some instances a heron has remained for a few hours, but failed to return after completing its foraging for the day. In other instances, what appeared to be the same individual returned day after day to exploit an easily available food source, though leaving each evening for a distant roost.

Specific dates when great blue herons were recorded from the Reservation were the following: 1949: September 19, November 24; 1950: April 9, April 13 (one), July 23 (one); 1951: April 14 (one), September 14; 1952: March 30 (one), May 22 (one), October 18 (one); 1953: May 19 (two); 1954: April 19 (four), May 28 (heard); 1955: June 10 (one), June 11 (one); 1956: April 18 (two), April 26, May 1 (one), May 15 (one), May 30 (one); 1957: April 7 (three), April 30 (one), May 6 (two), October 19 (one), October 26 (one).

According to a survey of nesting colonies in Kansas, made by Andrews and Stephens (1956:295), the nearest rookeries are approximately 45 miles west, near Maple Hill, Wabaunsee County, and 35 and 40 miles southwest, near Scranton and Burlingame, Osage County. Since most of the records obtained on the Reservation fell within the nesting season, the status of the herons involved is doubtful. Some may have been non-breeding adults, either residents of the general area or wanderers. Some may have been nesting apart from the rookeries, at places within a few miles of the Reservation. However, Andrews and Stephens obtained no records of nesting colonies in the two easternmost tiers of Kansas counties, including Douglas County.

**Buto rides virescens** (Linnaeus)

**Green Heron**

*Status.*—Common summer visitant.

*Habitat.*—Normally limited to vicinity of lakes, ponds and streams in or near woodland.

*Movements.*—These herons have frequently been attracted to the pond on the Reservation, and occasionally have come to the two small intermittent creeks. Frogs constitute the chief food supply attracting them to these places. The cricket frog is the kind
most utilized. On various occasions the herons have been seen strolling about on mud near the pond edge where these small frogs were extraordinarily abundant. Dates when green herons were recorded at the Reservation were as follows: 1950: July 13 and 15; 1951: April 25 and 27, May 2, June 22, August 6; 1952: May 3, 23, 24, 28, and 30; 1953: May 9; 1954: May 6; 1955: April 27 and 28, May 8, July 4 and 19; 1956: April 14, 25, 26, 27, 28, and 30, May 1, 4 and 13; 1957: April 30 and May 3.

In some instances the green herons that came to the pond probably stayed there continuously for several days, or even longer periods. In 1956, especially, a pair was seen regularly during the latter half of April and early May. They seemed to be preparing to nest there, but left suddenly after heavy rains on May 7, 8, and 9.

Several of the green herons that appeared in late summer were juveniles. On July 19, 1955, in late afternoon, one perched on a treetop 200 yards from the pond for more than an hour, calling at intervals of approximately five minutes.

**Nycticorax nycticorax** (Linnaeus)

**Black-crowned Night Heron**

*Status.*—Occasional transient.

*Habitat.*—Swampland is the preferred habitat. On several occasions migrant night herons have been flushed from the willow grove or the pond edge on the Reservation.

**Botaurus lentiginosus** (Rackett)

**American Bittern**

*Status.*—Occasional transient.

*Habitat.*—Marshland.

*Movements.*—Only one record—an individual flushed from the pond on May 9, 1953.

**Branta canadensis** (Linnaeus)

**Canada Goose**

*Status.*—Uncommon migrant.

*Habitat.*—Marshlands.

*Movements.*—These geese have been seen only as migrants passing over the area in spring. On April 14, 1951, at 8:30 A. M., a flock of approximately 40 were seen flying low, headed due north. On March 19, 1952, at 8:30 A. M., a flock of eleven were seen flying
north. On April 4, 1955, at 7 A. M., a solitary individual was flying low, headed north.

Anser albiçrons (Scopoli)
White-fronted Goose

Status.—Rare migrant.

Habitat.—Marshland.

Movements.—R. W. Fredrickson recorded a small flock over the Reservation on April 14, 1952.

Chen hyperborea (Pallas)
Snow Goose

Status.—Abundant migrant in both spring and autumn.

Habitat.—Marshland; arctic tundra in breeding season.

Movements.—The remarks in the species account of the blue goose apply almost equally well to the snow goose. Relatively few of the flocks seen were composed entirely of either kind, but both snow geese and blue geese were usually in the same flock in varying ratios. Also, a high proportion of individuals in a flock often were intermediates, that were partly white and partly “blue” in their plumage. Complete freedom of interbreeding is indicated.

Chen caerulescens (Linnaeus)
Blue Goose

Status.—Abundant migrant in both spring and autumn.

Habitat.—Marshland; arctic tundra in breeding season.

Movements.—In 1949 flocks were seen frequently between October 22 and November 13. In 1950 the northward migration occurred mainly during the first week of March. In 1951 the fall migration reached its peak on October 14. In 1952 the main spring flight lasted for approximately two weeks in mid-March. In 1953 the main spring migration occurred in the period March 8 to 15, but flocks were seen also on March 18, 19, 23, 25, and 30, and on April 1, 2, 3, 4, 8, and 17. A large flock seen on the latter date was flying south. Southward migration in autumn was first recorded on October 13 and reached a peak about October 24, but flocks were recorded also on October 28 and December 20. In 1954 spring migration was noted on March 7, 8, 10, and 12, reaching a peak between the two latter dates. The fall migration was recorded only on October 7 and 18. In 1955, spring migration was noted chiefly
between March 10 and 31, and fall migration was first noted on October 7. In 1956 spring migration began on February 22, reached a peak on March 19, and was last noted on March 26. In 1957 spring migrants were noted on March 1, 2, 3, 4, 12, 15, and 27, and on April 6, fall migration began the second week of October.

*Anas platyrhynchos* Linnaeus

**Mallard**

*Status.*—Irregular transient over area, occasionally stopping at pond when water supply is adequate.

*Habitat.*—Marshes, ponds, lakes and slow-moving streams.

*Movements.*—Mallards have been recorded at the pond on the Reservation on only a few occasions: March 19, 1950 (flock of eight); June 11, 1951 (lone female); October 31, 1951 (pair); November 1, 1951 (group of three); February 26, 1952 (pair); February 28, 1952 (pair); March 30, 1952 (about 35); April 3, 1952 (about 35); November 11, 1955 (lone female). Low water, or complete drying of the pond, in late 1952, 1953, and 1954, discouraged use of the pond in those years by ducks; also probably the population was low as a result of widespread drought. On many occasions, including December 9 and 24, 1951, November 5, 1954, March 3, 1955, February 21, 1956, and January 20 and 24, 1957, flocks of mallards were seen or heard flying over the area, although they did not stop there. Most often such flights were noted after dark.

*Anas acuta* Linnaeus

**Pintail**

*Status.*—Occasional transient.

*Habitat.*—Ponds, lakes and streams.

*Movements.*—The first evidence of the occurrence of this species on the Reservation was the strewn feathers of an adult male where it had been eaten by a predator (probably a horned owl) in December, 1948. The remains were found approximately 100 yards from the pond, where the duck probably had stopped. It may have been wounded in the hunting season. On many occasions ducks seen flying over the Reservation were too high to be identified positively. Some may have been pintails. R. W. Fredrickson recorded a small flock of pintails flying over the Reservation on March 5, 1949, and a lone individual on April 6, 1952.
Anas carolinensis Gmelin
Green-winged Teal

Status.—Uncommon visitant in late autumn and early spring.

Habitat.—Marshes, ponds, lakes and slow-moving streams.

Movements.—Flocks were recorded at the pond almost daily from November 7 to 14, 1949, March 3 to 11, 1950, and were also recorded on March 4 and 31, 1955.

Anas discors Linnaeus
Blue-winged Teal

Status.—Common visitant, chiefly in spring and autumn.

Habitat.—Marshes, ponds, lakes, and slow-moving streams.

Movements.—From one to 40 individuals were noted at the pond on the following dates: June 27, 1949; April 12, 13, 15, 20 and 23, 1950; April 13, 15, 16, and 19, and October 29 and 30, and November 22, 1951; April 1, 2, 7, 21, and 23, 1952; April 6, 1953; April 17, 20, and 29, 1955; and April 9 and 30, 1956.

Spatula clypeata (Linnaeus)
Shoveller

Status.—Uncommon visitant.

Habitat.—Marshes, ponds, lakes, and slow-moving streams.

Movements.—Throughout April, 1952, one or more groups of these ducks were seen frequently at the pond, which was then full of water. Often the shovellers were associated with blue-winged teal. The number seen at one time ranged from six to fifteen. In other years none was seen at the Reservation.

Aix sponsa (Linnaeus)
Wood Duck

Status.—Uncommon visitant.

Habitat.—Ponds and slow-moving streams in wooded areas.

Movements.—This duck has been noted on the Reservation on only a few occasions: May 29, 1950 (adult male); April 17, 1951 (adult male); November 3, 1951 (adult male); November 4, 1951 (adult male); and March 20, 1952 (pair). Although the records in 1951 extended over more than six months, it is almost certain that the same individual was involved in all three instances. This
was a crippled and flightless male. On the night of November 3, the pond froze over and when the duck was found on November 4, he was 200 yards farther down the gully, where there was still a trickle of water.

**Aythya collaris** (Donovan)

Ring-necked Duck

*Status.*—Uncommon visitant.

*Habitat.*—Ponds, lakes and streams.

* Movements.*—Recorded at the pond on the Reservation in 1950 only; on March 11 there were approximately 15, along with a larger number of green-winged teal; on March 20 there were approximately 20; on March 21, seven.

**Aythya affinis** (Eyton)

Lesser Scaup Duck

*Status.*—Rare visitant.

*Habitat.*—Ponds, lakes and streams.

* Movements.*—On March 15, 1952, a lone female was flushed from the pond, and a flock of approximately ten were seen at a farm pond half a mile south of the Reservation. On the following day they were seen again at the same farm pond, along with a group of shovellers. On March 24 several were seen flying to the pond on the Reservation late in the afternoon.

**Cathartes aura** (Linnaeus)

Turkey Vulture

*Status.*—Regular summer visitant.

*Habitat.*—Regularly patrols all parts of the Reservation, and most other areas in northeastern Kansas that are not subject to too much disturbance by humans.

* Movements.*—Vultures on their northward migration usually reach the Reservation in the last week of March. For the years 1951 through 1957, arrival dates were the 25th, 19th, 20th, 25th, 28th, 27th and 31st of March. In all but one instance the early records were of lone birds, but in succeeding weeks, vultures were most often seen in small groups. A close-knit social group of four pairs used the Reservation regularly. In their flight maneuvers and search for food the members of this group tended to stay near each other, and usually several or all of them were seen simultaneously. Within the group, pair-associations were nearly always
evident, as the members of each pair stayed closer to each other than to the other vultures belonging to the group. Activity of the entire group centered over "East Woods" and "Wall Woods," an area of rocky hilltops and steep slopes near the eastern boundary of the Reservation. When this part of the area was visited, the vultures were almost invariably seen maneuvering over it, whereas they were seen comparatively seldom over the part of the Reservation near the headquarters, two-thirds of a mile farther west. A large proportion of their time seemed to be spent in an area estimated to be less than 200 acres in extent, but whether this area provided their main food supply, or merely served as a rallying place where members of the group maintained contact and performed maneuvers primarily of social significance, is uncertain. Vultures that probably were members of this same group were often noted approximately 1½ miles farther south at the north edge of the Kansas River Valley, about the same distance north, and, occasionally, over the west boundary of the Reservation, a mile west from the place where they were most frequently seen. Nothing was recorded of their movements east of the Reservation, but a minimum area of perhaps six square miles is estimated as the range of this group.

In the area where the group's activity was concentrated, a nest was discovered in 1952, and the same site was used each year subsequently, through 1956. This nest site was in an elm more than two feet in trunk diameter, and having a large hollow in the trunk ten feet above the ground. When the nest site was discovered, there was evidence that it had been robbed recently. The rough bark of the tree was coated with the vulture's down feathers, where the bird might have struggled with a climbing predator that was either approaching or leaving the nest. In 1954, also, the nest was robbed by a predator before the eggs had hatched. The raccoon was considered the most probable predator.

Accipiter gentilis (Linnaeus)

Goshawk

Status.—Rare and irregular winter visitant.

Habitat.—Typically northern coniferous forests, but because of its migratory habits may appear temporarily in much different habitats, such as deciduous woodlands in eastern Kansas.

Movements.—Recorded on the Reservation on only two occasions. One was on December 29, 1950. At 10:00 A. M. alarm calls of a flicker and squalling of a rabbit were heard on a heavily wooded
north slope near the Reservation headquarters. Two cottontails, alarmed by the sound scurried from the edge of the woods and hid in nearby blackberry thickets. Hurrying toward the sounds, I flushed the goshawk, from beneath an osage orange tree. The hawk was carrying an adult cottontail but soon dropped it. The rabbit struggled to its feet and ran heavily a few yards to an old woodrat house where it found shelter. The hawk boldly perched within 100 feet of me, watching intently. I easily caught the rabbit, which was near collapse, and it died a few minutes later. Dissection disclosed that the jugular vein had been pierced, and there were masses of clotted blood in subcutaneous wounds. The back of the head, right side of the neck, and throat had been badly lacerated. A second goshawk was recorded on the area by Donald W. Janes in the winter of 1955.

**Accipiter striatus** Vieillot

Sharp-shinned Hawk

*Status.*—Occasional transient, chiefly in winter.

*Habitat.*—Chiefly woodland.

*Movements.*—The few records seem to pertain to wandering individuals, since most are well separated in time and space. None has been noted in summer. Specific dates of the records are: September 19, 1956; September 23, 1952; October 13, 1948; November 3, 1956; November 16, 1951; November 17, 1954; December 1, 1956; December 2, 1956; December 15, 1953; December 16, 1954; December 31, 1955; January 9, 1954; January 18, 1952; January 24, 1953; February 2, 1954; February 4, 1952; February 14, 1954; March 8, 1953; April 15, 1950; April 26, 1956, and May 15, 1952.

**Accipiter cooperii** (Bonaparte)

Cooper Hawk

*Status.*—Uncommon summer resident; occasional winter visitant.

*Habitat.*—Chiefly woodland, and mixed habitat of woodland alternating with open fields.

*Movements.*—Cooper hawks have been recorded on the Reservation most frequently in spring and early summer, the nesting season, when usually at least one pair resides on the area. Records in winter are sporadic, and seem to pertain to wandering individuals that are passing through.

A nest, in dense oak-hickory woods, on a north slope 100 yards south of the Reservation headquarters was used in 1950, 1951, 1952,
and 1953. In 1954 a new site approximately 100 yards east, on the same slope was occupied. In 1955, 1956, and 1957 the territory was not occupied, but Cooper hawks were seen from time to time in the area.

Each year that the territory was occupied, the hawks appeared abruptly in spring and passed through a period of maneuvering and display before nesting actively began. In 1952 the hawks appeared at about the beginning of March, and were heard cackling frequently in the vicinity of the nest site. In 1953 first appearance was nearly a month earlier. Although the bird that arrived first was seen frequently in the territory in February and March, it did not obtain a mate for several weeks. On April 1, 1953, the pair of hawks were seen in a courtship flight. The wings of the male were raised high over his back at each stroke, and moved in a wide arc, giving the flight a peculiar mechanical quality faintly resembling the flight of a nighthawk. Similar display flights were observed frequently throughout most of April. On March 8, 1954, the first Cooper hawk of the season was seen circling with the same slow rhythmic flapping, over a hilltop field area of 32 acres. Apparently this individual was a female.

Because Cooper hawks were ordinarily shy and secretive, the extent of their territories was difficult to ascertain. In late July and early August, 1951, a hawk was seen to bring young chickens regularly from adjoining farms. The farmyard which probably contributed most of the chickens was just under % mile from the nest, while the other farm was approximately .6 mile from the nest. The chickens appeared to be about one-third grown, and were heavy loads for the hawk. Both farmyards were on a flat hilltop approximately 115 feet above the elevation of the nest. The hawk, probably the female in each instance, was favored by the lower elevation of the nest, when burdened with heavy prey on her homeward flight. The area over which the pair of hawks were seen to fly, and which they were known to exploit for prey, consisted of at least half a square mile, but the actual territory was probably larger. In 1950, 1951, and 1952 other Cooper hawks were seen frequently on a wooded slope a little less than half a mile south southeast of the nest near the headquarters. Although a nest was never found in this second area, nesting almost certainly occurred there. In 1952 a nest was found in a ravine .6 mile east of the nest under observation near the headquarters, and approximately .8 mile north northeast of the second supposed nest site.
In 1951 the three young hawks left the nest near the Reservation headquarters in the last week of July. For three weeks subsequently they were heard or seen daily on the slope where the nest was located and within 100 yards of it.

**Buteo jamaicensis (Gmelin)**

Red-tailed Hawk

*Status.*—Year-round residents, winter residents, and transients occur on the area.

*Habitat.*—Red-tailed hawks use the entire area. While most perches and nest sites are in woodland, the hawks hunt their prey chiefly in open land. Parkland and woodland edge situations are especially favorable.

*Movements.*—Individual hawks could not be recognized with certainty except for relatively short periods when missing remiges or retrices occasionally permitted recognition at close range. Behavioral traits provided more useful but not entirely reliable means of recognizing individuals. In most instances, however, these means of recognition were inadequate to trace the turnover in the resident population. Of the red-tailed hawks seen on the area, most were wanderers that did not stay long.

Most of the section of land within which the Reservation is located was divided between the territories of two pairs of red-tailed hawks (Fig. 11). These two territories were maintained in essentially the same form throughout the period of my observations, from 1948 through 1957, although there was partial replacement of the hawks themselves. The configurations of the territories were largely determined by local physiography. The upland cuesta north of the Kansas River Valley has peninsular extensions. One of these extensions, a little more than a mile long but less than 100 yards across at its narrowest, crosses the Reservation diagonally from the northeastern to the southwestern corner, as a mesalike flat hilltop. There is a second peninsular hilltop, more or less parallel to this one but ¼ mile farther southeast, and a third about 1¼ miles northwest. These parallel hilltops formed territorial boundaries, and the territories consisted mainly of the intervening lowland areas, and slopes. Of the two territories, the more western was by far the larger, comprising approximately 800 acres, but it included much cultivated land that was less productive of prey. The more eastern territory was approximately 535 acres of which less than a fifth was under cultivation. The remainder was mostly woodland, with brush and
grassland of former pastures. The territory of this pair included no human habitations nor roads, and was mainly inside the Reservation on the part least visited by people. The pair of hawks occupying this territory are believed to have been the same throughout the eight-year period of observation. Their behavior differed notably from that of other hawks in their boldness and defiance. In May, 1949, I tried unsuccessfully to climb to their nest and thereafter they showed resentment whenever I entered their territory, regardless of whether or not the intrusion was in the nesting season. Upon seeing me as much as half a mile away both hawks might leave their perches, fly toward me screeching, and circle low overhead. Over the years their hostility subsided somewhat, as their nests were not further molested. In 1950 and 1957, the nests were in trees considered unclimbable, and in other years nests were not found while they were in use. The heart of this pair's territory consisted of thick woods of approximately 34 acres on a west-facing slope. On dozens of occasions, the hawks were seen perched on snags on this hillside.

Hawks of the second pair were much shier and more wary. Their territory included the Reservation headquarters, and the residences of four different farms and several roads. As a result, the hawks often encountered humans and probably had been shot at on many occasions. It is certain that in this pair there was occasional replacement when one was shot and the survivor obtained a new mate to share the territory. Whether there was continual tenure through such a line of survivors over the eight-year period is uncertain, but probable in view of the fact that the territory remained essentially the same. This territory centered on a brushy hillside, which had been wooded until it was cut and bulldozed in the winter of early 1949. Cottontails, rodents and small birds were abundant in the brushland habitat. Hunters, with shotguns or .22 rifles, often visited this hillside. When disturbed by humans, the hawks habitually flushed at distances of hundreds of yards and flew to distant parts of their territory. Sometimes they screamed at the moment of flushing, and sometimes flew silently. Their survival obviously was dependent on wariness and prompt response to the presence of humans. A melanistic individual was co-occupant of the territory from the autumn of 1948 until November 3, 1951, when it was found dead beside the county road at the west edge of the Reservation. On three other occasions buteos recently shot were found along this road. Probably wandering individuals suffered the most casualties. Despite their usual wariness, these hawks when hunting were
several times seen to fly through or past a barnyard, in a surprising display of boldness. Although they were not seen to catch anything in or near the barnyards, their behavior suggested that young poultry might be the object of their forays.

In May and June, 1955, the hawks were seen on various occasions carrying prey (usually a snake) to the nest. In each instance, the hawk was within a quarter mile of the nest when first seen. On June 19, a fledgling left the nest when attempt was made to climb to it. For the next six weeks, the fledglings were heard and seen frequently in the parents' territory. On several occasions they were seen soaring with the adults, but tended to be much more sedentary, and often perched for periods of hours in the same small area, calling to be fed.

Territorial encounters between pairs were relatively few. Even when such encounters occurred, they were usually brief and relatively mild, and might consist of circling and screaming with no actual fighting. This was in striking contrast with my observations on the species at the San Joaquin Experimental Range in the Sierran foothills of central California (Fitch, Swenson, and Tillotson, 1946), where habitat conditions were somewhere near the optimum, with high populations of diurnal rodents, and rabbits, sparse cover, and well distributed perch trees. Under these conditions territories averaged only half a square mile, and territorial pressure was intense. Each pair of hawks spent a substantial part of their time in fights and maneuvers with their neighbors as a result of territorial pressure.

Trautman (1940:212) found that red-tailed hawks, wintering in the vicinity of Buckeye Lake, Ohio (where the species is absent in summer), settled in individual territories of two square miles or less in extent. Having settled in such territories, the hawks ordinarily remained for the winter, unless forced to move by unfavorable weather conditions such as a heavy snow cover. After being forced out of its regular territory by a winter storm, Trautman found, an individual hawk would return as soon as conditions again became favorable.

Before there were buildings on the Reservation, in 1948 and 1949, the small valley that was later the site of the headquarters installation was much used by the hawks. The residence and other buildings were erected in the winter of 1949 and 1950. Thenceforth human activity greatly increased, and the hawks habitually avoided this part of their territory, and used the valley much less than they had before. They rarely came within 100 yards of the buildings,
and perched in the valley within sight of the headquarters only at times when there had been no human activity outside for periods of hours. They were most often seen perched 200 yards or more from the house in early morning. As soon as a person came out of the house, they would flush and leave the vicinity and would not reappear for the remainder of the day.

Fig. 11. Approximate extent of two territories of red-tailed hawks as they existed over a period of years. The long, narrow hilltop extending from northeast to southwest across the Reservation was the common boundary. The territory on the northwest was larger, as it contained a high proportion of cultivated land that, for the hawks, was unproductive of food. Dots show locations of nests for the years in which they were found.

**Buteo lineatus** (Gmelin)

**Red-shouldered Hawk**

*Status.*—Uncommon resident of this general area near western limit of breeding range.

*Habitat.*—Deciduous forest is preferred by this hawk. On the Reservation it was rarely seen in situations where there were mature trees of climax species. Rather it showed preference for such places as the pond and the adjacent willow groves, hilltops with low trees and thorny tangles, and areas of mixed grassland and second growth woodland.
Movements.—Compared with other buteonine hawks on the area, red-shouldered hawks are more secretive. Although I had heard the characteristic call from time to time, I was unfamiliar with it, and failed to recognize the species' presence until June 22, 1953, when a juvenile was flushed at close range at the edge of the pond. Judging from the appearance of this individual, it had not been fledged long, and could not have travelled far from the nest. No more definite evidence of nesting on the area has been obtained. Throughout the latter half of 1953, 1954 (except March and December), 1955 (except January and February), and early 1956, a red-shouldered hawk was seen and heard frequently on the Reservation. Twice in May, 1955, two were seen or heard simultaneously, near together and perhaps paired, but the records pertain mainly to a lone individual that spent most of its time on the Reservation, but occasionally sojourned elsewhere for periods of weeks.

Reason for considering the records to pertain to a single individual is that the hawk was nearly always seen or heard in the same general area, an elliptical territory of 180 acres, approximately twice as long as broad, mostly in the northwestern quarter-section of the Reservation (Fig. 18). Habits of this individual were noted to change over periods of weeks or months. It tended to spend much of its time in a small perching area, but from time to time neglected or altogether deserted one perching area in favor of another that was as much as half a mile away. In March and April, 1955, a red-shouldered hawk was seen at several places along the eastern edge of the Reservation, more than half a mile from the supposed territory. This may have been a second individual, but more probably it was the same. Stewart (1949:26) found red-shouldered hawks in a density of one pair per .8 square mile in the coastal plain of Maryland, in the habitat to which the hawks were confined—wooded stream courses.

The territory of the lone individual on the Reservation overlapped to a large extent the territory of a pair of broad-winged hawks, and also broadly overlapped a red-tailed hawk territory. Although not limited to mutually exclusive territories, these three species of large hawks were somewhat intolerant of each other. On the Reservation interspecific maneuvers, chases or fights involving two species were observed much more frequently than intraspecific encounters. Domination of the red-shouldered hawk by a red-tailed hawk was observed on various occasions. The red-shouldered hawk probably was able to maintain its territory only because it was limited
chiefly to areas little used by red-tailed hawks. In encounters be-
 tween the red-shouldered hawk and broad-winged hawks, domi-
nance was not clear-cut, nor was any actual fighting observed. The
encounters consisted of soaring in overlapping circles with an oc-
casional short swoop toward, but not near to, the opponent.

Fig. 12. Approximate extent of the territory of a pair of
broad-winged hawks, as it was maintained each summer
over a period of years. It was an area of hilltop pasture
and rocky, brushy south slope. Dots show approximate lo-
cations of nest sites in four different years, but nests were
not actually found in 1951 and 1955.

Fig. 13. Approximate extent of territory of a red-shoul-
dered hawk, in the northwestern part of the Reservation
and adjacent areas. This territory was shared with red-tailed
hawks, and (in summer) broad-winged hawks, but there
was constant friction between all three species.
**Buteo platypterus** (Vieillot)

**Broad-winged Hawk**

*Status.*—Moderately common resident in summer, absent from October to late April.

*Habitat.*—Mixed woodland, and adjacent open areas, especially of rock ledge.

On the Reservation, the abandoned rock quarry was a favorite haunt of these hawks, and on many occasions was the scene of territorial fights. The abundance of reptilian prey of several kinds at this open, rocky place made it attractive to the hawks. The hawks were seen chiefly along the south slopes of the northwest quarter of the Reservation section, where the aspect of the vegetation was xeric.

*Movements.*—Upon their arrival in spring, broad-winged hawks attract attention by their soaring flight and whistling calls. In autumn before migrating south they spend much less time soaring and are relatively silent; consequently the time of departure is difficult to determine. Arrival dates over an eight-year period, 1950 through 1957, were all in April: the 15th, 18th, 16th, 28th, 20th, 15th, 20th, and 23rd. For these eight years, April 19 was the average date of appearance. After the first appearance the hawks were usually heard and seen many times each day for the remainder of spring. Within the first two weeks they were especially noisy and conspicuous, while they were establishing and maintaining territories against competitors. At this season as many as five have been seen soaring together, with occasional threatening swoops and frequent squealing calls. Activity of broad-winged hawks was mainly limited to the areas of south-facing slopes with xeric second growth woodland, rocky hilltop edges, and upland pasture. Nests were found only in 1954 and in 1957, but probably the hawks nested on the Reservation every year. In 1951 and 1955 they were seen repeatedly, carrying prey items toward the same place, a hilltop edge, with low thorny trees and dense tangled undergrowth, but my many attempts to find the nest were unsuccessful.

For these hawks territorial boundaries were especially difficult to define, since the birds were usually seen circling high over the hillsides. The area over which they were known to forage regularly comprised approximately 250 acres (Fig. 12), but the western
and northern limits, being outside the Reservation, were not well determined. Most satisfactory information was obtained concerning the southern limit of the territory, since it followed the contour of the slope just north of the residence. In early summer the hawks were seen many times each day on this slope, but they only rarely ventured as far south as the residence. The opposite slope to the south supported a more mesic type of forest and obviously was not such favorable habitat. Occasionally, however, a broad-winged hawk was seen to fly out of sight in this direction, in a foray well beyond the limits of the usual territory. Within the territory, a much smaller, elongate area of hilltop edge and upper slope only a few acres in extent included the favorite perches and the places where the hawks most frequently flew.

In 1954, when the nest of these hawks was studied, prey included collared lizards of a marked population at an old quarry nearly a quarter mile east, and several Great Plains skinks, believed to have been caught along a pastureland outcrop ¼ to ½ mile northwest, where these lizards were especially numerous.

**Buteo lagopus** (Pontopiddian)

Rough-legged Hawk

*Status.*—Rare transient or migrant in winter.

*Habitat.*—Typically far northern forest, and tundra.

*Movement.*—Occasionally rough-legged hawks are seen in northeastern Kansas in winter. One was seen on the Reservation on November 2, 1948; one of the dark phase was seen as it was heckled by a pair of red-tailed hawks, over the southeastern part of the Reservation on November 14, 1951.

**Haliaeetus leucocephalus** (Linneaus)

Bald Eagle

*Status.*—Rare transient.

*Habitat.*—Most typically, forested areas bordering sizable bodies of water.

*Movement.*—Only one record of a bald eagle on the Reservation has been obtained. On the afternoon of December 9, 1951, my attention was attracted by the screaming of red-tailed hawks overhead; three of these hawks were chasing an adult bald eagle, which was flying northwest. It kept to this course until it was out of sight.
Circus cyaneus (Linnaeus)

Marsh Hawk

Status.—Appears from time to time at all seasons but mainly in winter, when nomadic individuals often wander over Reservation.

Habitat.—The marsh hawk usually frequents open fields of various types. In apparent order of preference, marsh hawks prefer marshland, prairie, bottomland pasture, upland pasture, parkland, and woodland. Although marsh hawks have been seen on many occasions flying over woodland, they were always flying well above the treetops and presumably were crossing from one open field to another. On the Reservation they were seen frequently on all open field areas and especially in the upland field at the north edge, that had a mixture of weeds and native grasses.

Movements.—Marsh hawks were seen on the Reservation each month from September through April, inclusive, but ordinarily they were absent during May, June, July and August. The individuals that used the area in winter were all wanderers that did not maintain regular beats; none was recognized on consecutive days, and there was no regularity in the times or places of their appearance. In 1951 a pair nested on the prairie tract at the north edge of the Reservation. The unusually heavy precipitation probably created conditions favorable for them. On May 8 the male was heard cackling and squealing, and was seen in a display flight over a grassy hilltop approximately 3000 feet south southwest of the spot where the nest was found later. On June 20, when I was walking across the same hilltop, 400 yards from the nest, the male flew toward me, cackling, and swooped with a display of aggressiveness, then withdrew in the direction from which he had come. As I moved farther in that direction, he again flew to meet me, this time accompanied by the female, and both swooped at me. The male was the more aggressive and the female soon retired. Moving back and forth across the field, I was able to detect corresponding increase or decrease in the male's excitement and aggressiveness, and was led to the nest which contained a single downy young. Five days later this young was destroyed by an unknown predator and the adults disappeared from the area. On April 7, 1952, a pair was observed in courtship flight in this same vicinity, but, so far as known, nesting did not occur.
Falco mexicanus Schlegel  
Prairie Falcon

*Status.*—Rare transient.

*Habitat.*—Typically grassland, in rugged terrain such as that with cliffs and buttes.

*Movements.*—Only one definite record of a prairie falcon on the Reservation has been obtained. On April 16, 1951, one was seen flying south across the hilltop on the northern part of the Reservation. On October 18, 1951, a medium-sized falcon, not definitely identified, but perhaps of this species, was seen flying rapidly over the southern part of the Reservation, on a southward course.

Falco sparverius Linnaeus  
Sparrow Hawk

*Status.*—Occasional on migration; individuals that live on nearby land wander farther than usual from time to time, encroaching onto Reservation.

*Habitat.*—Requirements include open ground, with sparse or short vegetation, and high perches from which the hawk may examine surrounding terrain. In 1948, a pair of sparrow hawks having a territory centering in grain fields south of the Reservation were seen frequently in the bottomland pasture of its eastern part, at a time when many cattle were pastured on the area and grass was kept cropped close. In subsequent years, after removal of the livestock and growth of high grass, sparrow hawks no longer included this area in their range.

*Movements.*—Sparrow hawks have been seen on the area mainly in winter and early spring, when the unfavorable effects of tall grass and other rank herbaceous vegetation are minimized. On February 23, 1955, at a time when the ground was snow covered, a male that normally ranged over cultivated land adjoining the Reservation to the west, was found 200 yards inside the Reservation attempting to attack a song sparrow that was in a trap.

On the afternoon of March 23, 1955, this male or another was found at a bird trap attempting to attack a chickadee. Half an hour later at dusk, a person coming out of the laboratory building flushed a hawk, that was probably the same individual, from an old phoebe nest on the porch. Flying erratically in the semi-darkness the hawk
crashed into the screen of a rear window, and a moment later, having circled the building, it lit beside the door and walked in. Its behavior indicated confusion and unfamiliarity with its surroundings. It was banded and released, and lingered in the vicinity, as in the next four days it was seen twice within a few hundred yards of the headquarters buildings. Cade (1955:11) mentions one territory occupied by a pair in a vacant lot 200 feet by 300 feet. He found that in southern California pairs usually remain together on their territories throughout the winter, though some pairs break up in fall and occupy separate winter territories.

On the Rockefeller Tract in 1957 sparrow hawks were frequently present for periods of days and were recorded April 6 to 9, April 24, May 28, July 17, September 3 to 5, and 24 to 26. Probably those that came from time to time were different individuals. Usually only a single hawk was present, but on July 17 there was a pair, and on September 24 a family group of five with recently fledged young. Invariably activity was concentrated along a line of telephone poles, extending west from the east boundary across the pasture to the buildings near the center of the quarter-section, and along a line of electric wire poles extending north from the south boundary to the buildings along a road with fallow fields on either side. There were 12 poles in all. The hawks usually perched on them (sometimes on the wires stretched between them) and foraged by making flights of usually less than 100 feet from the line to the ground to secure prey. Food was obtained chiefly in this elongated strip .43 mile in length and encompassing perhaps ten acres, but at the maximum a hawk followed over periods of hours and flushed frequently ranged over an area of somewhat more than 80 acres. This was a female present on the area on April 6, 7, 8, and 9.

**Colinus virginianus** (Linnaeus)

**Bob-white**

**Status.**—Common resident.

**Habitat.**—Although quail range over almost every part of the Reservation, areas in an early stage of secondary succession are preferred. My records of coveys are concentrated at the pond, the old quarry, and the formerly cultivated fields, which had grown up with weed patches adjacent to brush and woodland. Coveys were noted in woodland of various types but were rarely seen where stands of awnless brome grass were dominant in former pastures. In the nesting season when coveys had dispersed, pairs were
often seen in habitats different from those used by the coveys at other times of year. Pairs were often seen along the edges of pastures.

Movements.—In autumn, winter and early spring, there were as many as eight coveys using the area, but the number was variable. Fallow fields of 16.7 acres at the middle of the Reservation on its western edge provided headquarters for one covey, which likewise ranged over adjacent fields, to the west, cultivated for sorghum, corn, and other crops. A second covey ranged over the old quarry on a hilltop edge (where an abundant crop of lespedeza, sweet clover and ragweed furnished an ample food supply), the pond area at the foot of the same hill, the intervening brushy wooded south slope, and field cut by a deep gully. This area was roughly rectangular, approximately 1800 feet long by 1000 feet wide, and its

computed area was 40 acres. Two or three other coveys ranged over an area of fallow fields, of 42.8 acres in the northeastern part of the Reservation, and at least two others in another fallow area of 48.5 acres in the southeastern and south-central part. A hilltop field, adjoining the southwestern corner of the Reservation was headquarters of still another covey, which used the area from time to time.

In spring, territorial calling usually has been heard in or near the field where the Reservation headquarters are situated, but in the years when Cooper hawks nested nearby, relatively few quail were heard or seen there. In 1956, when the hawks were not present,
quail were especially in evidence. In May and early June some 13 calling males were recorded along the edges of this field, each in a distinct territory, and presumably accompanied by a mate. The males' habit of answering the calls of neighbors made it possible to establish the approximate position of territorial boundaries. Best data were obtained on the male whose territory included the area around the residence building, as he was seen and heard many times each day, and he was less wary than other individuals, having become conditioned to the presence of humans. On various occasions this male was seen, in early morning or after sunset, foraging with a female. When flushed on such occasions the birds would fly less than 100 feet, and, staying within the territory, would veer back to thickets along a ravine, always alighting close together. On most occasions the male was seen or heard alone, while presumably the female was occupied with laying or incubation. The male spent much time each day in territorial calling, especially in early morning, late afternoon, and in cloudy periods. The oval area within which he stayed was approximately 1.4 acres, but territorial calling and most foraging was mainly confined to the central part of it, an area only about 140 feet in diameter. Four intervals between territorial centers of adjacent calling males averaged 245 feet, indicating territories of approximately 1.1 acres. All the territories tended toward elliptical shape. Two, situated where the transition from woodland to grassland was abrupt, had their long axes along the edge. Three others that were partly in groves in a field adjacent to woodland, had their long axes at right angles to the edge. Some of these bob-white remained in their territories until late August, as they were heard calling from time to time. Nevertheless, territorial calling steadily declined after the end of May, and was not often heard after midsummer.

**Grus canadensis (Linnaeus)**

**Sandhill Crane**

**Status.**—Uncommon migrant.

**Habitat.**—Northern prairie and tundra in breeding season.

**Movements.**—On several occasions migrating groups of cranes have been seen near the Reservation, but ordinarily they fly high and do not stop in the vicinity. On the early afternoon of November 13, 1957, a lone crane, which had one leg dangling as if it was
injured, was seen flying west across the northwestern part of the Reservation. A short time later it was seen flying back in the opposite direction. In the following week it was seen daily, making trips back and forth over approximately the same route, which crossed the northern part of the Reservation or the southern part of the Rockefeller Tract. On two occasions it was flushed from the small pond on the Rockefeller Tract. A few days later feathers, bone fragments, and the legs of the crane were found strewn at the pond edge, and along a trail leading off to the south. Probably the crane had been caught and eaten by a coyote.

*Rallus limicola Vieillot*

**Virginia Rail**

*Status.*—Rare transient.

*Habitat.*—Marshland.

*movements.*—One was seen at the pond on May 8, 1955.

*Porzana carolina* (Linnaeus)

**Sora Rail**

*Status.*—Occasional transient.

*Habitat.*—Marsh.

*Movements.*—Only one record has been obtained to date; on May 14, 1950, O. M. King and R. W. Fredrickson saw one at the pond on the Reservation. This individual was almost certainly a migrant. At the time, marsh vegetation was abundant at the pond.

*Fulica americana* Gmelin

**American Coot**

*Status.*—Occasional transient.

*Habitat.*—Lakes, marshes and ponds.

*Movements.*—In April 1950, remains of a coot were found in a horned owl nest in the southwestern part of the Reservation. This coot had probably been caught at a small hilltop pond that was a little less than 200 yards from the nest. At the larger pond, on the Reservation, coots were recorded on April 22, 1955; May 7, 1951; May 21 to 24, 1953; and October 7, 1955. The pond seemed to provide favorable habitat with ample food and cover at times when coots stopped there, but probably was too small to hold them permanently. Although records are few, their concentration
in late spring suggests that they pertain to individuals dispersed from flocks in search of habitat favorable for nesting.

**Charadrius vociferus** Linnaeus

**Killdeer**

*Status.*—Regular transient, chiefly in early spring and autumn.

*Habitat.*—Typically in or near wet places with open or partly open expanses of mud, sand or gravel.

In the absence of such habitat on the Reservation, the killdeer has never been known to stop and all 37 recorded dates pertain to birds flying over, singly or in pairs or groups.

* Movements.*—The records are distributed throughout the year except for the months of December and January, but November 7, 1951, is the latest date in autumn. More than half the records (21) are for March. Earliest records in each of seven years, 1950 through 1956, were the 4th, 26th, 16th, 5th, 1st, 3rd, and 2nd of that month, but in 1957 one was heard on February 9 and in 1958 one was heard on February 26. Probably these numerous early spring records pertain to birds still on their northward migration, or at least still wandering in search of nesting territory. In 1958 precipitation was unusually heavy, and nesting occurred in a partly barren field on the Rockefeller Tract. Young were fledged. In 1951 also, several summer records were obtained (June 22, July 28, August 7, September 13). Most records of killdeers on the Reservation were obtained in rainy weather or soon afterward. Killdeers noted in spring and autumn were usually moving about erratically rather than holding to a direct course on migration. On October 10, 1951, at 10 A.M., five were seen in a group, flying south. On October 18, 1951, a group of 12 circled over a hilltop field.

**Philohela minor** (Gmelin)

**American Woodcock**

*Status.*—Rare migrant.

*Habitat.*—Wet places in or near deciduous forest.

* Movements.*—Several were recorded in the late summer of 1948, one on November 4, 1949, and one on August 30, 1951. In the unusually wet summer of 1958, woodcocks, probably a pair, were seen regularly along a 500-foot stretch of woodland edge, in a brushy, damp, upland area. Probably nesting occurred.
**Capella gallinago** (Linnaeus)

**Wilson Snipe**

*Status.*—Occasional migrant.

*Habitat.*—Wet meadows.

*Movements.*—On several occasions snipe have been seen on the Reservation, but my only definite record is for October 24, 1951.

**Bartramia longicauda** (Bechstein)

**Upland Plover**

*Status.*—Rare transient.

*Habitat.*—Prairie, especially of short-grass type, or where heavily grazed.

*Movements.*—On May 12, 1957, one was flushed from the blue-grass pasture on the Rockefeller Tract. It circled and lit in a newly cultivated field where it remained for more than an hour. When flushed again it flew back into the pasture. On the following day it was gone.

**Actitis macularia** (Linnaeus)

**Spotted Sandpiper**

*Status.*—Occasional transient.

*Habitat.*—Shorelines of streams.

*Movements.*—On May 2, 1949, one was seen at the edge of the pond.

**Tringa solitaria** Wilson

**Solitary Sandpiper**

*Status.*—Occasional transient.

*Habitat.*—Edge of water, in a variety of situations.

*Movements.*—On April 8, 1953, two were foraging along the edge of the pond, which then contained but little water. On July 14, 1952, one was foraging on mud at the pond edge, late in the afternoon.

**Totanus flavipes** (Gmelin)

**Lesser Yellow-legs**

*Status.*—Occasional transient.

*Habitat.*—Shorelines.

*Movements.*—The only definite records are of individuals stopping on northward migration in spring. On May 7, 1953, a group
of six were foraging, wading in shallow water at the edge of the pond in late afternoon. When flushed, they flew northeast. On April 25, 1956, one feeding at the edge of the pond was seen to catch a small frog (probably a cricket frog). When flushed, this bird returned within a few minutes, but after being disturbed a second time, it circled high over the area and left. On April 27, 1956, one that may have been the same was reported at the pond.

*Larus pipixcan* Wagler

Franklin Gull

*Status.*—Occasional transient.

*Habitat.*—Inland marshes and lakes.

* Movements.*—On May 2, 1951, late in the afternoon, four were seen flying high over the pond headed northeast.

* Zenaidura macroura* (Linnaeus)

Mourning Dove

*Status.*—Common summer resident; rarely seen in winter but flocks or lone birds, perhaps from more northern breeding populations, occasionally cross the area or stop on it briefly.

*Habitat.*—Most of the area is used by mourning doves for nesting, and nests have been found in a variety of situations. Two were on the mat of old dead grass in the bluestem prairie of the northwestern corner. Most others were in trees and shrubs. Parkland situations at the edge of the woods, and open glades with sumac patches on south slopes are favored situations for nesting and foraging. Doves were rarely seen in the denser oak-hickory woods of north slopes. The fallow fields with their abundant crops of weed seeds, provide a potential food source, which was much used in 1948 and 1949. Since 1949 these fields have been little used, because the accumulated dead vegetation makes foraging difficult for the doves.

*Movements.*—The flocks of mourning doves that are occasionally seen in Douglas County in winter tend to keep to cultivated land, and have rarely been seen on the Reservation. On mild days of early spring, doves appear abruptly and begin territorial calling. These probably are new arrivals that have spent the winter farther south. First recorded dates of territorial calling each year from 1950 through 1957 were: March 17, March 26, March 28, March
12, March 7, April 15, March 6 and March 2. Soon after arrival they begin to nest. Each year doves nested in the vicinity of the headquarters buildings, and on many other parts of the Reservation.

Males moving about and calling from territorial perches have been seen to use stations separated by as much as 700 feet. Others kept under observation for periods of hours, have stayed within an area 100 feet in greatest diameter. In the vicinity of the Reservation headquarters, distances between adjacent calling males in seven instances averaged 689 feet (1300 to 100). If this figure is representative of a territory's diameter, nesting territories averaging approximately eight acres are indicated.

Only rarely were doves seen to come to the ground to forage on the Reservation. On the contrary, those that bred on the area seemed to feed on other areas remote from their territories. Doves that nested near the Reservation headquarters were often seen travelling in strong and direct flight to the west for half a mile or more, to cultivated fields, or were seen returning from such flights, to nests, territorial perches or feeding of young.

A typical instance of territorial defense was recorded on April 20, 1954. A pair engaged in courtship in an elm tree beside the house. After a period of preening, three feet apart on a horizontal limb, they showed increasing awareness of each others' presence. One, presumably the female, postured with tail elevated and wings vibrating. The mate approached, and standing behind, pecked lightly at the other several times, then flew to another tree 50 feet south. The female followed. At this stage proceedings were interrupted when a second male began calling in another elm 100 feet farther south. He soon flew to telephone wires 150 feet west of the pair, and resumed calling. The male of the pair flew and perched on the wire beside him, and several times in succession lunged at him, causing him to fly a short distance. The intruding male moved to a nearby tree, and the female joined her mate on the wire. The pair followed the intruder, perching on the opposite side of the tree. After about ten minutes the unmated male, then the mated male, and finally the female flew to still another tree. Soon all three flushed again, travelling in rapid and erratic flight, the unmated bird closely pursued and harrassed by the mated male, while the female followed farther behind. The pursuit led for several hundred yards over a wooded north slope, and the outcome was not seen.
Nests were found each year from April through September. Few were successful, and most that I saw were destroyed by predators within a few days of their discovery. Often re-nesting, presumably by the same pair of doves, occurred promptly within a few yards of the site where a nest was destroyed. Individuals were not recognized.

**Coccyzus americanus** (Linnaeus)

Yellow-billed Cuckoo

**Status.**—Common summer resident.

**Habitat.**—Cuckoos utilize all types of woodland present on the area, but evidently prefer edge situations, where there are thickets. Nests often are situated in thorny trees or shrubs such as osage orange or honey locust. Territories may include extensive open areas, but these are crossed in rapid direct flight and most of the time cuckoos keep out of sight in dense foliage.

**Movements.**—Each year cuckoos have been first noted on the Reservation in May; the 15th (1950), 24th (1951), 17th (1952), 21st (1953), 3rd (1955), 12th (1956), and 9th (1957). Within a few days after recording of the earliest arrival, cuckoos are present in abundance and are establishing breeding territories. Nests have been found from May through September, but with a high proportion in the latter half of the summer, suggesting that more than one brood may be the rule. Most of the nests found were destroyed within a few days by predators, and some were blown down in storms. Because cuckoos tend to be silent after late August, and are somewhat secretive at all times, their departure in autumn usually passes unnoticed. On several occasions they have been recorded in the first week of October, but none has been seen later in the season.

Each year throughout the summer cuckoos were present in the headquarters area and were seen and heard daily. Territorial calling of each male tended to be concentrated in one or a few favorite perch trees. In July, 1955, a territory encompassing the grove of elms and other large trees in the headquarters area was approximately 250 feet in diameter and roughly circular.

As cuckoos tended to be secretive, keeping out of sight in dense foliage, their movements could not be readily traced. The spacing of calling males that answered each other provided some indication
of the size of areas occupied. In 17 such instances the interval averaged 615 feet (160 to 1000). On 13 other occasions linear distance covered was measured for individuals that were kept under observation for considerable periods, or that were seen to make relatively long direct flights. These distances averaged 323 feet (140 to 650), with more than half concentrated between 200 and 310 feet. A typical territory of a yellow-billed cuckoo might be approximately six acres.

On August 13, 1956, a cuckoo was watched while it was occupied with nest-building. It flew into a large elm in which one main limb was dead and devoid of foliage. It broke off a twig approximately five inches long, and carrying the twig crosswise in its bill, flew back to the nest tree. It paused, then made its way through thick foliage to the partly built nest situated in a horizontal crotch. As it passed through the thicker part of the tree, its movements were impeded by the transverse stick catching on twigs and leaves. In the next half hour it repeated the procedure time after time with but little variation. It always went to about the same spot on the dead branch, about 60 feet from the nest.

Brumwell (1951:220) at Fort Leavenworth, found the cottonwood-elm association along the Missouri River to be a favored nesting habitat. He observed several adults fly across the river and return with food for the young, making a round trip of approximately a mile.

Coccyzus erythropthalmus (Wilson)

Black-billed Cuckoo

Status.—Occasional transient and summer resident.

Habitat.—Deciduous forest and edge. The relative rarity of this species on the area suggests that its ecological tolerances are narrower than those of the yellow-billed cuckoo, and perhaps it is limited to habitats providing better cover.

Movements.—On September 6, 1951, one that was flushed in thick woods of elm, locust and osage orange, on a south slope, was carrying a caterpillar in its bill. It uttered rabbit-like squalling sounds and was joined by a mate. After their excitement had subsided somewhat, they gave frog-like rolling notes at intervals of a few seconds. A nest was nearby, about 13 feet above the ground. Others were recorded on the Reservation on May 17 and 22, 1952, and on September 24, 1957.
Tyto alba (Scopoli)

Barn Owl

Status.—Occasional transient.

Habitat.—Typically, grassland with nesting sites such as are provided by caves, hollow trees, old buildings, mine shafts, or niches in gully cutbanks.

Movements.—On December 7, 1949, a pair was flushed from a dense thicket at the edge of an eroded, fallow upland field. After being flushed both owls flew down a ravine and were heckled by small birds. A few minutes later one of the owls flew over, about 100 feet high and it veered, suddenly spiralling downward to the same place from which it originally flushed. On December 1, 1951, one was flushed on a wooded slope 200 yards east of the Reservation headquarters. No other barn owls have been seen on the Reservation but occasionally at night their calls have been heard. On February 7, 1952, at about 9 P. M., one was heard calling and from these calls its flight could be traced along the narrow, flat, grassy hilltop that extends across the Reservation. Those living on nearby farmlands may occasionally wander on the Reservation in the course of their hunting. For the barn owl, habitat conditions on the Reservation have worsened since areas that were formerly grazed or were cultivated fields, have become covered with a dense stand of rank vegetation.

Otus asio (Linnaeus)

Screech Owl

Status.—Probably regular resident, but records were not obtained with sufficient regularity to indicate that area was occupied by permanent population.

Habitat.—Woodland and parkland.

Movements.—Twelve records in eight different months were obtained in 1951, all within a radius of 100 yards, and probably all pertaining to the same pair. Activity seemed to center on a wooded north slope and the ravine along its bottom, south of the Reservation headquarters. On March 17 one of the owls was found sleeping in the hollow trunk of an oak near the center of the area where calling had been heard. On several occasions two owls were heard calling and answering each other. Screech owls were heard also in 1950 (once), 1952 (once), 1954 (twice), 1955
Home Ranges of Vertebrates

Bubo virginianus (Gmelin)

Horned Owl

Status.—Abundant (for a large raptor) resident, using nearly all parts of the Reservation.

Habitat.—By day usually seen in dense woods where roosts are located, but at night it is less restricted, ranging far and wide, through woodland, woodland edge, and open fields.

Roosts are usually in large trees such as elms, oaks or honey locusts, especially where thick branches or vine tangles provide concealment.

Movements.—Ordinarily horned owls are territorial. Each territory is occupied by a pair of adults. Territories are occupied throughout the year, and perhaps continuously for long periods of years. Most information concerning territories was obtained in the months of November, December, and January because the owls were especially vocal then. Their hooting would begin a few minutes before sunset and might continue sporadically throughout the night. However, the most concentrated vocalization occurred in a period of perhaps 15 to 20 minutes after sunset. The first owl to hoot would usually be answered, after it had called a few times, by its mate or by a rival on an adjacent territory. Soon still others would begin calling until as many as six pairs could be heard from one vantage point.

In late 1955, approximate centers were located for eight territories, six of which were on the Reservation, while the other two were near the boundary. For 13 instances of territories adjacent to each other, with continuously favorable habitat, the distances intervening between territorial centers ranged from 3070 to 1700 feet (average 2400). In 23 instances of owls answering each other from adjacent rival territories, the intervening distances ranged from 2360 to 686 feet (average 1360).

These figures represent conditions obtaining when the population was high. The number of territories on the Reservation varied somewhat from year to year. No figures are available for 1948 or 1949, but certainly the owls were moderately abundant in those years. In the winter of 1950-51, eight territories were represented.
on the Reservation. Three of these were almost or entirely confined to the area, and each of the other five overlapped it extensively. In the winter of 1951-52, there were nine territories represented. In general, they corresponded with the territories of the previous year, but with some shifting of boundaries and centers of activity. The increase in numbers of owls on the area did not represent a higher population density. In 1952-53 only six territories were known to be represented on the area. In correlation with this decrease, the territories were exceptionally large. The best known territory, which was known over the six-year period, reached its greatest extent that winter; it was .6 mile long and .42 mile wide. Baumgartner (1939:280) recorded three or four male horned owls per square mile in favorable habitat south of Lawrence. On a five-square-mile area he recorded an average of two males per square mile.

Low population density of the owls was probably correlated with deficient rainfall and, more directly, with the low population ofcottontails. In the summer of 1952 vegetation was relatively sparse because of drought. Having less food and cover than usual, cottontails did not increase normally in the breeding season. Only meager data concerning the numbers and distribution of owls were obtained in the winters of 1953-54 and 1954-55, but there were probably seven or eight territories in those years. In the winter of 1955-56 there were eight territories. Only one of these was entirely within the Reservation, but each of four others had more than half of its extent within the area.

On many occasions the presence of horned owls was revealed to the observer by the clamoring of crows, which heckled and pursued them on sight. Especially in winter, when the population of crows was high, and trees were bare, so that concealment was more difficult, crows spent many hours each day heckling the owls on the Reservation. An owl might be followed and harrassed for an hour or more at a time, and hundreds of crows might congregate. The owl might flush a dozen times or more before ridding itself of the crows. When it flew, excitement increased, as the crows pursued it. Harrassment by crows must be an important factor in the ecology of the horned owl in this region. On February 24, 1953, the course of an owl was recorded for about an hour that it was followed by crows. It flushed six times, with flights of 100 yards to a quarter mile, travelled a linear distance of .9 mile, and was finally left by the crows when it was a little more than .6 mile south of the starting place.
From time to time small accumulations of pellets were found where horned owls had roosted during the day. Such accumulations rarely consisted of more than a dozen pellets, and it was obvious that the owls of each pair changed roosts frequently. Nevertheless certain favored trees were returned to repeatedly and had new accumulations of pellets on many occasions over periods of years. The roosting area is only a small part of the territory, generally 100 yards or less in diameter. The members of a pair have never, in my experience, been flushed from the same tree, but are usually in nearby trees where each may be seen by the other. Upon leaving the roost at dusk an owl may fly to a distant part of its territory, followed by its mate. After dark the owls may move away from the woodland into relatively open situations, perching on fence posts, snags or isolated trees that command a view of the surroundings. Many of the owl kills found have been in fields or pastures, sometimes hundreds of feet from the edge of the woods.

In 1950 a nest was observed from time to time throughout incubation, and subsequent development of the young owls. Both young were banded. The nest was in a honey locust in a hilltop field. After the young had left the nest, they were found perched close together in the edge of the woods about 100 yards from the nest and about 15 feet above the ground. In subsequent weeks these young were seen frequently. At first they stayed within a small area and tended to stay close together. Gradually they shifted in roosting from the southern to the northern part of the territory and even beyond it, and they were no longer found together. Through the spring and early summer these young presumably were still being fed by the adults as their hunger calls were heard often at night, but the adults were never with them when they were flushed in the daytime. Five years later one of these banded young was shot by a farmer at Tonganoxie, some five miles from its parents' territory.

**Strix varia Barton**

**Barred Owl**

_Status._—Resident; one pair believed to have been in continuous tenure of territory from 1949 through 1957, and others have been present on various parts of Reservation from time to time.

_Habitat._—Deciduous forest.

The relatively small portion of the Reservation where a pair of these owls stayed, differed from other woodland areas in more nearly approximating the Oak-Hickory climax, as it had many large, mature trees, with a high proportion of red oak, chestnut oak, black
oak and shagbark hickory. The numerous hollow trees provided nesting sites and perhaps daytime roosts for the owls. This was at the head of a small valley, where two deep ravines joined, near wooded slopes, and a brushy bottomland. In other woodland and field-edge situations where barred owls were seen from time to time, they did not remain for long.

Movements.—The pair of owls that lived near the eastern edge of the Reservation were rarely seen but were heard hooting on numerous occasions, on overcast afternoons or at dusk. My imitation of their calls often caused them to begin hooting. They were almost always heard when the territory was visited after dark.

Most of their hooting was heard within an area estimated to be only 200 yards in diameter. However, these records mostly pertain to daytime or dusk, while the owls were on or near their diurnal roosts, and therefore are not adequately representative of the entire territory. The more dispersed records indicate a territory of approximately a quarter-mile in diameter.

When these owls were caused to hoot, by an imitation of their calls, the response of the first individual was usually followed within a few seconds by that of its mate. The calls of the two individuals came from different points, but within the same general area, evidence that they normally roosted in separate trees. Sometimes the calling was taken up by other barred owls in woods east of the Reservation boundary, at a distance in the neighborhood of half a mile from the resident pair.

More detailed information concerning movements was obtained in the vicinity of the Reservation headquarters, where a barred owl—probably the same individual—occurred over periods of months, alone at first, and later accompanied by a mate. Early records of it were obtained on October 12 and 17, 1950, and on March 5, May 26, and November 13, 1951. This owl may have had a territory farther north and east; if so it only occasionally ranged into the area. However, it was seen more frequently in the autumn and early winter of late 1952. Subsequently, in January, 1953, it seemed to have shifted so that its territory centered near the Reservation headquarters. Thenceforth, throughout 1953, it was recorded many times each month. From mid-May to mid-October it was accompanied by a mate.

In winter, its activity was largely diurnal. On many occasions it was seen hunting, and sometimes was kept under observation for periods of hours. Voles seemed to be the chief food source, and
in winter their activity likewise tended to be limited to the daylight hours. In hunting, the owl did not stay in the woods, but chose trees in meadows or that bordered on them. Flushing distance was usually 150 to 200 feet but sometimes the owl permitted approach to within 60 feet. When not disturbed, the hunting owl usually remained on its perch from a few seconds up to fifteen minutes. While on such a perch, it was alertly scanning its surroundings with almost continual, short, quick movements of its head. From time to time it would fly down into the grass in pursuit of prey, and sometimes would remain as much as a minute. Often it flew up with no evidence of a catch even after it had been on the ground for as much as half a minute. It was seen to fly distances

![Diagram of home ranges of vertebrates](image-url)

**Fig. 15.** Northwestern quarter of the Reservation showing territory of a pair of barred owls in 1953. Dots show locations where owls were heard hooting. Broken lines show course of an owl that was followed as it hunted in daylight on January 8 and 19. The circuit shown for January 8 was followed three times in succession, with minor variations.
as much as 100 feet to strike at prey, but usually the flight to the ground was shorter. In moving from one perch to another it sometimes flew only a few feet, rarely as much as 100 yards. The flight seemed remarkably slow. On the different occasions when it was followed, it covered more or less the same area, and returned to many of the same perch trees, although not using them in any definite sequence. The area that it covered was of irregular outline, approximately 1900 feet long and 1200 feet wide. Its diurnal activity in winter was largely between dawn and 10:30 A.M. It was occasionally seen in bright sunlight, but seemed to prefer overcast days. On numerous occasions it was found later in the day, inactive on a roost. It had no special roosting place, but was usually in some large tree with dense foliage, near the central part of the territory.

After this owl obtained a mate, hooting was heard much more frequently. Often the owls began hooting late in the afternoon, answering each other while still on their roosts. They were usually near together, but over periods of weeks their roosting areas shifted until almost every part of the territory had been utilized for this purpose. In fact the area encompassed by their perches was considerably greater than that otherwise known for them; it was bounded by seven marginal points, and was measured as 75 acres. The territory of these owls was separated by at least half a mile from that of their nearest neighbors, the pair already discussed, that occupied an area near the eastern edge of the Reservation. Obviously territorial pressure was not a factor limiting the size of either territory.

Asio otus (Linnaeus)

Long-eared Owl

Status.—Frequent winter resident; occasional in summer.

Habitat.—For roosting this owl prefers dense thickets, and locally most often uses clumps of red cedar which offer better protection than bare deciduous trees. On the Reservation no large cedar trees are present, and the owls have usually been found roosting in thickets of osage orange, honey locust, or chinquapin oak. In their nocturnal foraging, on the Reservation at least, these owls most often seem to hunt over grassland, as analysis of pellets has shown the prey to consist largely of prairie voles, cotton rats, and harvest mice.
Movements.—On October 11, 1950, two were found in a thicket of chinquapin oak at a hilltop edge. They flew about 100 feet and lit in another thicket. On December 7, 1951, one was flushed from a hilltop rock outcrop. On January 8, 1952, a group of three were flushed from an osage orange tree on a wooded south slope. On March 10, 1952, about 200 feet north of this spot, a group of at least a dozen was flushed from within a 20-foot radius in a thicket of chinquapin oak. Ground beneath the thicket was littered with pellets and their fragments, some of which appeared to be many weeks old. Later in the day the owls were located again, mostly together in an osage orange tree about 100 yards south of their regular roost. At my approach they flushed one by one and headed back in the direction of their former roost. White-footed mice and other prey that might have been secured in the forest made up but a small percentage of the items in the pellets that were examined; voles and cotton rats that must have been obtained in open fields, made up the bulk of the diet.

On January 22, 1954, one was flushed from a roost among projecting roots in the cut-bank of a gully. On February 2, 1954, strewn feathers of one were found in the middle of a hilltop field, and it seemed the owl had been attacked and eaten by another predator. On March 23 and 26, 1954, a pair was seen near the same place in a thicket on a brushy south slope.

On a December evening when it was nearly dark, a flock was observed hunting over a hilltop field. They paid little attention to my presence, but were wheeling and circling in a fairly compact group within a few yards of the ground.

On April 19, 1951, a quarter mile southeast of the Reservation, one was found incubating in a nest 20 feet up in a honey locust. The only summer record from the Reservation is of one seen on August 10, 1951.

Aegolius acadicus (Gmelin)

Saw-whet Owl

Status.—Rare transient in winter.

Habitat.—Breeds in northern coniferous forests but moves south in winter and may appear in variety of habitats.

Movements.—Only two have been definitely recorded from the Reservation. In December, 1948, one was seen on a wooded hilltop. It was tame at first, but became more wary and flew farther
at each attempt to stalk it, until it was lost. One perched ten feet above the ground in an osage orange tree on February 11, 1951, at 1 P.M. was in the act of swallowing a white-footed mouse. It permitted approach to within fifteen feet. Twice when it was flushed, it moved only a few yards before settling on another low perch, but it continued to watch my movements alertly.

Caprimulgus carolinensis Gmelin
Chuck-will's-widow

Status.—Irregular summer resident.

Habitat.—Woodland.

On the Reservation activity was concentrated on areas of south slopes with medium to small trees and dense thorny undergrowth, a type of woodland distinctly more xeric than that preferred by the whip-poor-will.

Movements.—The first definite record was obtained on May 11, 1953, when one was heard calling on the slope north of the headquarters. All other records were obtained in 1956 and in 1957, when the species was present throughout the late spring and early summer and was heard almost nightly. One calling on April 27, 1956, was answered regularly by a whip-poor-will in the same general area. In subsequent weeks whip-poor-wills were heard less regularly than they had been in other summers and perhaps were, in part, displaced by the chuck-will's-widows. On May 17 one of the latter began calling at 7:36 P.M., and soon a second began answering nearby. I approached to within 200 feet and heard a peculiar low growling sound, then saw one in close pursuit of the other in an erratic flight through the trees. They settled and resumed calling only about 50 feet apart and a third was calling on a hillside 150 yards away. Another pursuit, accompanied by the same peculiar growling sounds, was noted on June 6, as one chased a rival from one woodland edge to another, across intervening fields, a distance of some 320 yards. The pursuer quickly returned, and both chuck-will's-widows called, answering each other.

A chuck-will's-widow engaged in territorial calling as it shifted from perch to perch, moved, on the average, approximately 430 feet (640 to 240) at each shift. A supposed territory mapped on the basis of 16 stations covered 23.7 acres, but there is some doubt as to whether all the records pertained to the same individual.

An unusually late fall record of a goatsucker that appeared to be of this species was obtained on December 6, 1953, when the bird
was flushed at close range, from the ground or a low branch. It flew about erratically and lit in a large tree but could not be relocated. Temperature was slightly above 50°F. at the time it was seen, but light snow had fallen on the preceding night.

Caprimulgus vociferus Wilson

Whip-poor-will

Status.—Common summer resident, using most parts of Reservation, but chiefly confined to woodland and vicinity of woodland edge.

Habitat.—Woodland, especially that of more mesic types where there are oaks, hickories, and elms.

Whip-poor-wills flushed from their daytime roosts were in dense woods where the leaf litter was thick, and where there was underbrush such as dogwood and gooseberry. Calling males at night were frequently noted in edge or parkland situations.

Movements.—Whip-poor-wills arrived in April each year; from 1950 through 1956, earliest records were the 6th, 24th, 24th, 22nd, 10th, 17th and 20th. Late records include: October 11, 1949; October 1, 1950; September 23, 1951; September 16, 1952; September 8, 1953; September 20, 1954 and September 20, 1955. Throughout May, June and July territorial calling is persistent, beginning at dusk and continuing intermittently until daybreak. This “song,” the familiar “whip-poor-will” call, serves to maintain spacing between pairs on adjoining territories. Open spots are chosen for calling. The roofs of the house and laboratory buildings and top of the chimney were especially favored, as were the top of the dike at a dam, and the bare shaly bank of a ditch. In other instances the birds perched on horizontal branches of large dead trees while they were calling. On several occasions when a whip-poor-will was calling, I attempted an imitation. If the whip-poor-will was nearby, this imitation usually caused a strong reaction. The bird might hover erratically, coming within a few yards of me and on one occasion, one lit on the ground only 15 feet away, giving a peculiar purring sound. This same sound has been heard while one individual was chasing another, and immediately afterward. Exceptionally favorable sites for territorial calling may be used by different individuals at different times, neither of the two (or more?) being able to establish absolute control.

In 24 instances the distance between whip-poor-wills that were calling and answering each other, ranged from 1600 feet to 370 feet,
averaging 890. If this distance represents the diameter of a typical territory, the actual size amounts to some 22.6 acres. Territories actually measured insofar as they were known, covered 14.9 acres (18 stations, 4 marginal), 27.5 acres (28 stations, 6 marginal), and 6.9 acres (13 stations, 6 marginal).

On June 10, 1955, a whip-poor-will flushed from leaf litter in oak-hickory woods on a northwest slope feigned injury. On the following day it was flushed again, and the two eggs were found at the spot where it had been sitting. On June 17, the bird was flushed again, and the eggs were approximately twenty feet from the spot where they had been before. On June 21, when the nest was revisited, the parent flushed from a spot ten feet away. The eggs were at the same spot where they had been on June 17, and the parent may have crept away from them before making herself conspicuous. Again she feigned injury, jumping and flopping, moving a foot or two at a time until the sixth leap when she flew several yards, and at the next start she flew out of sight, but soon reappeared, approaching the nest from another direction.

Bent (1940:149) mentions instances of the closely related chuck-will's-widow moving its eggs after disturbance of the nest, and quotes Audubon as stating that the eggs are carried in the mouth. Bent (op. cit.:175) also cites instances of female whip-poor-wills flushed from the nest carrying nestlings for short distances grasped between her legs.

**Chordeiles minor** (Forster)

**Nighthawk**

*Status.*—Regular summer visitant; no evidence of nesting on the area has as yet been obtained.

*Habitat.*—The prey consists of flying insects, and where these are numerous the nighthawk may be present, in any of a variety of terrestrial habitats. The limiting factors are thus not so readily definable in terms of plant associations or physiography as in most other kinds of birds.

*Movements.*—Earliest records for the Reservation are May 18, 1952, May 22, 1954, and May 15, 1955. Latest records are September 21, 1948, September 20, 1953, September 20, 1954, and September 11, 1955. On September 18, 1954, soon after sunset, a group of more than a dozen, flying erratically on separate courses, passed over the field where the headquarters are located, and gradually moved away to the southwest until they were out of sight. Ap-
proximately a quarter hour later, a similar flight occurred, perhaps of the same individuals. In 1952 nighthawks were often seen foraging over the Reservation in late afternoon, and several times were flushed from woodland in the daytime. In later years, while drought conditions prevailed, they were rarely seen on the area between May and September. Foraging nighthawks that were flying over the area covered ranges much larger than those of other birds of comparable size. Their ranges seemed to be more than half a mile in diameter, and, although some tendency was noticed for an individual to make the same circuit several times in succession, they were not present consistently over periods of days or weeks suggesting that they wandered extensively, or that the areas they were seen to cover comprised only small parts of their total ranges.

Chaetura pelagica (Linnaeus)

Chimney Swift

Status.—Usually present in summer but not known to breed; those that appear from time to time evidently have large foraging ranges that include parts of the Reservation, or possibly all of it.

Habitat.—Aerial maneuvers of the individuals that are seen on the Reservation have little or no relation to the terrain or plant associations beneath. The chimney of the residence was an obvious focal point of activity, though the swifts were never seen to enter or emerge.

Movements.—Over the eight-year period, 1950 through 1957, chimney swifts were first recorded on the Reservation on the following dates: May 20, May 18, May 23, May 24, May 8, May 17, April 28 and April 24. In several years they were noted somewhat earlier within the Lawrence city limits than they were at the Reservation: May 8, 1953, May 5, 1954, and May 1, 1955. Most records for the Reservation are for late April, May, June, and July (latest September 24, 1957). Swifts may have nested in the chimney at the Reservation headquarters. At least, this chimney was the focal point about which their maneuvers centered. Maneuvering was seen chiefly near dusk and on overcast days. On June 24, 1952, two pairs were flying in the headquarters area. Those of each pair kept close together in their rapid flight, but seemed to pay no attention to the other pair. They were flying to distances of hundreds of yards in each direction from the chimney, about which their maneuvers centered. On May 25, 1953, two
seemed to be chasing a third, while a fourth was flying alone. On many other occasions, especially in early June, 1953, and in June, 1955, three were flying together in a group. On June 9, 1953, there were two such groups. On May 8, 1954, the first time that swifts were seen that spring, a pair was moving in rapid flight about the chimney, in circles about 200 feet in diameter, from time to time descending to the chimney in tight spirals, but not entering it. On May 17, 1955, the first swifts noted that season were heard chattering and then a moment later, were heard fluttering inside the chimney.

Archilochus colubris (Linnaeus)

Ruby-throated Hummingbird

Status.—Uncommon summer visitant or transient.

Habitat.—Less limited to specific plant associations and habitat situations than most other species of birds occurring locally. The limiting factor in most instances is an abundance of suitable flowers providing nectar. Hummingbirds shift their foraging areas frequently according to the availability of the food supply at different stages in the season. Germander (Teucrium canadense) is a favorite source of nectar. This mint grew in dense patches in some parts of the former pastures for several years after grazing was discontinued. It decreased in abundance and was replaced by grasses.

Movements.—Hummingbirds were generally seen only at times and places where there were abundant supplies of flowers, and may not have nested on the Reservation. Redbud and germander were two of the favorite kinds of blossoms. A hummingbird seen on May 18, 1952, was feeding from dandelion flowers. After 1953, as succession progressed, with germander and other kinds of flowering plants being replaced by grasses, hummingbirds became much scarcer on the Reservation.

Megaceryle alcyon (Linnaeus)

Belted Kingfisher

Status.—Occasional transient.

Habitat.—Vicinity of ponds and streams, requiring vertical cut-banks for excavation of nest burrows.

Movements.—Kingfishers, either lone individuals or pairs, appeared from time to time at the pond on the Reservation. In each instance probably the birds were migrants, which happened to notice the pond in flying over, and stopped there temporarily. Fish
were not present, and amphibians comprised the chief sources of food. Specific dates that kingfishers were seen at the pond were: July 8, 1950; April 7, 1951; May 19, 1951 (pair); February 17, 1952 (may have been one of a pair seen frequently along a slough two miles south of the Reservation); April 16, 23, and 24, 1952; May 28, 1952; April 5, 13, and 29, 1953; March 31, 1955; April 22, 1955; June 21, 1955; April 8, 1956, and May 3 and 4, September 18, and October 4, 1957.

Upon leaving the pond kingfishers sometimes flew in a low direct course as if headed for a predetermined goal. At other times they circled over the area, gradually rising until almost out of sight.

Colaptes auratus (Linnaeus)

Yellow-shafted Flicker

*Status.*—Common winter resident and migrant.

*Habitat.*—Woodland, but preferably where alternating with open situations such as grassy pastures.

Every part of the Reservation was utilized by flickers, but with temporary concentration on certain habitats, depending on the season, the weather, and availability of food sources.

*Movements.*—Flickers have not been recorded on the area from about mid-April to mid-September; generally they are absent in late spring and summer. The area is within the breeding range, and failure of the species to remain through the summer may result from the lack of suitably open situations where flickers might forage on the ground. Because the area is not grazed, or otherwise disturbed, the parts that were formerly open have grown up to thickets of young trees and shrubs, rank weeds, or tall grass.

First recorded appearances of flickers in fall of several different years were: September 28, 1948; September 13, 1951; September 12, 1952; September 19, 1953; September 17, 1954; October 5, 1955; September 21, 1956, and September 18, 1957. In late September and early October numbers on the area were rapidly augmented by new arrivals, and by late October flickers were among the most conspicuous birds of the Reservation. However, unlike most other wintering birds on the Reservation, individual flickers did not seem to become attached to specific areas for more than a few days at a time but were roving about with constant fluctuations in the numbers present.

On October 5, 1953, after one of the first cold nights of the season, many flickers were foraging on the ground near the house in com-
pany with red-bellied woodpeckers and robins, finding grasshoppers and other insects that were immobilized by the cold and were easily obtained in the short vegetation. By 8:30 A.M., this group had dispersed. In autumn, foraging is to a large extent arboreal, and wild fruits such as those of grape and poison ivy are major food sources. In winter relatively few remain, but from time to time there is an influx of migrants. At times when the ground was covered with snow and ice, flickers often concentrated their foraging on the cut-banks of gullies, digging in the loose soil for insects. On warm days after heavy snowfall, weedy fields were favorite places for foraging. There, the snow melted rapidly, being held off the ground by the mat of dead vegetation, and the flickers were able to find areas of exposed soil for digging.

**Centurus carolinus** (Linnaeus)

**Red-bellied Woodpecker**

*Status.*—Common resident; no seasonal shifts are apparent.

*Habitat.*—Woodland, with perhaps some preference for oak-hickory type.

The main requirement seems to be the presence of large old trees with numerous dead limbs and cavities. It matters little whether the tree happens to be cottonwood, elm, oak, or honey locust. The woodpeckers have been observed to utilize each of these kinds as the headquarters of a family group or an individual. Such groups or individuals are usually well scattered, with intervening woodland, often hundreds of yards in extent, that is little used or entirely unoccupied.

*movements.*—Red-bellied woodpeckers were observed to be notably sedentary. Large old trees, including elms, oaks, cottonwoods and honey locusts, were favorite foraging places, and an individual might spend a disproportionately large part of its time in one or several of these trees. At all times of year woodpeckers of this species are somewhat social, and two or more may be observed in the same tree. However, the bond between members of a pair in winter is weak if it exists at all. At that time each individual seems to be largely independent although it may at times associate with another, or even with woodpeckers of different species. In this respect the species differs from the hairy woodpecker, in which a strong bond between members of a pair exists, even at times of year other than the breeding season.
Each year, in warm clear days of early spring, males gave territorial calls from high snags. First records of such territorial calling, for several different years, were: March 24, 1951; March 28, 1952; March 13, 1953; February 1, 1954 (subsequently calling was heard often through February); March 11, 1955; March 30, 1956; February 16, 1957; and February 22, 1958. Often two males on snags hundreds of feet apart would answer each other regularly with the "churring" territorial calls. Also, territorial quarrels were frequent, and were notable for the persistence with which the intruder remained within the territory of his opponent or returned to it. A typical encounter between two males was observed on February 8, 1954, in a large honey locust in the edge of the woods, between the headquarters and the pond. The two males, clinging upright on opposite sides of a vertical branch, would engage in rapid sparring, uttering loud rolling calls every few seconds and also low grinding sounds. One would fly northeast 100 yards or more, chased by the other. In a few seconds the pursuer would return and perch on top of the snag, giving long rolling calls, but soon the second would return and renew the contest. While quarreling, the males drummed from time to time. A female, probably the mate of the defender, was also present in the tree, but she remained aloof and passive. A fourth woodpecker, possibly the mate of the intruder, was calling occasionally near the pond.

On many other occasions similar performances were observed. Probably they involved former co-occupants of a small area of favorable habitat, who became increasingly intolerant of each other and finally excluded each other from their territories as the breeding season approached.

Quarreling red-bellied woodpeckers strutted, bowed, postured and sparred, often moving about from tree to tree; the one that flew was immediately followed by the other. A quarrel might continue intermittently for hours, and might be resumed on successive days.

In their foraging, red-bellied woodpeckers seem to have an affinity for other kinds including hairy and downy, and often are observed in the same tree with one or both of the two last named. The abundant supply of insects probably attracts all three species, but also there seems to be a tendency for such a group to maintain itself in shifts from one tree to another. However, the nesting snags are jealously guarded against other woodpeckers, and against other kinds of birds that use cavities. In autumn the influx of flickers
caused much uneasiness among the red-bellied woodpeckers that lived near the Reservation headquarters. The larger and more aggressive flickers moving in numbers through and near the favorite trees of the red-bellied woodpeckers, caused the latter to scold and to make frequent short, restless movements. The red-bellied woodpeckers seemed to be incompatible with the red-headed woodpeckers, as the former were hardly ever seen or heard in an area at the east edge of the Reservation occupied by a colony of the latter, and from time to time when red-headed woodpeckers temporarily settled in the area near the Reservation headquarters, there was much quarreling. On April 2, 1956, a quarrel between a pair of red-bellied woodpeckers and a male starling was observed in a willow snag having a cavity offering a potential nest site for both species. The starling was the most aggressive. It would dart first at one woodpecker and then at the other, but it did not succeed in driving them from the tree. After ten minutes of continuous quarreling it gave up and flew out of sight headed northwest.

One woodpecker that was color-banded and recorded from time to time over a period of a year, used an area of 20.6 acres measured within the five marginal points. Most of the recorded movements and locations were near the headquarters and the pond, but a single record at a place 900 feet north of the pond greatly increased the total area involved. Certainly the entire 20.6 acre area was not used regularly. In 1955 the nest was in a sycamore snag southwest of the pond. In finding food for the nestlings the adult regularly made trips to places 550 feet southwest, 375 feet north, and 200 feet east of the nest.

In May, 1956, a nest was located in a willow snag beside a gully in a relatively open situation. The adults were often observed flying to and from the nest on foraging expeditions. Because the nest was away from woodland, the foraging expeditions probably were to greater distances than are typical for the species. The adults made expeditions in all directions from the nest, visiting not only the woodland but isolated trees and groves. The main line of flight was north northeast and south southwest, to an extreme distance of 520 feet in the one direction and 820 feet in the other. The area encompassed by all the observed foraging flights was measured as 17.3 acres. This total area, however, included several major portions that were not even crossed by the woodpeckers, and their movements were almost entirely confined to an area of irregular outline measured as nine acres.
A woodpecker that was actively foraging, with frequent shifts from tree to tree, was followed for several hours on December 7, 1953. The hexagonal figure outlining its route was 9.6 acres, and this probably represents the greater part of its home range at that particular time. For one banded, and recorded several times in November and December, 1953, a pentagonal range of twelve acres was recorded. Much of this area consisted of an open field, which was merely crossed by the woodpecker, staying mainly in the woods along its borders on each side. A triangular area of wooded slope within which another was noted repeatedly was 5.4 acres. This probably was only a part of the actual home range.

Occasionally red-bellied woodpeckers were seen making long direct flights, which were almost certainly beyond the limits of the usual home range or territory. On September 15, 1953, one was seen flying high, from a hilltop (“Sugarloaf”) in the northwestern part of the Reservation, across an intervening open valley to another hilltop nearly half a mile farther south, a total distance estimated as 2400 feet, although the exact spots where the flight began and ended were not seen. On December 27, 1953, one that was moving about from tree to tree frequently as it foraged was followed over an area 1350 feet across.

Territories between ten and twenty acres in extent are probably most typical of the species on the Reservation and in similar habitat. The same general area is occupied by an individual throughout the year, but with some shifting, occasioned chiefly by the mutual exclusiveness of pairs in the nesting season.

**Melanerpes erythrocephalus** (Linnaeus)

**Red-headed Woodpecker**

**Status.**—Moderately common resident, but localized to small area of woodland along eastern edge of Reservation.

**Habitat.**—Chiefly forest.

On the Reservation the one colony present from 1952 through 1956 was closely confined to an area of red oak woodland, the part of the area most closely approximating a climax deciduous forest.

**Movements.**—Red-headed woodpeckers were occasionally seen far from their usual habitat. These were wandering individuals. Some were travelling, but others remained for hours before moving on. It was not determined whether these wanderers had migrated for long distances or were from nearby colonies. They were seen
chiefly in late spring and early autumn, having dispersed just before and just after the nesting season. By months, they were distributed as follows: May—5, June—1, August—2, September—5, October—2. Some of those seen in September and October were injuvenal plumage. From September 10 to 19, 1955, a small group settled in the grove just northeast of the Reservation headquarters. During the time that they stayed most of their activity was confined to several large elms within a hundred-foot radius, entirely within the territory of a pair of red-bellied woodpeckers. There was almost constant quarreling between the two kinds. Scolding and pursuit by the red-bellied woodpeckers may have been the motivation for the red-headed woodpeckers to leave.

In 1956 there was a similar invasion at the same place in the last week of August. On the morning of August 31 at least six were present, and one or more had been heard in the vicinity for several days previously. This group remained until September 6, then disappeared abruptly, but in 1957 another group was present in the same place over the period September 4, 5 and 6.

The colony often observed on the eastern edge of the Reservation covered an area of more than 50 acres including almost level, creek-bottom land with exceptionally large, old trees, and the adjacent slope with oak woodland. More than a dozen of the woodpeckers inhabited this area, but no territoriality was discernible; they seemed to move about more or less at random, over the entire area, usually wandering singly or in small groups, each individual tending to keep within sight or sound of others.

**Sphyrapicus varius** (Linnaeus)

Yellow-bellied Sapsucker

*Status.*—Rare transient.

*Habitat.*—Woodland.

*Movements.*—On September 30, 1952, at 8 A. M., one in juvenal plumage was working on an elm at the Reservation headquarters. Another, also in immature plumage, was seen in oak woods on the Rockefeller Tract on April 9, 1957.

**Dendrocopos villosus** (Linnaeus)

Hairy Woodpecker

*Status.*—Permanent resident, with population of several pairs.

*Habitat.*—Woodland, especially where there are large mature trees, oaks, hickories, elms and locusts.
It is rarely seen in parts of the woodland where the trees are sparse or scruffy, nor in isolated trees growing in the open. Occasionally seen crossing broad, open fields, in high, direct flight.

**Movements.**—Hairy woodpeckers were especially noteworthy for the year-round association of pairs in permanent territories. All individuals on the area were shy (a flushing distance of approximately 150 feet was typical) and none was individually marked. Therefore, individual recognition ordinarily was uncertain, but pairs were followed from time to time and were seen in the same places with such regularity that identity could be guessed with some assurance.

On December 10, 1953, a territorial encounter between two males was seen. Soon after one flew into a large elm, another came from the opposite direction and perched nearby. They challenged each other, bowing and scolding. One lunged at the other and when it flushed he followed in close pursuit. The chase led in a circular course, with two complete circuits approximately 200 yards in diameter. Two days later a male which probably was one of those involved in the chase, was followed as he moved about from tree to tree, and the area covered corresponded roughly with that over which the chase extended.

In late 1953 and early 1954, two pairs were often observed separately, and occasionally in contact, in the area about the headquarters. The woodland encompassed by the records of one pair comprised approximately 37 acres. The second pair occupied an adjoining territory consisting of two separate blocks of woodland totalling approximately 22 acres, but with an intervening area of open field that was almost as large. On several occasions these woodpeckers were seen to make high, direct flights from one hillside to another one thousand feet or more away, crossing the open field intervening. In these and shorter flights, the bird that flew first (most often the female in observed instances) called as it launched into flight, and the mate followed within a few seconds. They were never seen to fly close together, but always made their moves to new areas well spaced in tandem fashion. In their foraging they tended to keep in separate trees, often as much as 100 feet apart, but obviously aware of each other’s whereabouts through the sound of pecking and the occasional sharp squeaking calls.

Hairy woodpeckers were often noticed foraging in close association with other kinds of woodpeckers, especially the downy and less frequently the red-bellied. Such associations often were maintained when the birds were shifting from one tree to another, suggesting
that actual sociability, rather than mere attraction to a common food supply was involved. However, at other times hairy woodpeckers have been seen to display varying degrees of intolerance (scolding, threat, and actual pursuit) toward both these other species. The reason for such intolerance is not understood. It does not seem to be seasonal, and has been noted at times of year other than the breeding season. Perhaps intolerance involves unfamiliar individuals, while those that are met regularly are accepted as co-occupants of the territory.

A roost in a hollow elm at the gully just south of the Reservation headquarters was used regularly from 1952 to 1957, probably by the same individual. Each evening near sunset this female hairy woodpecker came to trees near the roost, usually making a flight of hundreds of yards, from a remote feeding area. She was remarkably circumspect in approaching the roost, and sometimes spent as much as an hour in the process, maneuvering and calling in the vicinity.

In May, 1955, a nest with young was discovered fifteen feet high in a live honey locust, in thick woods on a north slope. The parents were not observed to forage near this nest, but upon leaving it they usually made flights of hundreds of yards to other hillsides.

**Dendrocopos pubescens** (Linnaeus)

**Downy Woodpecker**

*Status.*—Abundant resident.

*Habitat.*—Found in all situations where there are trees or large shrubs.

It is numerous in all parts of the woodland, using every species of tree on the area; perhaps even more abundant in parkland where trees are scattered. This small woodpecker does part of its foraging on annual weeds, notably the giant ragweed.

* Movements.*—In the breeding season each pair keeps to its own small territory, excluding those of other pairs. As these woodpeckers are sedentary in habits, they tend to remain year-round in the same general area. Occasionally there is some displacement. Especially after severe winter storms individuals have been seen foraging in roadside weeds and in other situations removed from their usual woodland habitat. Pairs may continue their association throughout the winter. In February, 1952, a male was color-banded near the Reservation headquarters and was seen frequently in a
period of weeks thereafter, usually associated with a female. All records for this male were within a quadrangular area of 31.5 acres, with most remote locations separated by 2180 feet. Most of the records were concentrated in an oval inner area of only 4.6 acres. Downy woodpeckers were perhaps especially in evidence in 1952 and 1953, when elms were dying off as a result of the combined effects of drought and attack by bark beetles (*Scolytus multistriatus*). These minute but numerous beetles produced an ample food supply, and the woodpeckers concentrated their attention on heavily infested trees. About the bases of such trees, chips of bark accumulated to depths of several inches. The same tree even though small, might be returned to day after day.

Often in winter, a downy woodpecker or a pair were found in association with mixed flocks of small passerines, usually including black-capped chickadees and tufted titmice, and sometimes including other kinds, such as brown creepers, and golden-crowned kinglets. When such mixed flocks were kept under observation, they were soon noted to undergo at least partial disintegration. The woodpeckers, especially, were liable to be left behind because they moved about less rapidly than the other kinds in foraging.

In a pair that is moving about, each keeps the other informed of its whereabouts by an occasional sharp metallic call. In winter, frequently, a pair has been observed to attack or chase a third individual or a second pair. This does not involve a defense of hard-and-fast territorial boundaries, but is indicative of intolerance for other individuals foraging in the neighborhood of a favored feeding place or of the mate.

Although such hostility is noticeable at all times of year, it is especially prominent in early spring. In mid-April, 1954, a dead snag, having several hollows, at the edge of the woods near the headquarters, was the scene of constant quarreling. Sometimes as many as six downy woodpeckers (presumably those of three different pairs) were in the vicinity simultaneously. Though both sexes participated in the quarrels, males were especially pugnacious. Two would fly from tree trunk to tree trunk, uttering whinneying calls, and perched on opposite sides of a trunk, would thrust at each other with their bills. Territorial drumming was heard as early as the first week of February but chiefly in late March and early April.
Tyrannus tyrannus (Linnaeus)

Eastern Kingbird

Status.—Often present in summer, but not known to breed on the Reservation. Those that appear from time to time are wanderers that have not yet established territories or have left them after the breeding season. Usually they do not remain for more than a few hours in any one place.

Habitat.—Prefers relatively open ground with high perches, for foraging.

On the Reservation, in the absence of grazing, the dense grass or herbaceous ground cover evidently renders habitat conditions unsuitable for this kingbird.

Movements.—In July, August and September, 1948, when field work was begun on the Reservation, kingbirds were seen regularly. Parts of the area were then heavily grazed pastures, and habitat conditions were probably favorable for breeding of the kingbird. With discontinuance of grazing in early 1949, habitat conditions deteriorated for this species because of the high rank growth of herbaceous vegetation. Thenceforth, kingbirds were seen on the area only on migration and, occasionally, as wanderers from adjacent farms where the habitat remained favorable.

Kingbirds have been seen on the Reservation chiefly in May, when they have recently arrived from their northward migration, and perhaps are still moving about in search of territories.

Kingbirds nesting at a farm a quarter mile north of the Reservation boundary were seen on the area near its northern edge on several occasions. In late August of several different years, loose groups of kingbirds were seen moving across the Reservation or nearby areas, perhaps already embarked on their southward migration.

Muscivora forficata (Gmelin)

Scissor-tailed Flycatcher

Status.—Rare transient.

Habitat.—Short-grass prairie or closely grazed pasture with elevated perches such as are provided by scattered trees, fence posts, or telephone wires, comprise suitable habitat for this flycatcher. Presence of woodland and thickets alternating with rank ground vegetation in more open situations renders the Reservation unfa-
vable for occupancy. This area is on the margin of the species’ range, and breeding pairs have been recorded within a few miles.

Movements.—The only definite record for the Reservation is one seen by Donald W. Janes on August 28, 1955, perched on a telephone wire between the headquarters and the west boundary. It was seen twice at the same place. On the second occasion, as a vehicle approached on the road, it flushed and flew out of sight to the west.

Frank W. Fitch, Jr. (1950:153) studying the species in east-central Texas, found that "Territories . . . included the ground within a radius of 35 yards from the base of the nest tree." " . . . an area of complete intolerance to all species immediately surrounds the nest, with gradations of intolerance outside of that, their extent depending on the species involved."

Myiarchus crinitus (Linnaeus)

Crested Flycatcher

Status.—Common summer resident.

Habitat.—Deciduous forest, and edge.

Ordinarily these flycatchers stayed in woodland, showing a distinct preference for large old trees, especially those that were dead or dying and therefore had open crowns.

Movements.—Crested flycatchers first appeared on the Reservation in late April each year; dates were the 27th, 30th, 28th, 20th, 22nd, 26th and 22nd over the period 1951 through 1957. Within a few days after the first one was heard they were present in abundance, and were establishing territories. They were noted chiefly in May and June. As the season advanced, their calling became increasingly restricted to early morning and evening, and finally ceased altogether. Latest seasonal records are August 27, 1952, August 30, 1953, and August 31, 1955.

In early May crested flycatchers were already associated in pairs. Quarrels between pairs, and pursuits have been noted chiefly in May and June. Often two pairs perched in separate trees within 100 feet of each other where their territories adjoined and the males called in seeming defiance, answering each other in turn. Pairs have been seen nest-building in early June. In the nesting season crested flycatchers have often been seen to chase other kinds of birds, including phoebes and cardinals.

In 1955 three adjoining territories were measured, one in the
headquarters area of the Reservation, and one on each side of it. The approximate areas computed were: 7.2 acres, 6.6 acres, and 5.6 acres. All three territories included areas of fields with groves and scattered trees, and edges of woodland bordering the fields on each side. Activity of the flycatchers was mostly confined to the woodland, but in early morning and evening each ventured out into the field and called from the tops of several of the larger trees, in succession. In several instances such a favorite perch tree was used at different times by the birds from each of two territories. Neither seemed able to establish exclusive control, but in each instance the tree was on the borderline of territories that otherwise did not overlap each other.

Engles (1949:287) describes two nests in dead trees where forest had been killed by wind blown sand, on Shackelford Bank, a small island on the North Carolina coast. These nests were, respectively, 274 and 167 "long paces" from the edge of the woodland where the flycatchers did nearly all their foraging. As a result of their unusual situations, the nests were relatively safe from predators, but it was a hard struggle for the flycatchers to fly against the wind back to their nests.

Sayornis phoebe (Latham)

Phoebe

*Status.—* Common summer resident, several breeding pairs present each year.

*Habitat.—* The distribution of bridges and buildings providing sheltered nest sites seems to be the chief factor in determining the number of phoebes on the area.

There were perennial nest sites at the Reservation headquarters buildings, at a wooden bridge over a deep gully of the creek in the southeast part of the area, and inside a seven-foot concrete culvert under the county road at the west edge of the Reservation. In their foraging, phoebes seemed to prefer parkland situations, perching in large elms, but also spent much time in nearby fields of brome grass, where they perched in isolated trees or on stakes and weed stalks.

*Movements.—* Phoebes arrived on the area each year in early spring, and their annual sojourn was of longer duration than that of any other kind of bird that was not a permanent resident. Earliest appearance each year was in March, and for 1950 through 1957 first recorded dates were the 21st, 22nd, 12th, 14th, 12th, 10th, 6th,
and the 13th. In most years the first phoebe noted was in the headquarters area, where nesting occurred annually. Several times such recent arrivals were noted at daybreak or soon afterward, presumably having arrived in the night. The fact that they preceded the main wave of migration, and that they came directly to a nesting territory, suggested that these individuals were survivors that had nested there the year before. However, in 1954, the first phoebe, recorded on March 12, was more than 100 yards from the headquarters area, and it did not come to the buildings. After a few minutes it left, and no others were recorded until March 21.

Buildings were erected at the Reservation headquarters in early 1950, and these provided three perennial nesting sites. One was on a bend of the drain pipe beneath the eaves of the residence at the southwest corner, one was in the garage (or under its eaves) 150 feet east northeast, and the third was on the porch of the laboratory between the other two buildings and approximately 50 feet from the garage. Two pairs always occupied this vicinity; the house and the garage were in different territories. The laboratory nest site was usually used as an alternate by the pair whose territory included the garage, but occasionally it was used by the pair from the house.

The territories occupied were contiguous, and they were similar from year to year. In each, foraging was concentrated in a parklike grove, mainly of large elms, in an area that was roughly circular, and approximately 170 feet in diameter, a little more than half an acre (Fig. 16). Several favorite perches, five to fifteen feet high, were used with such regularity that conspicuous accumulations of excreta and pellets formed beneath them. However, the phoebes often foraged far beyond the limits of the groves where their activities were concentrated. The pair living at the garage often used the open field to the west, perching in the several isolated trees or on weed stalks, as far as a gully that was 600 feet from the nest site. At times, they spent hours daily along the cut-banks of the gully and in adjacent trees and shrubs, and seemed to be preparing to nest there, but no nest was ever found at the gully. In the opposite direction this pair foraged to the pond, approximately 580 feet east from the nest and their territory was about 100 yards wide. Their territory was measured as 7.1 acres, while the pair thatnested at the house had a less elongate territory of 3.3 acres.

Throughout the breeding season territorial pursuits and attacks were frequent, owing to the proximity of the two nests. Conflict
Fig. 16. Territories of two pairs of phoebes; activities of both pairs were concentrated about the Reservation headquarters, as shown by the lines of crosses. Little used outlying portions of the territories are enclosed by the dotted lines.

was especially severe early in the season before territorial boundaries were fully established. The sequence of events in 1953 well illustrates the establishment of territories, and the seasonal cycle. The first phoebe noted was present on the morning of March 14, but no other was seen that day, or on March 15 and 16. At daybreak on March 17, two were calling near the old nest at the southwest corner of the house. Later in the morning they were seen near the garage and at other places nearby, perched near together and seemed to be paired. Once there was a spirited pursuit. On March 18 and 19, two phoebes, probably the same, were present in the vicinity. On March 20 at 8 A. M., a third phoebe was present, and the three were involved in a violent quarrel, centering at the old nest on the drain pipe at the corner of the house. The two already paired were trying to drive away the one newly arrived. Most maneuvering was within thirty feet of the nest, and one member of the pair was much more aggressive than the other. Attacks were most severe when the intruder lit on or beside the nest. A defender would fly at it, and would follow close behind as it darted about erratically. Sometimes the pursuer would catch the other, and clinging to it persistently, forcing it to the ground where the two might continue to struggle for a few seconds before separating. After escaping, the pursued bird would soon return to approach the nest again. Its persistence suggested that it may have used this
nest site previously. However, by 9:30 A. M. it had withdrawn from the contest for the nest site and was keeping to the vicinity of the garage and laboratory apart from the pair. The latter were staying mostly within thirty feet of the nest site, alternately foraging and courting. The female tended to fly away a short distance each time the male approached. A little later the male flew to the single bird and perched beside it momentarily, twittering as in courtship. Later he repeated this procedure with increasing frequency. In the latter part of the morning he was distributing his time between the two females, spending about two-thirds of it with his original mate and the remainder with the second female. On March 21 wintry weather returned, with high wind and freezing temperatures. On March 22 weather moderated, but the phoebes were preoccupied with foraging, and no courtship or quarreling was noted. Once, all three were seen perched in the same tree. After dark two were flushed from the garage, suggesting that the lone female had acquired a mate, and on the morning of March 23 four phoebes were present, behaving as two pairs on separate territories. There was persistent quarreling and maneuvering in the area between the buildings on this morning, and probably the territorial limits of each pair where their ranges met were established as a result. Later in the day, one (female?) was seen carrying nesting material to the garage, from the ravine 250 feet south of it. On March 25 the nest in the garage was well underway and one of the phoebes made frequent trips to a ditch 190 feet north, carrying back mud for building material. On March 26 a territorial quarrel involving all four phoebes lasted intermittently for more than an hour in the area south of the house. On March 28, a phoebe was observed nest-building at the corner of the house for more than an hour. It was making frequent trips to the ravine 225 feet southeast, and carrying back moss and perhaps mud. On April 3 this nest seemed to be completed. On April 4 the female was accidentally entangled in a net and was found dead. She contained a fully formed egg ready to be laid. The nest in the garage probably received its first egg on this day or the next. The clutch of four was completed on April 8. At dawn this same day a new female had replaced the one accidentally killed and courtship was in progress beside the nest at the corner of the house. Spirited pursuits and fighting were noted later in the day, doubtless resulting from the new female's unfamiliarity with the limits of the territory she had inherited. On April 11 an egg was found broken beneath the
nest in the garage. On April 13 the garage nest had again been disturbed by an unknown marauder; only two eggs remained and the phoebes had deserted. The nest on the house had been raided, torn loose from its foundations, and its lining ripped out. The pair of phoebes that had used this nest were making frequent trips to a puddle 250 feet west and carrying back mud to repair the old nest on the porch of the laboratory.

On April 20 the nest in the garage was empty. On April 21 it was being repaired, partly with spider webs being gathered by the phoebes in a thicket 275 feet south. On April 26 at dusk, a phoebe was flushed from the renovated laboratory nest, which contained a newly laid egg. On April 29 there were four eggs in the garage nest. On April 30 and May 1, the second and third eggs were added to the laboratory nest. The eggs of the garage nest all hatched on May 11 and 12; those of the laboratory nest hatched May 19 and 20. Both broods were fledged. Those of the laboratory nest left June 3 to 6. On June 10 the adults were seen in courtship beside the nest and on the following day one was carrying material to repair the nest. A new clutch of eggs was completed on June 19 and the young that developed from them were fledged on July 18. Thenceforth, phoebes were little in evidence about the headquarters buildings where they had spent the spring and early summer, but throughout August and September the buzzing courtship calls were heard almost every day at dawn at one or more of the old nests. This behavior was last noted on October 18.

If not prematurely disturbed, the young phoebes stay in the nest until well feathered and upon leaving fly strongly to an elevated perch. When one flies from the nest, others may follow close behind it and alight near its perch. Or, if the brood is scattered at first, the hunger calls given by all the young guide them in assembling. Characteristically they perch in a tight cluster in the same bush or tree, and at least one parent stays nearby foraging in the vicinity and feeding them in turn. Whenever one young flies, others are likely to follow. Presumably such an aggregation of fledged young is tended largely by the male parent, and in some instances the female was already incubating a new clutch while the previous brood of fledglings was still dependent. So far as observed, the dependent fledglings remained in the adults' nesting territory but shifted to a part of it remote from the nest itself. For aggregations of young of seven different broods recorded over a period of several years, the distance from the nest tended to lengthen somewhat with elapsed time, as follows: 1 day, 70 feet;
2 days, 200 feet and 260 feet; 3 days, 90 feet and 100 feet; 5 days, 460 feet; 8 days, 120 feet; 11 days, 240 feet; 12 days, 300 feet. Smith (1942:410) recorded similar tendencies in fledglings in Vermont. He observed the young all within a 75-foot radius, 150 to 200 feet from the nest the first day after leaving. At dusk on the third day the young were observed clustered on a branch 300 feet from the nest. By the seventeenth day after leaving, the young were seen with one parent 1300 feet from the nest, but on the eighteenth day, all were back near the nest. Smith noted a gradual reduction in parental attention for the fledglings, which had become partly independent by the seventh or eighth day. After the eighteenth day they were fully independent, and had dispersed.

On one occasion I observed a phoebe 850 feet from its nest, and another was seen 750 feet from its home base, but these distances are unusual. When feeding nestlings, phoebes may stay within 70 feet of the nest.

Latest recorded occurrences in six different years were: October 11, 1951; October 31, 1952; October 18, 1953; September 16, 1954; October 26, 1955; and November 3, 1956. In each year phoebes may have actually remained somewhat later in the season, as they were relatively inconspicuous and silent, and might have been overlooked.

**Empidonax flaviventris** (Baird and Baird)

Yellow-bellied Flycatcher

*Status.*—Rare migrant.

*Habitat.*—Northern coniferous forests in wet places during the breeding season.

* Movements.*—R. W. Fredrickson recorded one on May 12, 1950.

**Empidonax traillii** (Audubon)

Alder Flycatcher

*Status.*—Temporary resident in late spring.

*Habitat.*—Groves and woodland edges.

*Movements.*—These small flycatchers have been noticed on the Reservation each year in May. In 1952 and 1956 they were especially conspicuous and seemed to be present in unusually large numbers. The willow grove at the pond was their favorite habitat. They were frequently seen also at various places along the woodland edges of the field in which the headquarters were situated. In 1952 they were seen or heard almost daily from May 20 to June
3. In 1956 they were noted from May 4 to approximately June 4, with the main influx about May 9. In late May several could be found at the willow grove at almost any time, and singing was frequent. Each seemed to move about the grove freely rather than being restricted to any definite part of it, but occasional squabbles and pursuits were seen. Larvae of chrysomelid beetles were abundant on the willow leaves and provided a ready food supply. Several times the flycatchers were seen to depart from their usual method of foraging to hover while picking off these larvae. In 1957 the only record was obtained on May 10.

**Empidonax minimus** (Baird and Baird)

**Least Flycatcher**

**Status.**—Occasional temporary resident in late spring.

**Habitat.**—On the Reservation seen chiefly at woodland edges having thickets and dead trees.

**Movements.**—On May 17, 1952, one was seen chasing another, at woodland edge beside the ravine about 100 yards south of the Reservation headquarters. On the following day one foraging near the same place moved from perch to perch in open tree crowns, tending to keep over blackberry thickets. Several were seen on May 17, 1955.

Breckenridge (1956) studied territoriality in this species in Minnesota. He found that territories were usually less than one acre, but size depended partly on height of the trees. He regarded territories as three-dimensional, extending vertically from the top of the shrub stratum to the leaf canopy of the dominant trees.

MacQueen (1950:204) also studied territoriality in this species, at Douglas Lake, Michigan. For 33 territories the size range was from .5 to .03 acre and the average was .18 acre. The territory was found to be defended chiefly by the male.

**Contopus virens** (Linnaeus)

**Eastern Wood Pewee**

**Status.**—Common summer resident in wooded parts of Reservation.

**Habitat.**—Deciduous forest especially in edge, parkland and other situations where leaf canopy is somewhat discontinuous.

**Movements.**—Pewees were notably consistent in their arrival
dates; over a six year period earliest records were: May 16, 1952; May 11, 1953; May 17, 1954; May 10, 1955; May 14, 1956; and May 10, 1957. They were seen and heard much less frequently in late summer. The latest record is September 17, 1956. Dead trees or branches seemed to be the favorite locations for territorial calling, but in the course of its normal foraging each bird shifted frequently from perch to perch through the crowns of the trees, in a circuit of its territory.

In defense of territory pewees were especially pugnacious, not only against members of their own species, but against other kinds of birds. They have been seen to chase away mourning doves, bluebirds, phoebes, and field sparrows. On May 22, 1953, one pewee darted at another and caught it in midair. They fell into the grass and after a brief struggle one escaped, closely pursued by the other. A third followed these two.

A pewee that stayed in the headquarters area was observed and followed frequently in August, 1954. On the morning of August 8 its activities were confined to an area measured as .34 acre. On August 12 it covered .57 acre, overlapping only in part the area covered August 8. The woodland edge grove within which it usually stayed totalled 1.1 acres, but occasionally it visited outlying isolated trees in the adjacent field. If these and the intervening area of field were considered part of the territory, its size would be more than two acres.

Notably larger territories were found by Odum and Kuenzler (1955:131), perhaps in more open habitat. They used the wood pewee to illustrate their standardized method of determining size of territory in birds. The individual (male) most thoroughly studied by them was determined to have a territory of 10.8 acres, and fifty observations were necessary, as with each series of ten observations, up to the fifth series, the size of the known range increased by more than ten per cent. At this stage the known territory was a nine-sided polygon. With subsequent observations, the size of the known home range continued to increase, but at a slower rate—below the one per cent level. With the total of 90 records finally accumulated, the territory was still a nine-sided polygon, but with boundaries somewhat extended. Many of the records were in sizable clusters (14, 10, 10, 8, 5), and it was evident that certain parts of the area were intensively used, whereas more extensive intervening portions were used relatively little or not at all.
Nuttallornis borealis (Swainson)

Olive-sided Flycatcher

Status.—Rare migrant.

Habitat.—In breeding season, northern coniferous forest; on Reservation, on migration, woodland and edge.

Movements.—On May 22, 1951, at dusk, two were calling at different places at the edge of the woods near the Reservation headquarters. On October 13, 1951, one was seen by Maurice F. Baker on a telephone wire between the headquarters and the west edge of the Reservation.

Eremophila alpestris (Linnaeus)

Horned Lark

Status.—Common year-round resident in the general area, with numbers augmented in winter by an influx of northern birds; on Reservation, habitat has disappeared as revegetation of formerly barren areas has progressed, and no horned larks have been recorded since 1949.

Habitat.—In eastern Kansas, chiefly cultivated fields; occasionally other open areas that are nearly denuded of vegetation, such as sand or dried silt of stream deposits, and heavily overgrazed pastures.

Movements.—In June, 1949, a male was seen singing as it flew over an eroded fallow field at the north edge of the Reservation, and a cornfield adjacent on the north. Its territory seemed to include parts of both areas. In subsequent years none was seen at this place or elsewhere on the Reservation, because the open type of habitat that horned larks require had disappeared as plant succession progressed.

In the spring of 1957 horned larks were much in evidence on the newly acquired Rockefeller Tract adjoining the Reservation on the north. Fields which in 1956 had crops of milo and wheat, were disked and sown with seeds of native grasses in March, 1957. In early April, seedlings chiefly of annual weeds appeared on this almost barren area, and by late May weeds on some parts of the area had increased in height and density rendering the habitat much less favorable for the larks. A northern block of field comprising slightly more than 36 acres was separated from a southern block of a little less than 36 acres by an alfalfa patch, barnyards
and pasture. Six pairs of horned larks occupied the 72-acre area of fields, with three pairs each on the northern and southern blocks. The distance between the two fields varied from 150 feet to 360 feet and the field’s edges formed natural territorial boundaries. However, on many occasions a pair or a male living on one side of the pasture or alfalfa patch flew across and invaded a neighboring territory. Fighting and pursuit were seen frequently. Sometimes a chase lasted for several minutes, one lark flying in the lead, low and rapidly, with frequent sharp turns to avoid the one behind it. Flight song was prominent throughout the nesting season, and especially after territorial encounters. The lark would spiral and tower over the territory in a flight often continuing for five minutes or more, then would swoop abruptly to the ground. It might continue to sing at intervals as it wandered about the territory foraging. Relatively little singing was done from perches. In the nesting season females were seldom seen in flight except when they were flushed. Territories of approximately twelve acres were typical in this habitat.

**Riparia riparia (Linnaeus)**

Bank Swallow

*Status.*—Occasional.

*Habitat.*—For nesting requires cut-banks; otherwise not closely limited in habitat requirements.

* Movements.*—In May, 1949, a pair was seen patrolling up and down a gully and the adjacent pasture on the Reservation, west of the headquarters area. These swallows may have been nesting or preparing to nest in the bank of the gully, but a few days after they were first seen they disappeared, and none was recorded in subsequent years.

**Stelgidopteryx ruficollis (Vieillot)**

Rough-winged Swallow

*Status.*—Occasional in summer.

*Habitat.*—Usually near bodies of water.

* Movements.*—Rough-winged swallows have been identified flying over the Reservation on a few occasions in summer. Locations of breeding colonies in surrounding areas are not known. The swallows seen over the area were probably either migrants or individuals that had wandered farther than usual from their normal ranges.
Hirundo rustica Linnaeus
Barn Swallow

Status.—Present in summer; many nest on nearby farms, but none has nested on Reservation.

Habitat.—The chief habitat requirements are: nesting sites of the preferred types, as provided by old farm buildings, and foraging places, chiefly meadows or cultivated fields. Swallows were often seen foraging over the Reservation but it is doubtful whether any individuals had definite home ranges including parts of the Reservation. They were seen over every type of habitat represented. The altitude of flight and the place chosen for foraging probably varied according to the availability of insect prey, as determined by season, temperature, and humidity.

Movements.—Barn swallows usually were not seen on the Reservation until somewhat after their arrival in the general area, in late spring. Earliest dates recorded over a period of years were: May 7, 1952, May 15, 1953, May 18, 1954, May 17, 1955, and April 25, 1956. There were nesting colonies in some years, at least, at farmsites located a quarter-mile north of the Reservation (this latter acquired by the University in 1956 as the Rockefeller Tract), and a half-mile west. These colonies were the sources of most that were seen on the Reservation. On May 15, 1953, when conditions were unusually dry, a pair flew to the Reservation pond and settled on bare ground at the edge of the water, gathering mud for a nest, then flew up a slope, headed for the farmsite some 2800 feet to the north. Ordinarily material for building was collected much nearer to the nest. In the nesting season most activity was within a quarter mile of the colony and was concentrated about a small pond 100 yards from the barn in the area between the pond and barn, and in the adjacent pasture and wheat field. Only an occasional individual crossed to the Reservation a quarter mile south.

On May 30, 1955, a pair came to the buildings on the Reservation and spent several minutes circling the house, hovering under the eaves, and clinging to the walls. These birds soon left, and did not return. Probably they were from a nearby colony and having failed in an attempt at nesting, were in search of a new nest site.

On July 9, 1952, there were many barn swallows on the wires at the west edge of the Reservation and foraging over the fields to the west. These were from the colony at the farmsite half a mile west of the Reservation. The groups on the wires included many fledglings, that were being fed from time to time by the adults.
In 1957 a pair nested in the barn on the Rockefeller Tract. Most of their foraging was confined to an area of about 20 acres, the farmyard, the 14-acre pasture to the east, and a five-acre alfalfa field to the west, although they frequently cut across corners of the cultivated fields adjoining. The pair of swallows perched mainly on a 50-foot stretch of electric wire beside the barn. Latest dates of records were September 12, 1957, and September 27, 1948.

**Petrochelidon pyrrhonota** (Vieillot)

Cliff Swallow

*Status.*—Occasional in summer.

*Habitat.*—Vicinity of water probably is preferred, especially where cliffs or buildings provide nesting sites.

*Movements.*—No nearby colonies are known and appearances over the Reservation are infrequent. My only specific record is for July 23, 1948. In most instances swallows seen over the Reservation were flying high and were not definitely identified as to species.

**Progne subis** (Linnaeus)

Purple Martin

*Status.*—Transient in late spring and summer.

*Habitat.*—Breeds chiefly about farms and suburban situations.

*Movements.*—Martins are seen over the Reservation most often in May. Those seen probably are still on migration or are wandering in search of suitable nest sites.

**Cyanocitta cristata** Linnaeus

Blue Jay

*Status.*—Common resident.

*Habitat.*—Hardwood forest.

Locally jays keep mainly to the woodlands of oak, elm and hickory. They are often seen crossing open areas, in high direct flight, but have never been seen to stop on the ground in open fields. They seldom stop in isolated trees in open fields, and spend little time in such situations. In summer they often frequent woodland edge and parkland situations, but in winter, they seem more inclined to stay in thick woods.

*Movements.*—Numbers of blue jays on the area varied widely from month to month and from year to year. In part this variation
was due to passage, through the area, of migrants from farther north. Jays that breed on the area reside year-round in the vicinity, but are inclined to shift their ranges seasonally according to availability of cover and food. The tendency of the jays to carry on most of their activities as members of social groups, and the existence of more or less permanent bonds between the members of a pair, are factors that control, to a large extent, the movements of individuals.

In spring, the migratory northward movement through the area occurs chiefly in late April, after the resident blue jays have begun nesting. At 9 A.M. on April 29, 1952, 30 or more strung out in a long loose group, were moving northward across the Reservation, passing near the headquarters building. Many of the birds in this group seemed to be associated in pairs. At 4 P.M. on the same day, a smaller group was moving north along a hilltop edge, a quarter mile farther east. At 8:20 A.M. on May 18, 1953, a long loose flock of 22, mostly grouped in pairs, moved north across the Reservation near the west edge. At 11 A.M. on April 24, 1954, a straggling group of 27 was travelling north northeast, flying high over the treetops. On April 26, 1956, between 9:00 and 9:07 A.M., a group of 32 passed the Reservation headquarters headed north. Many seemed to be in pairs. There was a distance of hundreds of yards between the vanguard and those bringing up the rear. They were moving steadily but unhurriedly, in flights mostly less than 100 feet between perches, except where there were open stretches with no perches available. Like other migrating groups this one was relatively silent, but with some low conversational notes between nearby individuals. Each individual maintained contact with the group mainly by sight. Most of the group passed through an elm at the Reservation headquarters where a female was incubating. Although some of the migrating jays passed within a few yards of the nest, neither the female nor her mate, nor any other resident jays in the vicinity paid any attention to the migrating flock.

Transients moving south in autumn are less easily identified, because the residents are restless and noisy at that season, and their numbers are augmented by the annual brood. Southward migration probably occurs mainly in late September and early October—before the advent of cold weather. On September 27, 1954, while approximately a dozen blue jays were foraging in oaks near the pond, 27 more came straggling down the slope from the north and joined them, with much commotion. Obviously these new arrivals, at least, were migrants, as there were not this many jays living in
the vicinity. In 1957 migrating groups were seen on September 27 and October 9.

In the winter of 1953-1954, when the population of jays was low, there were three distinct groups on the Reservation, which kept to separate ranges, one group in the northeastern part, another in the southeastern part, and a third in the western part ranging also onto adjacent farmland farther west. Most observations were made on this latter group, which consisted of approximately eight pairs. The members of each pair usually stayed near together, or at least maintained contact by sight or sound. The whole group also tended to move about as a unit, and each individual maintained contact with the main group by occasional calls and answers, even though at the time the individual might be foraging independently, hundreds of yards from its companions. The precise limits of activity for this group were not determined, but the area encompassed by their usual activity was measured roughly as 3000 feet from north to south and 2000 feet from east to west. It consisted of two wooded hills, with an intervening valley of fields and pasture, 300 yards across. The jays spent most of their time on one or the other of the wooded hills, crossing the intervening valley frequently, and pausing en route to perch in high isolated trees or groves. Occasionally they foraged along creekside thickets in this predominantly open area. Jays were often seen to fly \( \frac{1}{2} \) to \( \frac{3}{4} \) mile from one hillside to another.

With the onset of the breeding season, flocks such as the one described did not disintegrate completely. Although largely preoccupied with its mate and nest, each individual continued to participate to some extent in group activities. Two or more pairs often joined each other in foraging or maneuvers which were for the most part amicable. Each year jays nested in the grove near the Reservation headquarters. On several occasions a jay incubating at this place was seen to fly off its nest to a hilltop 1150 feet west in response to the calls of others on the hilltop, and it joined a group there. The calls to which it responded were not indicative of any unusual disturbance. In the process of nest building, jays were seen to bring sticks the full distance from this same hilltop, but more often twigs were obtained nearer the nest site, sometimes from the same tree where the nest was situated. After a fledgling had left the nest, but was still unable to follow the adults, the latter were seen to bring food regularly from a hillside approximately 400 feet from the young bird's hiding place beneath the nest tree. In
June, 1956, an adult was seen to bring food to a nest in this same tree from a distance of 900 feet.

In the nesting season instances of intolerance observed from time to time, did not seem to involve defense of a well defined territory. However, the nesting jays were intolerant of other pairs courting or lingering in the nest tree or in nearby trees. On May 11, 1955, while incubation was in progress in one nest at the Reservation headquarters, a pair of jays came into a large elm 90 feet from the nest tree, and were met there by the resident pair. The beginning of the encounter was not seen. When noticed, all four jays were moving about through the tree rapidly, uttering low calls. After several minutes of maneuvering, they shifted to the nest tree where the scolding and movements became more animated. A defending jay would dart at an intruder and follow it persistently for several seconds. A variety of squawks, squalls, and scolding sounds were uttered. Finally the intruding pair was put to rout, and with raucous calls they flew off together headed northeast.

In time of stress, in the presence of a natural enemy, nesting jays were completely tolerant of neighboring pairs, and two or more pairs might combine in mobbing it. On June 7, 1955, excited calling drew my attention to a large black rat snake which had climbed to a jay's nest and had begun to eat the young. Within a few seconds the scolding adult jay was joined by its mate, and both set up a frantic clamoring. They closed in, and actually attacked the snake, striking it many times and staying within a foot of it throughout most of the encounter, though leaping back warily at each movement it made. After approximately one minute a second pair of jays arrived. They participated in the heckling, but did not attack, and stayed at a safe distance, several feet away. They left after approximately two minutes, while the snake was still on the nest.

**Corvus brachyrhynchos** Brehm

**Crow**

*Status.*—Common resident; those that breed on Reservation remain in vicinity throughout year, with influx of migrants from farther north in winter.

*Habitat.*—During annual cycle crows use every available habitat, exploiting any available food source. In general, however, they probably utilize open fields more than woodland, and cultivated fields in preference to pastureland. All nesting sites discovered were in thick woodland.
Movements.—Resident crows generally kept apart from the large flocks of wintering crows, and the two groups were notably different in habits during the part of the year when both were present. In autumn the population of migrant crows moving in for the winter built up gradually over periods of weeks, as numbers were augmented by new arrivals. In several different years flocks of recently arrived wintering birds were first noticed on the following dates: October 17, 1950; October 3, 1951; September 18, 1952; September 14, 1953; October 26, 1957. The wintering crows were especially gregarious. In roosting they congregated in flocks which sometimes had thousands of individuals. Each morning there was partial dispersal of the roosting aggregation, and the flocks of varying sizes scattered over an area as large as ten square miles. As the crows proceeded with their morning foraging, the large flocks disintegrated into progressively smaller units. In late afternoon the crows became increasingly restless, tending to gather at rallying points such as tall trees on hilltops. Usually before sunset these groups began homeward flights toward the roosting area, strung out in long straggling files. Roosting procedure was much influenced by the weather. Rain, snow, and wind interfered with the normal foraging activities, and caused the crows to congregate in the roosting area long before dark, as early as 3 P.M. on midwinter days. Prolonged maneuvers preceded the actual roosting, as hundreds or even thousands of individuals milled about, calling, flying and perching together. These maneuvers were notable for their seeming aimlessness and lack of leadership, often with indecision up to the last moment regarding choice of a roosting site. Often the main group would split, one division moving away hundreds of yards or more to a different roosting area. Movement from one group to the other might begin with a lone individual or a pair, followed by a trickle and then a steady stream and finally a mass movement as those remaining merged with the rival flock. Occasionally there might be simultaneous interchange between two such large groups, with uncertainty as to which would eventually be drained into the other. Actual roosting sometimes occurred soon after sunset but in other instances it was delayed until almost total darkness. Roosts were in dense thickets of osage orange, or less frequently, in thick honey locusts. The crows flew down rapidly from their hovering over the roost or from tall trees nearby, into the thicket.

Many of the wintering crows seemed to be in pairs as they foraged and moved about during the day, sometimes within a group
and sometimes more or less independently. In the evening flight toward the roost, pair-associations were especially noticeable. In maneuvers over the roost or nearby, pairs were even more readily discernible. In a hovering flock individuals would often swoop at others nearby. The one followed would bank sharply downward in a long swoop, and then carried on by its momentum, would rise abruptly to approximately its former elevation, closely followed by the partner, which maintained approximately the same spacing throughout the maneuver. In some instances three individuals seemed to be associated; such groups perhaps included a young of the previous nesting season still remaining with its parents.

Throughout April the numbers of wintering crows dwindled, but usually some stayed on into May. The latest dates when sizable roosting aggregations were seen in several different years were May 4, 1952, May 11, 1953, and May 21, 1956. Crows were known to come for as much as three miles to roost. It is doubtful whether any came from much farther. The wintering flocks varied greatly in numbers from year to year, but it was not determined whether these variations represented widespread trends in population or whether they resulted merely from shifts to other roosting areas. A roosting aggregation estimated to contain at least 2000 crows was first discovered on December 25, 1950, in a dense osage orange grove a quarter mile southeast of the southeast corner of the Reservation. By February 8, 1951, this aggregation was roosting a half-mile farther east. In October, 1951, both these sites were utilized, and smaller groups that split off from the main aggregation roosted at greater distances. The crows seemed reluctant to enter any roost, and were inclined to panic at any alarm. On several occasions when it was nearly dark, after crows had already settled on the roosts, they were heard cawing in excited confusion, and were seen erupting in all directions, flying low and rapidly, and continuing on out of sight. Presumably they then roosted singly or in small groups far from the communal roost, which was subsequently shifted to a new site. On the roosts they were especially subject to predation by a variety of flesh-eaters, notably the horned owl. Evening flights toward the roost were often interrupted when one of these owls hooted, inadvertently drawing attention of the crows to itself. As the owls were most vocal between sunset and dark, this mobbing was an almost daily occurrence. A crow having spied the owl, swooped down toward it cawing excitedly and causing others streaming past to join it. Soon hundreds might congregate to heckle the owl, but they continued on their course within a few minutes.
In spring long before the wintering crows left, the resident crows began nesting. Each pair selected a nest site in thick woodland and spent much of each day in the vicinity. The onset of the breeding season was indicated by the peculiar squalling calls in the woods where courting pairs had settled to nest. Over several years these calls were first heard on March 25, 1953, March 22, 1954, April 18, 1955, March 31, 1956, and April 26, 1957. The nesting crows were non-territorial, and were social in many of their activities. Foraging was carried on chiefly at a distance from the nests, in open land, and several pairs from the same nesting area or from different areas, might mingle freely in their search for food. In several different years, for much of the nesting season, a small patch of alfalfa in a field west of the Reservation was observed to be a favorite feeding ground. Insect prey, perhaps scarabaeid beetles, seemed to be abundantly available at this place, which was approximately ¼ mile south of a slope covered with a dense grove of osage orange. Crows that nested in the grove spent much of their time in the alfalfa patch, and made the round trip to it and back many times each day.

Often two or three or four pairs of crows nested in the same part of the woods, within a distance of 100 yards. An individual might guard the entire nesting area, and spread the alarm at any disturbance. In the summer of 1952, in a 200-acre woods in the western and northern part of the Reservation, five distinct nesting areas were noted, with a total of approximately 20 adult crows.

**Parus atricapillus** Linnaeus

Black-capped Chickadee

*Status.*—Abundant resident, present on all parts of the area where trees or tall shrubs are present.

*Habitat.*—Forest.

Much of the activity of this species is in American elms, these being the most abundant trees of the area, but clear-cut preference is not evident, and all available species of trees and large shrubs are used. The population of chickadees tends to concentrate along edges of woodland, especially where the adjacent open land is in an early stage of succession, with coarse weeds such as sunflower and giant ragweed, their seeds providing a food supply. Presumably the presence of tree holes for roosting places is a limiting factor.

*Movements.*—Chickadees are social at all times of the year, and are nearly always seen with a group, or, in the breeding season, a mate. Mild sunny days in late winter initiate pairing and terri-
torial behavior. Territorial calling was first heard on February 11, 1952, January 26, 1953, and January 29, 1954. By early February, pairs may separate from the flocks and keep to themselves, temporarily, but cold, wet or windy weather causes recombination into groups. On March 20, 1952, a group of six were foraging together in a small ragweed patch, with no indication of pairing or of hostility, except that frequently they gave calls "zr-wick-ick" usually associated with territoriality. In early March trios of chickadees have been observed in prolonged quarrels and maneuvers, as two competed for the same mate, each competitor scolding persistently and striving to keep between the mate and the opponent.

In late March, April, and May, 1953, the establishment of a territory, and part of the nesting cycle were observed in a pair in the vicinity of the headquarters. On the morning of March 26 the pair was observed moving about silently in what was later recognized as their territory. One entered a cavity in a dead snag where bluebirds were nesting, and was instantly routed by them. On March 30, both chickadees were in the top of an elm 150 feet farther north, and were staying within a radius of a few yards. Catkins of the elm provided an abundant food supply. An inclined dead limb approximately two inches in diameter had a decayed spot near its end, and the chickadees were persistently working on this trying to enlarge it into a cavity for nesting. As one pecked at the soft wood, removing small fragments, the other would forage nearby. At frequent intervals the one at work was relieved by its mate, and took a turn at foraging. When another pair flew into a large elm 50 feet away, giving territorial calls, the pair under observation promptly flew toward them and engaged them in a quarrel which consisted chiefly of maneuvering at close quarters in the top of the tree, with much scolding. The commotion attracted a third pair and then a fourth, and for a quarter hour the scolding birds milled about through several nearby trees, including the one where the nest cavity was located. After they dispersed, the pair under observation promptly resumed work on the nest cavity. Later the same day another territorial melee similar to the first one was observed. It seemed that territorial boundaries were as yet ill-defined, and individuals that attracted attention in intermediate areas were harrassed by others until they retreated, or until the quarrel was terminated by mutual withdrawal. If such quarrels were prolonged, they usually attracted
other pairs. Many three-pair and four-pair quarrels have been witnessed in late March and early April.

On the morning of April 2 work was still in progress on the same nest cavity, but several times that day one of the chickadees was seen to fly down to a five-foot log leaning against the side of a building and peer in a cavity near its upper end. This was approximately fifty feet northeast of the nestsite originally chosen. On the morning of April 3 the pair had definitely abandoned the original nest cavity, on which they had made little progress in four days of excavation. They were visiting the new cavity every few seconds. Although it appeared to be of ample size, with an entrance 1\(\frac{1}{2}\) inches in diameter and a depth of several inches, the chickadees spent most of their time from April 3 through April 9 enlarging the cavity. Carrying of nesting material was first observed on April 13 and last on April 23. The carcass of an opossum approximately 100 feet from the nest was the source of most of the nesting material. Many times the chickadees were seen flying with billfulls of hair from the carcass to the nest. On other occasions they visited a blackberry thicket some 200 feet south of the nest, and brought back tufts of cottontail hair. The total area covered by this pair during nest building and incubation was computed as 2.3 acres, and was a little more than 600 feet in length. Actually the outlying parts of this area were visited rarely and they overlapped broadly the areas of at least two other pairs. Activity was concentrated in two elm trees within a 70-foot diameter, an area of approximately .1 acre. This territory was remarkably small compared with those that Odum (1942: 526) observed and mapped on the Huyck Preserve near Rensselaerville, New York, which ranged from 8.4 to 17.1 acres (average 13.2). Odum found that the size of the territory and the vigor of its defense decreased as the nesting season progressed.

In late May, 1953, a pair of adults with fledged young were observed and followed several times within a half acre area of woodland edge, suggesting that at this stage, with varied and abundant food supply, and while fledglings are still unfamiliar with the terrain, family groups may confine their activities to relatively small areas.

In winter, individuals cover relatively large home ranges, usually associated as members of a flock, and often associated, although more loosely, with other kinds of small birds. In few instances were a sufficient number of records obtained, for any one individual,
to permit outlining a home range with any degree of completeness. One such home range, plotted on the basis of nine capture points, was a pentagon of 19.1 acres. However, the average distance between successive captures for a series of individuals provides the best basis for calculating size of home range in winter. A total of 56 such movements for 21 different individuals averaged 583 feet. A home range with a radius of this length would cover 24.4 acres. Odum (op. cit.:529) found larger home ranges in New York, with an average size of 36 acres (21 to 55). For the individuals in my study, successive records were obtained within a few weeks at most and it is unlikely that extensive shifts in range occurred within the period that an individual was trapped. In six other instances consecutive records of individuals were in different winters, and for these, distances averaged 800 feet, indicating that there is generally some reshuffling of ranges after the summer interval.

In winter mixed flocks of small birds often forage together, and three kinds or even four or five kinds are often found in close association. The black-capped chickadee is perhaps the pivotal member of such associations. At least it is usually the most conspicuous species, and being less specialized than some other kinds in its foraging habits, it may function as an intermediate link to hold them together. Wing (1946:511) listed nine species-combinations in such winter aggregations. He stated "... it seems to me that the company sticks together day after day." At times aggregations have been followed by me for hundreds of yards, and have been noted to change the rate of travel or to reverse directions abruptly without losing their unity. Nevertheless, it is obvious that the associations are temporary. On many occasions when the travelling groups have been followed, individuals or species have dropped out after a short time. Actually, the associations are ephemeral and change rapidly. The tufted titmouse is the most consistent associate of the chickadee. For both parids, seeds of giant ragweed are a favorite winter food, and mixed groups often forage together where there are ragweed patches near the edge of woodland. Instances of incompatibility between the two species are rare and have been observed only when a titmouse and chickadee were competing for a roosting place, in a cavity of a hollow limb. In mixed groups there are almost always more chickadees than titmice. The chickadees tend to forage more rapidly, and to cover larger areas, and sooner or later they leave the titmice behind. Foraging habits are somewhat similar, but at times the titmice do
much of their foraging on the ground, while chickadees rarely come to the ground. Golden-crowned kinglets appear on the area irregularly, but are frequently in association with chickadees. In such mixed groups, the kinglets tend to move more rapidly and leave the chickadees behind. Downy woodpeckers and brown creepers also frequently forage in association with chickadees, but both kinds move about more slowly than the chickadees and tend to be left behind. Junco and myrtle warblers at times associate with chickadees but less persistently than the other species mentioned.

**Parus bicolor** Linnaeus

Tufted Titmouse

*Status.*—Common resident in woodland.

*Habitat.*—Forest, with tendency toward preference of oak-hickory-elm type especially in summer; similar to the chickadee in general habitat and in preference for edge situations which provide a food supply of weed seeds, and are frequented in winter especially.

It differs from the chickadee in doing much of its foraging on the ground, and it often forages on exposed soil in sheltered spots such as cut banks of gullies at the edge of the woods. Like the chickadee, this species requires tree holes for roosting and nesting, and in some situations the absence or scarcity of holes may constitute a limiting factor.

*Movements.*—An individual titmouse ordinarily remains year-round in the same general area, varying its home range according to the seasonal availability of food. Changes in population density and in intolerance according to season, are also important factors controlling the size of an area occupied by an individual.

Territorial calling usually is initiated by unseasonably warm weather in January. For example, on January 4, 1956, a clear day with temperature in the mid-fifties, singing was heard several times. On January 11, 1951, an unusually mild day (74°F.), singing was frequent. Individuals well spaced through the woodland were calling and answering each other at regular intervals. Such early territorial activity was quickly terminated by the return of inclement weather. However, by the end of January or early February, territorial calling was more easily evoked, and might occur on clear mornings even when air temperature was at or near freezing. In February territorial behavior became increasingly prominent.

At times of year other than the breeding season, titmice are
somewhat social in their habits. In summer, family groups of
fledged young and their parents, move about together. In autumn,
titmice are usually found in associations of two to eight individuals.
In most instances these, too, are perhaps family units that have
maintained their identity since the nesting season. However, some
of the larger groups must include either successive broods reared
by the same parents in the course of the season, or composite as-
semblages from different families. At all times of year there is some
intolerance for individuals other than the mate or the social group.
Seeds of osage orange made available by fox squirrels tearing apart
the “hedge balls” constitute an important part of the diet in winter,
especially when the ground is snow-covered. An isolated osage
orange tree in a field near the headquarters was a favorite feeding
place in February, 1952, because of its heavy crop of fruit. On
February 6, a group of three titmice, recognizable by their color
bands and often seen together, were followed to the tree. After
they had fed there for several minutes, two others came to the
tree from another direction. Immediately one of the original group
darted at one of the newcomers and chased it rapidly from branch
to branch for several seconds, causing it to leave, and it flew to
another tree 150 feet south. In the next few minutes it returned
time after time to the osage orange tree, but each time it was soon
driven off by the hostile member of the original group. When
driven away it retreated to a tree 150 feet south, or to one 50 feet
north or a third 250 feet west. Several times, flying toward the
osage orange tree it was intercepted by the defending titmouse and
turned back. The pursuit was accompanied by much scolding and
calling by both titmice. Hostility was notably lacking in the other
three individuals.

Outright fighting has not been observed, but territorial encoun-
ters are frequent in spring. These may involve two individuals of
different pairs, or may involve as many as three pairs simultaneoulsy.
With loud and persistent scolding, the opponents would hop and
flutter from twig to twig, within a few inches of each other, each
trying to block the other’s progress into its own territory. Such
quarrels might take place frequently at about the same place
over periods of days, when some attraction such as a potential
nest site or food source happened to be situated near the territorial
boundary.

Size of territory is subject to much variation. In late February,
March, April, and May, when territorial calling is prominent, indi-
Individually in adjacent territories answer each other regularly. In 24 instances approximate distances between such calling titmice on adjacent territories were recorded. These distances ranged from 190 feet to 900 feet, averaging 484. Assuming this figure represents the average distance between centers of adjacent territories, the average territory would cover 4.2 acres. In April and May, the nesting season, individuals or pairs were often kept under observation for periods up to several hours. For 19 such observations the most distant points reached by individual titmice ranged from 250 to 950 feet apart and averaged 400 feet. Assuming that the latter figure represents the average diameter of a territory, the territory would average 2.9 acres. This is a minimum figure, because an individual watched for a relatively short time could not be expected to cover the full extent of its territory. A typical territory probably is somewhere between the two average figures obtained (4.2 acres and 2.9 acres) or about $3\frac{1}{2}$ acres. One pair observed frequently in June and July, 1952, while they were feeding young, covered an

Fig. 17. Winter range of a tufted titmouse, recorded at 26 places from December 21, 1954, to January 20, 1956. A relatively small inner area shown enclosed by crosses, comprised the usual home range, but occasionally the bird wandered farther. All parts of this winter range were used also by many other titmice.
elliptical ten-acre area, approximately 600 feet in length and 220 feet in breadth. The young were banded on June 29, when they were nearly fledged. Although still unable to fly, they had remarkable climbing ability. When released on the ground each would make for the base of a tree, and gripping the rough bark firmly, would walk up the vertical trunk, fluttering to maintain its position. Three days later all the young had left the nest and were in the treetops, all within a 50-foot radius some 200 feet from the nest. Although still unable to fly strongly, the fledglings seemed to be at ease, as they were preening and frequently fluttering from branch to branch. The adults were foraging in different directions, and frequently returning to deliver food.

In winter, individuals and groups range more widely than in spring and summer. Average size of the minimum home ranges measured varied according to numbers of marginal locations, as follows: 4 points (8), 10.4 acres; 5 points (14), 10.5 acres; 6 points (7), 13.9 acres; 7 points (2), 11.3 acres; 8 points (2), 19.7 acres. Fig. 17 shows the known range of the individual for which the largest number of records were obtained. For 16 individuals each live-trapped in seven or more locations, the areas encompassed varied from 43.9 to 3.2 acres but were mostly in the range, 9 to 15 acres and averaged 14.4. These are minimum home ranges in most instances, but several for which the higher figures were recorded may have shifted within the time span of the records. For 34 other titmice that were live-trapped fewer times, a total of 80 movements recorded between consecutive points of capture, averaged 466 feet, indicating home ranges of 15.5 acres.

Sitta carolinensis Latham
White-breasted Nuthatch

Status.—Rare and irregular visitor.

Habitat.—Typically oak woodland.

Movements.—One was recorded on the area in 1949, by R. W. Fredrickson. The only one recorded by me on the area was first seen on November 24, 1955. It was seen and heard frequently in the next three months, and was color-banded in December. Its isolation from others of its species together with the fact that it was banded, made individual recognition easy. It was often observed and followed, and was live-trapped several times. Its known range was a woodland slope of northwest exposure, with mixed growth, chiefly of American elm, chestnut oak, and shagbark
hickory. It showed no definite preference for any one kind of tree, but seemed to forage on any kind that happened to be in the vicinity. On several occasions it was seen in a large elm at the Reservation headquarters. It usually spent many minutes in a tree before moving on to the next. On one occasion it was followed on a circuitous course 740 feet between most remote points, and, on another occasion, 500 feet. The hexagonal area encompassed by the records over the three-months period was measured as 37.1 acres, of which approximately one-sixth was open field, the remainder woodland. The area was approximately 2000 feet long. The nuthatch may not have ranged over all of this simultaneously as only the later records were in the southern half of it. Usually this nuthatch was seen moving about alone, but at other times it was associated with creepers, chickadees, and titmice.

*Sitta canadensis* Linnaeus

Red-breasted Nuthatch

*Status.*—Rare and irregular winter visitor.

*Habitat.*—Coniferous forest.

* Movements.*—R. W. Fredrickson recorded this nuthatch from the Reservation in 1949 or 1950. On September 11, 1954, one was calling near the headquarters, and on October 8 one was heard 700 feet northeast. On October 22, 1954, two were heard in woodland at a hilltop just west of the Reservation boundary. Probably different individuals were involved in each instance. There are no conifers on the Reservation, and the only evergreen trees present are red cedars (*Juniperus virginiana*) of bush size. Wintering nuthatches therefore usually do not stop on the area, and the fact that several were recorded in the autumn of 1954 suggests an unusually heavy wave of migration then. Another was seen on October 1, 1957.

*Certhia familiaris* Bonaparte

Brown Creeper

*Status.*—Moderately common in winter.

*Habitat.*—Woodlands throughout the entire area; most often seen in denser type of woods but little preference for any particular kind of tree has been noted.

* Movements.*—Creepers are present on the area each winter. However, because of their inconspicuousness, secretive habits, and small numbers, they are not regularly observed. Early autumn rec-
ords are October 13, 1948; October 23, 1955; and October 14, 1956. Latest spring records are April 9, 1953; April 6, 1954; April 4, 1956. An individual was often seen frequently over periods of days or weeks in the same tree. Most commonly each individual was solitary but sometimes two were seen together and one might follow the other as they shifted from tree to tree. In early February, 1955, a group of at least four roosted together regularly on the stoop of the laboratory building. In late afternoon, or at any time in the day when particularly inclement weather, such as sleet, snow, or high wind, interfered with normal foraging, the members of this group would suddenly appear on the outer wall of the building, and climbing up the rough siding, would cluster in a compact mass at the top. The well protected spot selected for this aggregation was only a few inches from the corner of the door at the entrance of the building, and persons passing in and out often disturbed the creepers. Probably as a result of this frequent disturbance, the creepers deserted this roost in favor of one in the bole of a hollow elm 140 feet northeast of the building. Somewhat similar observations on roosting were recorded by Stone (1950:391) at Schenectady, New York, on February 27, 1949. He observed two come to roost at 4:15 P. M., climbing stucco siding to the point where a chimney met the overhang of a roof, partly sheltered by an old mud-dauber’s nest. The birds roosted snuggled together, with their bills piercing the wood of the roof. According to Stone’s informants, the birds had been using this roost for more than a month.

On most occasions the creepers seen on the Reservation were associated with other small insectivorous birds, including black-capped chickadees, tufted titmice, downy woodpeckers, and golden-crowned kinglets. These associations seemed to be extremely loose and fluid. Because of differences in rate of foraging, the birds of one species might soon move out of sight and hearing of the others. Each kind was attracted to the group whenever it saw or heard them.

Individual creepers were often followed for an hour or more in order to determine the extent of the area covered in their daily movements. The creeper was usually soon lost to the observer. Its inconspicuousness, and faintness of its utterances, which were audible only at close range, made it especially difficult to follow. On November 30, 1957, one was followed from the creek near the Reservation headquarters through woodland on a north slope to a hilltop approximately 800 feet from the starting point, and then part way back down the slope.
Troglodytes troglodytes (Linnaeus)

Winter Wren

Status.—Rare winter migrant.

Habitat.—Well sheltered places such as thickets and ravines are required.

 Movements.—One was seen on the Reservation in December, 1948, but none has been recorded since then.

Troglodytes aëdon Vieillot

House Wren

Status.—Present each year only briefly after arrival from northward migration in spring, and before departure in autumn, but there are no breeding records from the Reservation.

Habitat.—Mainly woodland edge, especially where there are thickets, gullies with exposed tree roots, or rock ledges, providing an abundance of niches and crannies such as this species requires.

Although numerous singing males in apparently established territories are present in early summer, they soon leave the area. It is not fully evident what habitat deficiencies cause this exodus; scarcity of low cavities of the type required for nest sites is probably one factor but it cannot wholly explain the failure of these wrens to breed on the area.

 Movements.—Over a six-year period, 1952 through 1957, wrens have first appeared in April, on the 28th, 23rd, 8th, 15th (approximately), 25th and 10th. Each year in a period of a few days after the first one was noted, numbers increased rapidly, and the song was heard frequently. Singing males seemed to be settling in breeding territories but within about three weeks all were gone, ordinarily. In 1956, an exceptionally late one was heard singing on June 2, but none had been heard previously since May 19. None has been noted on the area in July or August. In September there is an influx of wandering house wrens, perhaps already started on their southward migration. They were first noticed on September 14, 1948, September 8, 1953, September 11, 1954, September 20, 1955, and September 14, 1957. Such individuals may settle for periods of days. From September 15 to 18, 1953, a wren thought to have been the same individual was seen repeatedly in a weedy gully within a distance of approximately 100 feet, and it would turn back when driven to the limits of this small range.
Thryothorus ludovicianus (Latham)

Carolina Wren

Status.—Resident in woodland; because of its specialized requirements, total population amounts to few pairs or family groups. Populations fluctuate noticeably, and, as this locality is near northwestern extreme of geographic range, intolerance to cold and food scarcity occasioned by winter storms are perhaps important limiting factors.

Habitat.—Woodland and "edge" where there are streams or gullies with steep, cut banks, and exposed tree roots are preferred. Both spreading of the forest and severe eroding of gullies presumably have improved habitat conditions for this wren.

Movements.—Carolina wrens have been observed in pairs at all times of year. The pair-associations and the territories occupied are probably permanent for as long as both birds survive. These wrens sing more consistently throughout the year than do any other birds on the Reservation. On sunny days, even in midwinter, song may be heard frequently. The territory of a pair may be so remote from those nearest it that ordinarily the neighbors are neither seen nor heard. In most observed instances territories were well separated, but some were adjacent. Such territories were in contact for only a small part of their circumferences, because the two pairs ranged along different stretches of the same gullies and their territories were placed end to end. When numbers were relatively low, territories were usually not adjacent and a pair might take over the former territory of an adjacent pair, in whole or in part. In six instances in which different adjoining males were heard answering each others' songs, distances between them, in feet, were approximately: 1300, 1200, 1100, 900, 800, and 580.

The gully of the intermittent creek near the Reservation headquarters provided the axis for a territory which was occupied through most of the period covered by my observations. Over a six-year period the occupants were often replaced by newcomers as shown by the disappearances of several banded individuals. The total number involved is unknown but probably on the average each pair was replaced at least once annually. Nevertheless this territory tended to maintain its general conformation. At one end a broad dike across the ravine, and the pond behind it, formed a territorial boundary seldom crossed by the wrens. In the other
Fig. 18. Territory of a pair of Carolina wrens, as revealed by the male's singing stations, in 1953, 1954, and 1956. Each year the territory extended along a wooded ravine. In 1953, when by far the most complete records were obtained, activity was most concentrated in the relatively small central portion. In 1953 the wrens occasionally crossed the narrow east end of the field to the woodland edge thicket on the north side, while in other years they kept on the south side of the field.
direction, where the gully emerged from woods into almost flat, open fields, and abruptly changed in aspect, with lower less eroded banks, the habitat became less favorable, to the exclusion of the wrens. In 1952, 1953, 1954, and 1956 the length and area of this territory were measured as 1100 feet, 5.8 acres (from 6 points); 1150 feet, 9.2 acres (from 9 points); 1150 feet, 3.9 acres (from 9 points); and 1250 feet, 7.6 acres (from 10 points), respectively. Singing and other activities of the wrens tended to be concentrated in a relatively small central area of blackberry thickets, logs and steep eroded banks with exposed tree roots. The gully along which this territory was situated was in woodland edge. A hillside extension of this same woodland converged to join that of the gully near the pond (Fig. 15). A grassy field lay between. In 1953 the wrens often crossed the narrow end of this field to the edge of the hillside woodland. A distance of about 250 feet was the maximum that they essayed to cross, and even then they were likely to pause en route in isolated trees or shrubs. Failure to cross the field where it was wider emphasized the secretive habits of these wrens. Brewer (1955:141) recorded average areas of only .3 acre (.12 to .61) covered by three Carolina wrens in a swamp thicket habitat in southern Illinois.

Chapman (1947) who observed several nesting pairs in La Salle Parish, Louisiana, noted that the feces of the young were dropped by the parents 50 to 100 feet from the nests. Goin and Goin (1954:59) noted that in carrying any but minute objects to the nest, the wrens would climb to an elevated perch to gain altitude before taking off. They cited instances of wrens climbing 14 feet to fly 44 feet, and 16 feet to fly 49 feet.

Wrens were absent from this area from mid-February to late June in 1952; from mid-May until late December in 1954; for many weeks in late winter and again in early summer in 1955. These absences from the area of favorable habitat were correlated with general reductions of the population, which perhaps resulted from the decimating effects of severe winter storms.

Trautman (1940:318) at Buckeye Lake, Ohio, noted that in unusually cold weather Carolina wrens often shifted from their regular territories in partly exposed situations to neighboring woodland.

In late August and early September, 1953, the two adults in the territory near the Reservation headquarters were accompanied by three fledglings. When first observed, on August 19, this group stayed in a thicket area only a few yards in diameter, but within a
few days the group was moving about over the entire territory, still
tending to remain near together.

In the winter of 1955-1956 the resident pair roosted huddled to-
gether in an old phoebe nest under the eaves of the garage at the
Reservation headquarters which was near the center of the terrri-
tory. The previous summer they had nested successfully in an
open can lying in a cardboard carton inside this same building.

**Cistothorus platensis** (Latham)

*Short-billed Marsh Wren*

*Status.—*Rare migrant.

*Habitat.—*Usually associated with rushes, reeds or tall grass in
riparian situations.

*Movements.—*On April 9, 1957, one was seen at the small pond
on the Rockefeller Tract. Cover was limited to a strip of low smart-
weed approximately 15 feet wide and 100 feet in circumference.
Several times the wren permitted my approach to within 15 feet
before making a short flight. It was seen several times that day
and again on the following morning, but late in the second day it
had disappeared.

**Mimus polyglottos** (Linnaeus)

*Mockingbird*

*Status.—*Occasional wanderer, chiefly in spring.

*Habitat.—*Open situations, with groves or scattered trees are
favored. Deficiencies of the Reservation as a habitat probably result
from the too dense growth of vegetation—both the herbaceous
cover in the more open situations and the trees and shrubs in the
woodland.

*Movements.—*My only definite records are for April 27 and 28,
1956. On many occasions mockingbirds have been seen perched
on telephone wires or in roadside thickets adjoining pastures or
cultivated fields within half a mile of the Reservation.

On April 10, 1957, one was observed on the Rockefeller Tract.
Its behavior suggested that it was still on migration. It had stopped
at a fence corner where there was a high mound of earth with
weeds and trash providing shelter. Mostly it perched silently, with
no attempt at foraging. About 15 minutes after first seeing it, I
heard it sing briefly. After about an hour, it became more animated,
and from time to time, made short, quick flights of 15 to 20 feet to
the ground nearby to catch insects. After several such sallies, the bird flew to the nearby fence and then struck out north northeast and flew out of sight across open rolling fields.

_Dumetella carolinensis_ (Linnaeus)

**Catbird**

*Status.*—Moderately common spring migrant and temporary resident in early summer.

*Habitat.*—Thickets, blackberry, elderberry, dogwood, and saplings of honey locust and osage orange, mainly at woodland edge.

* Movements.*—Arrival dates for several different years were: April 30, 1951; May 1, 1952; May 9, 1953; May 6, 1954; April 28, 1955; May 6, 1956; and May 6, 1957. In 1956 several were seen at Lone Star Lake on April 29, more than a week before their appearance on the Reservation. Pairs have often been seen together in the latter half of May, along creekside thickets between the headquarters and the pond, and elsewhere on the Reservation, but none has ever been seen or heard on the area in June. They find habitat conditions unfavorable and move elsewhere. On July 7, 1954, and July 25, 1952, individuals were heard calling in thickets near the headquarters. There are several records for August and even more for September, probably resulting from a dispersal after the nesting season. Late records, probably of individuals already started on migration, are: October 3, 1951; October 4, 1953; and October 1, 1956.

_Toxostoma rufum_ (Linnaeus)

**Brown Thrasher**

*Status.*—Occasionally heard and rarely seen in summer; one or more pairs may breed on Reservation, but as yet no nests have been recorded.

*Habitat.*—On the Reservation thrashers have been heard and seen mainly on a relatively small area of a few acres, a south slope with trees mostly of honey locust and osage orange, the larger ones scattered, but with dense thickets of saplings of these species, and of dogwood, prickly ash, and blackberry patches. For two miles south of the Reservation, the county road is bordered by dense thickets of osage orange, and many pairs of thrashers nest in these thickets.

* Movements.*—Thrashers arrive on the Reservation each spring, and are seen and heard frequently over a period of days or weeks
thereafter. For several years, first appearances in spring were April 26, 1951; April 18, 1952; April 23, 1953; April 10, 1954; April 20, 1955; May 3, 1956; and April 24, 1957. So far as known, thrashers have not nested on the Reservation. Lack of open areas, with suitably short vegetation adjoining thickets, probably prevents their establishment. In 1951, 1952, and 1953 thrashers were noted only in April. In 1954 thrashers appeared earlier than in other years, and were seen more often than in the other five years combined. They were seen repeatedly in June, August and September.

**Turdus migratorius** Linnaeus

**Robin**

*Status.*—Resident in general area, but of erratic occurrence on Reservation, where evidently occurs only as migrant; in summer rarely seen; those present from time to time do not stay for more than part of day, and they seem to be dispersing juveniles or individuals that are wandering, having failed to establish breeding territory, or having completed breeding cycle.

*Habitat.*—Robins that stop on the Reservation use nearly all parts of the area, at different times, depending on the season and the local distribution of the food supply. Grape (*Vitis vulpina*) is the one chief food supply that attracts robins to the area at the time of the fall migration. Grapevines are most abundant on the cooler, moister, north slopes, and in these situations robins congregate. In early fall, with the first wave of migration, robins may feed avidly on pokeweed fruits in open fields and edge situations.

* Movements.*—Robins have been recorded every month of the year, but there is only one record for June. In July, August, and early September they have been seen only occasionally, wandering singly or in small groups. In early autumn there is a sudden influx of migrants. Robins were first noticed in large numbers on October 11, 1948; October 25, 1950; October 13, 1951; September 13, 1952; October 5, 1953; October 5, 1954; October 7, 1955; October 24, 1956; and September 21, 1957. Through much of October, while weather remained warm and leaves were still unshed from deciduous trees, the robins tended to stay in well shaded places in thick woods, and did not wander over the area extensively. At times in late October, November, and December, the species may have exceeded in numbers all other kinds of birds on the Reservation. Numbers were difficult to estimate because of the frequent and erratic movements. Throughout the colder part of the winter robins were seen much
less frequently, and at times, in late December, January, and early February, none was present on the area. In early April robins, usually single or in small groups, and obviously migrating, were seen more frequently than in February or March. On April 11, 1956, a pair was seen near the Reservation headquarters, the male singing frequently in several favored perch trees. Foraging was chiefly on a bare area where the soil had been turned in the installation of a pipe line the previous October. After remaining in the vicinity for two weeks, this pair disappeared.

**Hylocichla mustelina** (Gmelin)

**Wood Thrush**

*Status.*—Moderately common summer resident in woodland.

*Habitat.*—Wood thrushes on the Reservation forage on leaf litter in low, damp situations where there is a large amount of shrubby or herbaceous undergrowth.

* Movements.*—Dates of arrival on the Reservation in several different years were: May 5, 1950; April 20, 1951; April 30, 1952; May 5, 1953; April 25, 1954; May 7, 1955; April 26, 1956; and May 9, 1957. In 1953 they were seen and heard in abundance at Miami County State Lake two days before they appeared on the Reservation 50 miles farther north. Singing was heard chiefly in May and early June. Later in the season singing was more subdued, and was largely confined to short periods around dawn and dusk, and just

![Fig. 19. Territory of a wood thrush, as revealed by singing stations of male (dots) in early summer of 1953. The territory was in woodland edge along a streamside thicket. Occasionally the thrush crossed the narrow east end of the field to the edge of the woodland on the north side of the field. In the absence of adjoining pairs, the thrush sometimes visited outlying stations, as shown here, beyond the usual limits of its territory.](image)
after showers. On May 12, 1952, several wood thrushes were foraging within a 50-foot radius, and it seemed that territoriality was not yet well established. Usually within a few days of first arrival a pair was established along the creek south and east of the Reservation headquarters, to the exclusion of others. In 1953 the pentagonal area within which the singing male ranged was measured as 12.6 acres. Actually only small parts of this area were regularly used. The territory proper, within which the male moved about as he sang, consisted of two separate parts, each several times longer than wide. The combined area was computed as 1.4 acres (1.05 and .35), both along woodland edge, with an intervening field 150 feet across. (Fig. 19.)

**Hylocichla guttata** (Pallas)

**Hermit Thrush**

*Status.*—Uncommon migrant in spring and autumn; occasional in winter.

*Habitat.*—Woodlands, thickets and edges, with fairly open ground for foraging.

* Movements.*—In 1954 hermit thrushes arrived on the Reservation around mid-October. Although they were seen on only a few occasions, one or more were heard each morning for almost a month, calling in thickets just south of the Reservation headquarters. On December 25, 1955, one was seen in a thicket of wild plum (*Prunus americana*) at the edge of a field.

**Hylocichla ustulata** (Nuttall)

**Olive-backed Thrush**

*Status.*—Rare migrant.

*Habitat.*—Boreal forests.

* Movements.*—R. W. Fredericksen recorded one on May 7, 1949, and several on May 11, 1950.

**Hylocichla minima** (Lafresnaye)

**Gray-cheeked Thrush**

*Status.*—Occasional migrant.

*Habitat.*—Woodland.

* Movements.*—On April 11, 1956, two were seen on a brushy east slope in woodland dominated by American elm (*Ulmus americana*). Each time the observer approached, they flushed and moved farther
up the slope, keeping near together, and continuing for more than 100 yards in the same direction, until finally they were lost. The association suggested that these thrushes were already paired. However, Dilger (1956:345) found that in this genus the male arrives first to establish a territory, and reacts to the female’s arrival with hostility and pursuit, which lasts for several days, gradually subsiding as the male becomes tolerant of the female and the pair-bond develops.

**Hylocichla fuscescens** (Stephens)

*Veery*

*Status.*—Rare migrant.

*Habitat.*—Northern deciduous forests.


**Sialia sialis** (Linnaeus)

*Eastern Bluebird*

*Status.*—Resident and common in general area, but of somewhat erratic occurrence on Reservation; habitat conditions most favorable in winter, worsening in late spring as growing season progresses, to detriment of those individuals that attempt to breed on area.

*Habitat.*—Parkland, with medium to large trees for perches, and short grass or other low ground vegetation.

Open groves of walnut and honey locust, especially on hilltops where soil is shallow and grass is short, provide preferred situations in winter. In summer, as brome and other grasses grow longer, and mature, bluebirds are handicapped in their foraging and they tend to shift from the Reservation to fallow fields, stubble or grazed pastures where, evidently, the shorter vegetation facilitates the detection and capture of ground-living insects.

*Movements.*—Bluebirds are present on the area throughout the year, but their numbers and local distribution vary. Regularly each year a pair established a territory in the vicinity of the Reservation headquarters, and invariably their nesting attempt failed. Each year singing began on clear, mild days of late winter. In the six-year period, 1952 through 1957, singing was first heard on the following dates: March 16, February 28, February 14, March 11, March 22 and March 12. As singing begins winter flocks break up into pairs, and each sets up a territory. Disintegration of the flocks is gradual, and may be temporarily halted by inclement weather. For periods of weeks the birds may spend part of each
day on the territory and the remainder with the flock. On March 24, 1952, nearly a month after first singing, four bluebirds flying high together, headed south southeast, came to the field near the headquarters, and the two pairs lit in trees approximately 100 feet apart. They remained most of the day, the males singing from topmost branches of trees, and tending to keep to different parts of the field. However, from time to time all four gathered in the same tree with no show of hostility. It seemed that all four were members of the same flock.

In early spring the usual procedure was for the birds to remain with the flock for the main foraging period in the morning, and visit the territory later in the day. Several times in early spring small flocks have been seen fluttering about trees with hollow branches that offered potential nest sites. In such instances there was much scolding and quarreling, and occasional short pursuits. Territories seem to be selected originally without regard for the presence of possible nest sites. These are investigated later. In 1953, 23 days elapsed between the time that singing started and the first record of the birds carrying nesting material; in 1954 this interval was 54 days.

In 1952, 1953, and 1954 the movements of bluebirds that were nesting in the headquarters area were observed in detail and territories were mapped (Fig. 20). Nest sites were different in each year but all three were within a hundred-foot radius. Location and conformation of the territory varied from year to year, but its size was approximately the same. Greatest diameter varied from 850 to 950 feet. Outlying areas constituting a large part of each territory were used relatively little and activity was concentrated in a smaller central part that was only about half as broad and half as long as the entire territory. Because the territory studied did not adjoin others, it may have been somewhat expanded in each year that it was observed, and the central part where activity was concentrated may have been more typical of the size in areas where the birds are subject to territorial pressure from neighbors. In the three years territories and their more intensively used central portions were measured as follows: 1952, 5.4 acres and 1.9 acres; 1953, 8.6 acres and 1.5 acres; 1954, 7.0 acres and 1.4 acres.

In 1952 and 1953 fate of the nest was unknown. In 1954 the upright log which contained the nest cavity blew down in a storm. In 1955 the nest was robbed by a black rat snake (a probable fate also in the years for which no information was obtained). The day
Fig. 20. Territory of a pair of bluebirds, as revealed by singing stations of the male, in 1952, 1953, and 1954. Each year the area of principal activity was concentrated in an elm grove at the Reservation headquarters, but the distance and direction of outlying stations varied from year to year. Invariably nesting attempts in this area failed.
after destruction of the nest the bluebirds deserted their former territories and did not return again that season. Failure to re-nest may have resulted in part from the deterioration of habitat conditions as the season progressed, and herbaceous vegetation grew tall and rank. Disturbance of the natural vegetation in the headquarters area of more than an acre, by trampling and cutting, seemed to render it more favorable for nesting than other parts of the Reservation that were like it.

In two different years shortly after failure of the nest and disappearance of the pair in the headquarters area, bluebirds thought to have been the same, were seen in May, 1953, and May, 1955, frequenting an area 660 yards north at the edge of the Reservation where it adjoined a mowed field. On July 4, 1954, a family group appeared in the headquarters area and spent much of their time there through July, August and early September. Sparseness of vegetation resulting from drought that spring, and unusually heavy cutting of grass and weeds in the yard and clothesline area, probably rendered this place sufficiently favorable for occupancy by the birds.

Laskey (1940:189) who made an extensive study of the nesting of bluebirds in Nashville, Tennessee, stated, “Apparently boxes should be several hundred feet apart to allow sufficient territory for each breeding pair. They should be set out in winter because nest sites are investigated by bluebirds on mild days throughout the cold season, and territorial defense starts in early spring.”

Polioptila caerulea (Linnaeus)

Blue-gray Gnatcatcher

Status.—Common summer resident; many pairs breed on Reservation each year.

Habitat.—Gnatcatchers live in woodland, with preference for more open, drier situations. Large honey locusts in fields near the edge of woodland provide the favorite sites for nesting and foraging. Large elms are the second choice. On south slopes of xeric aspect, with scruffy growth of chinquapin oak, osage orange, and dogwood, gnatcatchers may be abundant. They are least often in oak-hickory woodland with a dense leaf canopy.

Movements.—Earliest recorded dates for gnatcatchers, over the years, 1950 through 1957, were in April each year: the 11th, 23rd,
16th, 3rd, 10th, 15th, 11th, and 23rd. Each year within a few days after the first arrivals the species becomes common. Because of their brisk and frequent movements, often in low or open trees, and their almost constant calling, individual gnatcatchers could be kept under observation more easily than most other kinds of birds, and they were frequently followed. On May 6, 1950, a pair was observed nest-building in the headquarters area. On the following day this nest was completed, having been built mainly or entirely within a 24-hour period. On May 8 the same pair was nest-building again approximately 100 feet from the recently finished nest, which had been abandoned for undetermined reasons. One gnatcatcher visited the first nest and took material from it to be incorporated in the new nest. In mid-July, 1952, a pair was observed feeding young in a nest just south of headquarters. Foraging was chiefly within 50 to 100 feet of the nest, either in the same large American elm or in three adjacent trees, two elms and a walnut. In a period of an hour and a half (3:30 to 5:00 P. M. on July 13), the two parents made a total of 57 trips to the nest to feed their young. The total area encompassed by this pair in foraging for their young was measured as 1.2 acres, but some outlying parts were rarely visited. On July 6, 1953, another pair was observed feeding nestlings, foraging in a willow grove 70 to 120 feet from the nest. In late May and June, 1952, a pair observed on several occasions covered a territory of 2.2 acres. This territory was along a wooded ravine, with a grove on one side and several scattered trees in a field on the other. In May, 1952, a pair was observed in a large honey locust in a hilltop field. They seemed to spend most of their time in this one tree, but occasionally crossed to nearby woodland.

Gnatcatchers have rarely been seen after July. The latest record is September 4, 1953.

**Regulus satrapa** Lichtenstein

**Golden-crowned Kinglet**

*Status.*—Regular winter visitor but variable in numbers. Unlike some other wintering birds these kinglets do not seem to settle in one place to spend winter but are inclined to wander. As result, numbers present at any one time vary from none at all to dozens or even much higher numbers.

*Habitat.*—Woodland, especially of northern conifers, but on Reservation in winter, most typically where trees are low and dense, with vine tangles.
 Movements.—Golden-crowned kinglets have most often been first noted on the area in October (25th in 1950; 25th in 1951; 18th in 1952; 14th in 1953; 27th in 1957). They have also been recorded in November, December and January, but never in late winter or spring. Those seen were usually in flocks of three to fifteen, and they were often associated with brown creepers, black-capped chickadees, tufted titmice, or downy woodpeckers, or with two or more of these kinds simultaneously. Kinglets were never seen on successive days in the same place. Either because they habitually wander, or because habitat conditions were unfavorable, those that came to the area never stayed long.

Regulus calendula (Linnaeus)

Ruby-crowned Kinglet

Status.—Regularly present for short periods in spring and autumn on migration.

Habitat.—On the Reservation the ruby-crowned kinglet most typically frequents edge situations, working through willow, dogwood, redbud, and saplings of elm and other trees.

Movements.—Ruby-crowned kinglets are recorded on the Reservation each spring (March 30 to May 16), and autumn (September 17 to October 27). Unlike golden-crowned kinglets, they are solitary, and individuals tend to settle for periods of days in woodland edge thickets, along ravines or beside the pond. Although none was individually marked, kinglets of this species were often seen on successive days in the same tree or thicket, and those kept under observation for varying periods usually remained within a radius of a few yards, despite the fact that they were almost constantly in motion. In a rocky situation just south of the old quarry, in a thicket of tall elm saplings mixed with redbud and dogwood with tangles of vines, ruby-crowned kinglets were seen much more regularly than at any other one place. Habitat conditions were so favorable in this situation that it invariably attracted some of those migrating across the area.

Bombbycilla cedrorum Vieillot

Cedar Waxwing

Status.—Occasional transient.

Habitat.—On Reservation, woodland and edge situations.

Movements.—Definite records are November 2, 1948, November 5, 1952 (flock of ten feeding on bittersweet berries), November
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22, 1955 (flock of 15), December 20, 1955, December 26, 1949, and in May, 1956, and April and May, 1957. Unlike those recorded in November and December, which were obviously wanderers, the flocks seen in spring stayed in the same vicinity for several days. In 1956 the flock was first noticed at 5 P. M. on May 23, in the willow grove beside the pond. The birds were feeding avidly on the chrysomelid beetle larvae that were abundant on the willow leaves, often hovering momentarily to reach these larvae. There were approximately 30 waxwings in the entire flock and they were scattered through the grove, but tended to keep together in small groups. This flock was seen frequently in the next four days at the willow grove. On several occasions the flock temporarily left the vicinity, all flushing nearly simultaneously, prepared by the rapid lisping notes uttered for several seconds before the take-off. On such occasions they passed out of sight in high rapid and direct flight, but sometimes returned within a few minutes, obviously having not stopped elsewhere.

Putnam (1949:148) described social nesting habits of the cedar waxwing; each pair’s territory consisted of a nest site, a guarding perch, and a small amount of space (225, 270 and 1100 square yards). The shortest distance observed between nests was 38 feet.

**Lanius ludovicianus** Linnaeus

**Loggerhead Shrike**

*Status.*—Resident on nearby areas, but present on Reservation only as rare visitor.

*Habitat.*—Most typically closely grazed pasture or short-grass prairie with scattered thorny trees.

* Movements.*—On the Reservation the chief habitat deficiency seems to be the rank growth of herbaceous vegetation, preventing the shrike from seeing its prey on the ground. Shrikes are notably sedentary in habits, and in some instances at least, stay for the entire year within the confines of the small territory. On only two occasions was a shrike definitely recorded from the area, and in each instance it was foraging on adjacent land and did not venture far onto the area.

Through 1954, 1955, and 1956 a pair of shrikes, perhaps the same individuals, were often seen perched on wires along the county road just south of the southwest corner of the Reservation section. The maximum range along the county road was approximately half a mile, but on most occasions they were seen within an interval of
about 200 yards. The extent of the territory in other directions was undetermined.

Throughout 1957 a shrike was seen frequently on the Rockefeller Tract. It kept to the pasture, the vicinity of the buildings, and the telephone line along the road. Occasionally it was accompanied by a second shrike. Its known range was approximately 25 acres, but at times it could not be found within this area.

**Sturnus vulgaris** Linnaeus

**Starling**

*Status.*—Appears on the Reservation chiefly as migrant in spring and autumn; occasionally as wanderer at other seasons.

*Habitat.*—Requirements including that of hollows for nesting sites and that of open situations permitting easy walking, are not well satisfied on Reservation; therefore starlings never have stayed long.

*Movements.*—In autumn, especially, spectacular migrations of starlings over the area occur, and the total numbers probably exceed those of any other species. Early season records of migration are: September 16, 1951 (several small groups, stopping to feed in thickets); September 27, 1953 (flock of twelve); September 20, 1954 (a single immature bird); September 30, 1956 (several hundred). These were forerunners of the main migration, which was usually at its peak in approximately the last week of October, and in the first week or two of November. In this period many thousands might pass over in one day, and migrating flocks might be in sight almost continually. Occasional compact flocks of from less than a dozen to several hundred individuals, maneuvered, perched, and fed in close formation. One such flock having several thousand starlings remained on the Reservation most of the day on October 28, 1957. The largest flocks flying high over the area, were strung out on a broad front and straggling in loose formation.

On their northward migration each spring starlings were far less conspicuous. Earliest record is February 22, 1956, when several flocks passed over, flying high, headed northeast. On March 8, 1954, one paused briefly in a tree near the headquarters before continuing on north.

On March 20, 1953, a male was observed quarreling with a pair of bluebirds, in an elm having a hollow limb. This male starling soon flew northwest and did not return. On April 1, 1952, a male was seen moving about slowly, investigating the same nest cavity
and others in nearby trees. On March 28 and April 17, 1954, a male was investigating cavities in trees near the headquarters. In the last four days of March and throughout early April, 1955, a pair was seen frequently in the headquarters area, where they seemed to be preparing to nest. In April, 1956, a male was seen quarreling with a pair of red-bellied woodpeckers near the cavity where they had begun nesting, but he gave up and flew away headed northeast. On May 3, 1956, a pair seemed to be preparing to nest near the headquarters. So far as known, all these nesting attempts were abortive, and the starlings soon left the area.

On the Rockefeller Tract many starlings were present throughout the summer. Their activities were concentrated about the house, barn and sheds, and an elm with hollow limbs in the yard. The relatively open habitat made this area more favorable than the Reservation. In their foraging the starlings often flew half a mile or more to newly plowed fields, pastures, or other areas that were especially favorable for finding food.

**Virgo griseus** (Boddaert)

White-eyed Vireo

*Status.*—Moderately common summer resident.

*Habitat.*—Brush thickets, scrubby woodland, and woodland edge.

The species of plants present seem unimportant as long as the growth habit, with abundance of stems and leaf surface for foraging within a few feet of the ground surface is fulfilled. Dogwood, dwarf oak, plum, blackberry, elm and hackberry saplings, and poison ivy are among the plants most frequently used on the Reservation. Several or many pairs of these vireos nested on the Reservation in most summers of the past few years. The numbers have varied noticeably from year to year.

*Movements.*—Arrival dates have been notably variable: May 24, 1952; May 6, 1953; April 23, 1954; May 3, 1956; May 3 (approximately), 1957. In 1955 none was seen. Latest dates of record were August 31, 1952; October 5, 1953; July 30, 1954; September 16, 1956; and September 8, 1957. In 1952 and 1953 pairs (or perhaps the same pair) nested near the headquarters. The nest was not found in either year, but the male vireo was a consistent singer, and his course could be easily followed as he moved about through dense vegetation where he could be seen only with difficulty. In 1953 a bob-tailed fledgling was found in the southwestern part of this territory, and it could not have travelled far from the nest.
The nest of a second pair 850 feet farther west along the same ravine was kept under observation for part of the period of incubation and nestling development. When this latter nest was destroyed by a predator, two cowbirds, nearly fledged, were the only remaining occupants.

![Fig. 21. Territory of a white-eyed vireo in early summer of 1953, and in early summer of 1954. Dots indicate locations where singing male was recorded. In both years the territory covered the same general area, differing only in details. It consisted chiefly of streamside thicket along woodland edge, but included also part of an elm grove in the narrow end of a field, and a strip of woodland edge thicket on the north side of this field.](image)

The territory near headquarters was, in both 1953 and 1954, crescent-shaped, following up the ravine and edge of the woods, northwest and crossing the narrow, brushy east end of the meadow to the woodland on the opposite side. In 1953 the territory was measured as 6.5 acres, and in 1954 as 5.4 acres; the areas corresponded throughout most of their extent (Fig. 21). In every instance territories observed by me were much larger than the .33 acre territory listed by Brewer (1955:141).
In 1955 no white-eyed vireos were heard or seen anywhere on the Reservation, and numbers must have been exceptionally low. In 1956 and 1957 the territory near the headquarters was not occupied and these vireos were heard elsewhere only a few times in the entire season. Their numbers were still low on the Reservation.

**Vireo bellii Audubon**  
Bell Vireo

*Status.*—Moderately common summer resident.

*Habitat.*—Brush thickets in open places. Wild plum perhaps provides the optimum habitat. Wild cherry, dogwood, fox grape, crab-apple, and stands of saplings, of elm, honey locust, and sycamore also are used.

* Movements.*—In 1948 and 1949 these vireos were observed occasionally in roadside thickets at the west edge of the Reservation. Subsequently none was seen until 1953, but thenceforth they were present each summer, chiefly in thickets that had sprung up since discontinuance of grazing in 1949, and were not yet sufficiently developed to provide adequate cover in the period 1950-52, when no Bell vireos were present. Earliest records for a four-year period were May 5, 1954; May 10, 1955; May 13, 1956; and May 8, 1957. The two latest records are August 17, 1953, and August 23, 1954.

Two wild cherry trees (Prunus serotina) at the north edge of the Reservation, bordering a wheat field, constituted the focal point of a vireo's territory each year from 1953 through 1956. The singing male spent most of his time in the two adjacent trees, in an area only about 60 x 20 feet, but occasionally he ventured to nearby low thickets along the boundary fence and at the edge of the field. In 1954 this territory was measured as .4 acre. Another territory occupied each year was in a gully having a thicket of wild plum, sumac, prickly ash and saplings of elm and honey locust. In the summer of 1954 the singing vireo was recorded and followed many times and its territory seemed to be co-extensive with this thicket, which was approximately 620 feet long and averaged 50 feet wide (.6 acre). By 1955 thick stands of saplings had grown up in nearby parts of the field west of this gully, and the vireo ranged through them being no longer closely confined to the gully. By 1956 this new thicket area seemed to be the center for a territory, and the vireo was followed about over an area approximately 150 x 60 feet. Another individual, separated from this one by an open meadow 150 feet across, was followed for 450 feet along a woodland edge thicket.
A territory in a brushy field, in June, 1955, was measured as one acre, but a central area comprising about one-fourth of the total was used much more intensively than the remainder. Knowledge of the territory of these vireos was gained almost entirely by following the song. As a bird moved about through thick brush or flitted from clump to clump it was glimpsed only rarely. Females, being relatively silent, were observed on only a few occasions.

Hensley (1950:243) recorded a territory of 3.1 acres for a pair in Piatt County, Illinois. The area was grassland, with scattered trees and shrubs, and it was more open than the areas where my own observations were made. Hensley observed young 30 feet from the nest on the day they left it, and five days later observed the brood congregated 300 feet from the nest.

**Vireo flavifrons Vieillot**

*Yellow-throated Vireo*

*Status.*—Rare migrant or transient.

*Habitat.*—Deciduous forest.

* Movements.*—The only record from the Reservation is of one recorded by R. W. Fredrickson on May 6, 1950.

**Vireo solitarius (Wilson)**

*Solitary Vireo*

*Status.*—Rare migrant or transient.

*Habitat.*—Forest, usually of conifers.

* Movements.*—The only record from the Reservation is of one seen May 3, 1952, by R. W. Fredrickson.

**Vireo olivaceus (Linnaeus)**

*Red-eyed Vireo*

*Status.*—Regular summer resident; except for the field sparrow is perhaps most abundant species of this category.

*Habitat.*—Deciduous forest, occurring throughout the woodland on the Reservation except that of more xeric type, as represented on south slopes.

The trees most regularly used, in approximately their order of importance, include American elm, shagbark hickory, black walnut, chestnut, oak, sycamore, black oak, red oak and coffee tree. Trees that are rarely used are honey locust, osage orange, red haw, dwarf oak and wild plum. There is scarcely any overlapping of habitat between the red-eyed vireo and the two other species, Bell and
white-eyed, that nest on the Reservation. However, the warbling and red-eyed overlap broadly in habitat preferences.

**Movements.**—The arrival dates recorded for several different years were: April 26, 1951; April 25, 1952; April 30 (approximately), 1953; April 26, 1954; April 21, 1955; May 2, 1956; April 24, 1957. Latest records of occurrence were: August 31, 1952; October 5, 1953; and September 6, 1956. In May and June, especially, the red-eyed vireo is a persistent singer. An individual foraging through the treetops might seldom be visible from the ground, but its course could be followed by its frequent bursts of song. Such a bird might move across its small territory several times in the course of an hour. An individual that lived on the wooded slope just southeast of the Reservation headquarters in 1955 was often followed and observed in May and June. The total area encompassed by its records was measured as 2.5 acres, but included many outlying points. Most of its movements were within a smaller area of elliptical shape, measured as .5 acre.

In 31 instances distances between singing males in what seemed to be adjoining territories, were measured, and these ranged from 700 feet to 80 feet, averaging 346. Territories averaging approximately 2.1 acres are indicated.

**Vireo gilvus** (Vieillot)

**Warbling Vireo**

**Status.**—Transient and temporary resident in late spring.

**Habitat.**—Groves at edge of woodland or near it. In almost all instances these vireos were in large American elms.

**Movements.**—The species has been recorded on the Reservation only in May and in the last week of April: May 6 to 18, 1953; May 3 to 31, 1954; April 25 to May 12, 1955; May 2 to 7, 1956; and April 29 to May 26, 1957. For periods of days an individual might be heard at about the same place, as if it had settled on a small territory. Often such a bird tended to stay within one tree. Habitat conditions must have been deficient in some respect, as such birds never remained more than a few days.

**Mniotilta varia** (Linnaeus)

**Black and White Warbler**

**Status.**—Known from the Reservation only as transient and temporary resident in spring, although there are breeding records for northeastern Kansas.
Habitat.—Deciduous forests.

Movements.—On April 12, 1951, one was seen moving about with a group of chickadees as it flitted from trunk to trunk. Other specific records are: May 17, 1951; May 8, 14, and 15, 1953; and May 14, 1954. On May 8, 1953, one was seen to fly at another and chase it from the grove south of the Reservation headquarters.

Vermivora peregrina (Wilson)

Tennessee Warbler

Status.—Migrant and temporary resident in late spring; perhaps crosses area on southward migration in autumn also, but no specific records have been obtained.

Habitat.—Northern coniferous forests in the breeding season and tropical forests in winter. During brief sojourn on Reservation seems to prefer large American elms.

Movements.—Because of my unfamiliarity with this species and the brevity of its stay on the Reservation, I have overlooked it in most years, but probably it is present regularly, on migration. On May 14, 1954, many were present within a small area of an elm grove south of the headquarters, and the song could be heard almost continually. Chasing was observed from time to time, and there was a distinct tendency for each individual to keep to his own part of a tree, excluding others. On May 20, 1954, further observations at the same place heightened this impression. An individual observed for 15 minutes foraging rapidly through the crown of a tree stayed within a space perhaps 20 feet across, tending to make a regular circuit as it hopped, flitted and sidled through the leaf canopy, moving only a few inches at a time, and frequently picking off minute food items. It was covering approximately the same beat as one of those observed six days earlier, and quite possibly was the same.

Vermivora celata (Say)

Orange-crowned Warbler

Status.—Migrant and perhaps temporary resident in spring. Probably crosses area on southward migration in autumn but no records have been obtained at that season.

Habitat.—Boreal forests in the breeding season; chiefly Gulf States in winter.

On the Reservation these warblers have been seen in woodland edge—American elms with vine tangles of grape, Virginia creeper,
and poison ivy. On April 19, 1954, these warblers were heard singing at several places and chasing was seen.

**Vermivora ruficapilla** (Wilson)
Nashville Warbler

*Status.*—Rare migrant.

*Habitat.*—Woodland and thickets.

*Movements.*—Richard W. Fredrickson saw several on the Reservation on April 30, 1949, the only definite date of record.

**Dendroica petechia** (Linnaeus)
Yellow Warbler

*Status.*—Regular spring migrant and temporary resident; not known to nest on area, which however, is within breeding range.

*Habitat.*—Deciduous forest.

*Movements.*—Heard and seen frequently each year in late April and May. In 1954, for example, it was recorded from April 27 to May 18. In May for five days in succession one was seen at the same place in the elm grove south of the headquarters, and it was suspected that this was the same individual.

**Dendroica coronata** (Linnaeus)
Myrtle Warbler

*Status.*—Regular migrant in spring and autumn.

*Habitat.*—Northern coniferous forests in breeding season, and southern deciduous forests in winter.

*Movements.*—This is the most conspicuous of migrating warblers on the area, in both spring and autumn.

Fall migration is concentrated in October, especially the first week, and spring migration is chiefly in late April and early May. In 1948 myrtle warblers were recorded on October 13 and 14. On October 13, 1950, several newly arrived migrants were seen in company with white-throated sparrows. At noon on October 11, 1951, many were noticed in elms in the headquarters area, the vanguard of a migration wave. None had been seen earlier, but they were present thenceforth through most of October. In 1953 the first one was seen on October 4, but by the next day they were present in abundance. In 1956 two were seen on October 2, and in 1957 the first record was on October 4. Spring records are April
23, 1953; April 23 and 27, 1954; April 25 and 27, May 8, 22 and 25, 1956; and April 23, 24, and 26, 1957. The species has been recorded on the area only in April, May and October.

**Dendroica virens** (Gmelin)
Black-throated Green Warbler

*Status.*—Rare migrant.

*Habitat.*—Chiefly northern coniferous forest in nesting season.

* Movements.*—Seen on several occasions in late spring. No definite date recorded.

**Dendroica fusca** (Müller)
Blackburnian Warbler

*Status.*—Rare migrant.

*Habitat.*—Boreal forest in nesting season; tropical forests in winter.

* Movements.*—The only recorded occurrence is of a male seen on May 15, 1954.

**Dendroica striata** (Forster)
Black-poll Warbler

*Status.*—Uncommon migrant and temporary resident in spring.

*Habitat.*—Northern coniferous forest in nesting season; tropics in winter.

* Movements.*—Black-poll warblers were recorded on May 18 and 19, 1953, and May 14 and 15, 1954. The 1953 records probably both pertain to the same individual, as both were in the same tree, an American elm in a field near the edge of the woods. The warbler was silent, and moved deliberately, usually running along small branches rather than flitting. It was in the same part of the tree on the two successive days and on the second day while it was under observation, it spent more than an hour there.

**Seiurus aurocapillus** (Linnaeus)
Oven-bird

*Status.*—Rare migrant.

*Habitat.*—Deciduous forest.

* Movements.*—My only definite record is of one seen on April 30, 1951.
Seiurus noveboracensis (Gmelin)
Northern Water Thrush

*Status.*—Rare migrant.

*Habitat.*—Northern forests, in swampy places.

* Movements. *—The only record for the Reservation is of one seen April 30, 1949, by R. W. Fredrickson.

Seiurus motacilla (Vieillot)
Louisiana Water Thrush

*Status.*—Rare migrant.

*Habitat.*—Deciduous forest.

* Movements. *—The only one recorded by me was seen on May 5, 1952. It was called up by squeaking.

Oporornis formosus (Wilson)
Kentucky Warbler

*Status.*—Moderately common summer resident.

*Habitat.*—Occurs throughout most of woodland on Reservation, but prefers mesic situations, with abundant leaf litter, and with dense understory vegetation to provide concealment for nest.

* Movements. *—Earliest recorded occurrences of Kentucky warblers in several different years were: April 21, 1952; April 26, 1954; April 28, 1955; May 3, 1956; and April 26, 1957. Arrival was timed when woody vegetation had leafed out, and the individuals first recorded were singing males, which were seen rather than heard. Establishment of territories begins as soon as the males arrive; whether females reach the area simultaneously, or later, is not known. Throughout their summer sojourn on the area, however, Kentucky warblers are rarely seen. Information concerning their movements has been obtained chiefly from the song, and therefore is based on the males, which are persistent singers in May and June.

In 1952, 1954, 1955 and 1957, a pair nested in the headquarters area. Conformation of the territory varied from year to year. In 1952 the territory was measured as 4.3 acres, and it centered on a south-facing slope of thorny woodland with dense undergrowth. A small, disjunct segment of this territory was along a ravine in woodland edge 100 feet south across a meadow from the main portion. In 1954 the entire territory, measured as 3.4 acres, was along this ravine in the woodland edge, and it overlapped only the small
disjunct portion of the 1952 territory. The 1955 territory was measured as 3.9 acres, most of which corresponded with the 1954 territory, but .5 acre was separate, on the north side of the meadow, within the area of the 1952 territory.

In May, 1956, a male that was singing persistently in dense woods on a northwest-facing hillside, was followed and observed frequently. A large elm, that was dead and bare, was the focal point of his activity and he returned to it regularly after frequent short forays in different directions. Unlike most other individuals that were noted, this one did most of his singing from high perches in the trees. His territory was only one acre.

**Geothlypis trichas (Linnaeus)**

Yellowthroat

*Status.*—Summer resident; many establish territories in early summer and some may breed on the Reservation.

*Habitat.*—The swampland habitat most typical of this species has been in some years totally lacking on the Reservation when the pond was dry and in other years at best was limited to much less than an acre in extent, in *Typha* patches at the edges of the pond. Nevertheless, many yellowthroats arriving on migration in late spring, settle on the area temporarily in atypical habitats. Some have been found established in grassy fields, both in bottomland and on hilltops. Others have been seen in woodland edge thickets, and still others in woodland, where undergrowth of gooseberry and
coralberry was plentiful. Just west of the Reservation boundary a small alfalfa field provided the territory for one of these birds in 1949.

**Movements.**—Yellowthroats were seen and heard most often in May upon their arrival from their northward migration. Earliest recorded dates on the Reservation for several years are: May 14, 1950; May 17, 1952; May 9, 1953; April 26, 1954; May 4, 1955; May 3, 1956; and May 8, 1957. The singing males established themselves temporarily in a variety of situations, such as: fields of brome grass; willow grove beside the pond; thickets at field border; dry, south-facing slope with thorny woods and thick undergrowth; alfalfa field. In June and early July they were seen or heard relatively seldom, and so few were noted after mid-July that it seemed they must have moved away from the area except for occasional stragglers. In 1953 one was seen repeatedly at the pond and near it in late July and early August. In 1955 one was seen at a fence along the edge of a field of tall grass. Only one territory of a yellowthroat was measured. It was 3.4 acres, based on only 5 marginal points. Perhaps the relatively large size of this territory was due to some lack in the habitat.

Stewart (1953:105) recorded territories of ten monogamous males which averaged $1.26 \pm .12$ acres ($0.8$ to $1.8$), while one polygamous male occupied a territory of $3.4$ acres. Brewer (1955:141) recorded five territories in a swamp habitat in southern Illinois, with an average of $0.56$ acre ($0.24$ to $1.09$).

**Icteria virens** (Linnaeus)

**Long-tailed Chat**

**Status.**—Regular summer resident but in variable numbers.

**Habitat.**—Limited to situations where there are dense thickets such as blackberry, and rank weedy growth.

**Movements.**—Over a period of several years earliest dates of record on the area for chats were: May 9, 1953; May 12, 1954; May 14, 1955; May 18, 1956; and May 10, 1957. Most records are for May and June, but probably chats remain through the nesting season. Because of their retiring habits and the dense cover of their habitat, they might have easily escaped attention after the singing and use of prominent perches associated with establishment and defense of territory stopped.

In May and June, 1955, a singing male was heard and followed several times in a hilltop field. A sapling thicket with crabapple, American elm, osage orange, honey locust and other woody plants,
up to ten feet high, provided such dense cover that the chat was rarely glimpsed. The thicket area was approximately .9 acre in extent and was well separated from other suitable habitat. The chat’s territory seemed to be co-extensive with the thicket. In May and June, 1956, a chat was followed as it moved about and sang, along a gully bordered with thickets of wild plum and various other shrubs and saplings. On both sides of this gully there were formerly cultivated fields, but on one side woody vegetation, chiefly of elm saplings, was invading the field. The chat used this thicket also, though preferring the denser growth adjacent to the gully. The territory encompassed by its movements while singing was 575 feet long and 230 feet wide at the broadest point, covering approximately two acres.

Brewer (loc. cit.) recorded four yellow-breasted chat territories that averaged .33 acre (.14 to .71).

**Wilsonia pusilla** (Wilson)  
**Wilson Warbler**

*Status.*—Occasional migrant.  
*Habitat.*—Boreal forests in breeding season; tropics in winter.  
*Movements.*—The only definite record is of one seen in the elm grove near the headquarters on May 19, 1953.

**Wilsonia canadensis** (Linnaeus)  
**Canada Warbler**

*Status.*—Occasional migrant.  
*Habitat.*—Boreal forests in breeding season, tropics in winter.  
*Movements.*—The only definite record is of a male seen on May 15, 1953. It was working through an elm grove near the headquarters in the morning, and shortly before dusk one (presumably the same) was seen at the edge of the woods 100 feet farther south. It was foraging by catching flying insects, darting out in pursuit at intervals of a few seconds.

**Setophaga ruticilla** (Linnaeus)  
**American Redstart**

*Status.*—Rare migrant.  
*Habitat.*—Woodland.  
*Movements.*—On May 3, 1952, a pair was seen and heard in a thicket near the Reservation headquarters by Richard Fredrickson and Mr. and Mrs. Bert Chewning. On May 15, 1953, I saw a male
moving rapidly through the tops of large elms and it chased away another small bird, perhaps of the same species. These are the only definite records for the Reservation.

Passer domesticus (Linnaeus)

English Sparrow

Status.—Frequent but irregular visitant; does not breed on the Reservation.

Habitat.—This introduced species is characteristically associated with man-made structures and altered habitats. In northeastern Kansas, large flocks frequent nearly every farmyard. Roadside hedges of osage orange and other thorny trees and shrubs that border grain fields or are near to farm buildings often are the headquarters for such flocks. Where grain is grown or where poultry or livestock are kept, the food supply encourages sparrows. Lone sparrows, pairs or small groups often were attracted to the buildings at the Reservation headquarters. Nesting sites, thorny thickets for shelter, and grain for food (that used as bait for trapping birds and rodents) were available, but the sparrows never became established on this natural area.

Movements.—All but two of 25 recorded occurrences on the Reservation were in late January, February, March, and April. The visits to the area seemed to be motivated primarily by a search for nesting sites. Individuals or pairs might visit the area daily for several days or even several weeks. They might stay for only part of the day. A barn and farmyard slightly less than a mile to the west were the source of most of the individuals that came, or perhaps of all. These pioneering sparrows were wary, and upon being disturbed they would flush, circle over the area gaining altitude, and, heading west, would pass out of sight in high, rapid flight. Usually they would not return the same day. Those sparrows that came alone were all males. On November 21, 1955, a pair was hovering about the eaves of the garage, probably in search of a nest site. On April 13, 1956, a pair was seen carrying nesting material to an elm at the headquarters, but this nesting attempt was abortive.

In the spring of 1957 there were several dozen sparrows on the Rockefeller Tract. They nested in the barn and several sheds, about the house, and in nearby trees. By July most of these sparrows had left. The buildings were no longer in use, and high weeds had grown up in the adjacent areas that were formerly under cultivation, evidently creating conditions unfavorable for the sparrows.
Sturnella magna (Linnaeus)

Eastern Meadowlark

Status.—Common resident in general area but rarely present on Reservation.

Habitat.—Meadowlarks in this area occur mainly in hay fields, and prairie habitats where grass is fairly short. The habitat deficiencies of the Reservation are not clearly apparent. As compared with nearby occupied habitat on farmlands the habitat on the Reservation differs in having a heavy accumulation of dead vegetation on the ground, and in having denser grass. Neither the extensive areas of brome grass fields, the original bluestem prairie patch nor the re-established prairie have meadowlarks ordinarily. In view of this bird’s great abundance in the general area, its sporadic appearance and brief sojourns on the Reservation are somewhat remarkable. In most instances the individuals heard or seen on the area have not remained for more than a few minutes, but nesting has been attempted on several occasions.

Movements.—In 1948, when the area was still grazed, the habitat was unfavorable for meadowlarks. The first time one was seen on the area was on June 1, 1949, in a hilltop field, where a crop of new grass provided cover. None was known to have nested on the Reservation that summer, but several were seen there in October and November. In 1950, 1951 and 1952, meadowlarks appeared briefly on the area in April and early May. Obviously these individuals were dispersions in search of territories for the nesting season. Some were in pairs. Singing and pursuit were common, but in each instance the birds soon moved off the area. In 1953 on March 20, a pair was found established in a hilltop field dominated by brome grass. In the next two months these birds were seen many times, and on several occasions were followed and caused to flush several times in succession. The area covered was 2.8 acres. In 1956 a male appeared on March 24, singing in the field near the headquarters. Subsequently he appeared there regularly, sometimes accompanied by another. After arriving together, the two would separate and sing from different trees, or from lower perches, usually with no show of hostility. However, on April 12 three were seen circling and dodging over the field in a high rapid pursuit. The area which the male was seen to cover was 1.4 acres, and two trees 250 feet apart were his favorite singing stations. He did not acquire a mate, and he disappeared from the area in mid-April.
The failure of the meadowlarks that settled on the Reservation almost every spring to consummate their nesting cycle there probably was due to the presence of grain fields nearby. As the grain grew tall, these fields provided better nesting places than the fields of brome grass on the Reservation, which were then deserted by the meadowlarks.

In the spring of 1957 there were several pairs on the Rockefeller Tract. Their activities were concentrated in the former pasture and in the alfalfa field.

**Sturnella neglecta** Audubon

*Western Meadowlark*

*Status.*—Uncommon transient.

*Habitat.*—Typically, short-grass prairie.

*Movements.*—On March 3, 1955, one was heard singing in a tall grass prairie hilltop area of the Reservation near its northern edge. Later in the day a flock of 19, probably of this species, were seen flying northwest over the same field. On November 1, 1955, at 9:30 A.M., a small flock was perched on a wooded and brushy hilltop near the west edge of the Reservation. They were resting, and singing from time to time. One chased another, and both flew out of sight to the west. Two days later a flock was seen foraging at the edge of the county road ¾ mile farther south, in an area of big bluestem. After heavy snowstorms, in early January, 1956, western meadowlarks were seen and heard frequently in a pasture adjoining the Reservation on the west, and along the county road just southwest of the Reservation section. One was singing in the pasture on the Rockefeller Tract on October 9, 1957.

**Xanthocephalus xanthocephalus** (Bonaparte)

*Yellow-headed Blackbird*

*Status.*—Uncommon transient.

*Habitat.*—Marshland.

*Movements.*—On November 17, 1955, a flock of 50 or more was seen flying south over the headquarters, strung out on a wide front, as is characteristic in migrating blackbirds. On November 12, 1956, a similar migrating flock, with a few starlings intermingled, was seen at the same place.
Agelaius phoeniceus (Linnaeus)

Redwing

Status.—Several pairs usually are summer residents at the small pond. Thousands migrate over the area without stopping in spring and autumn, and many stop only for short periods.

Habitat.—The small pond and the marsh habitat about its edges provide the only breeding habitat on the Reservation.

Movements.—Redwings were seen on the Reservation chiefly as migrants in spring and autumn. Each spring the pond attracted them, but because of the uncertain water supply, they sometimes did not stay to nest. In the period of years 1948 through 1952, and in 1957, with moderate to heavy precipitation, the pond retained water at least through the early summer, and redwings nested in the marsh at the edge of the water. In 1953 through 1956, with more meager precipitation nesting was unsuccessful there. Singing was first heard at the pond on March 20, 1951; February 29, 1952; March 13, 1953; April 6, 1954; and March 15, 1955. Mass migrations were noted each spring, sometimes beginning in early February, and sometimes lasting into late April. Autumn migration was noted chiefly in October and November. In 1954 spring migration reached its peak on approximately March 12, although it had been in progress since early February. On March 12, weather was unseasonably mild, with a high wind from the southwest, and redwings were passing over by the thousands. They were in sight or hearing almost continually. Some were flying alone, others in twos or threes or larger groups up to those numbering many hundreds. Such large flocks strung out on a broad front, sometimes as much as half a mile across.

In contrast to the loose formation of the flocks that were actually migrating was the compactness of flocks that lingered in the vicinity for periods of days, or even weeks, in spring. These flocks came to the Reservation to roost in late afternoon or early evening, usually not appearing until near sunset, and otherwise their daily routine of activity was unknown. Presumably they foraged and visited prospective nesting areas within a radius of a few miles. Flying swiftly, in close formation, a flock of up to 200 birds would maneuver over the area and then settle in the top of one of the tallest trees available, where they would chatter and sing in chorus.
In the hour or more that sometimes elapsed between its appearance and its final settling to roost, the flock would normally shift several times from one high tree to another, sometimes splitting into two or more units, and sometimes joined by new contingents. When finally it had become nearly dark, the redwings would fly into tall grass to roost, each bird choosing its own moment for the descent, and finding its own spot to settle. Usually only part of a flock would settle in any one small area, and the remainder might shift uneasily to another tree before finally going to roost. That such roosting aggregations consisted largely of the same individuals over periods of days or longer was strongly indicated by return of the flock to the same trees in more or less the same sequence on successive evenings. In 1954 the roosting aggregations were seen daily over the period March 8 through April 5. Within this period the largest aggregations were seen in late March and April.

In spring male redwings always appeared at the pond and sang, well before any females were in evidence. In some seasons, when habitat conditions were unfavorable, females probably did not come there at all. The entire area about the pond that was used by redwings, was less than two acres in extent; the area actually available for nesting was variable, but usually was considerably smaller. The male redwings that came to the pond in the early part of the nesting season spent only a part of each day there. Often two or more males travelling in high rapid flight, would come to the pond together, and perch separately in tall trees to sing and display. In departing also, they usually kept together, in high rapid flight, probably headed for distant roosting areas.

Nero (1956:130) found the average size of territory for 17 well established males to be about 1/12 of an acre. He found that size of territory varied inversely with the population density. Males are polygamous, and one's territory may have several mutually hostile females living within it. These females may be at different stages of the breeding cycle.

Icterus spurius (Linnaeus)

Orchard Oriole

Status.—Rare visitor.

Habitat.—Parkland, and trees in relatively open situations.

Movements.—On May 16, 1951, a group of at least eight was in a Kentucky coffee-tree (Gymnocladus dioica) at the Reservation headquarters. Only two were males in breeding plumage. All
were feeding avidly on the flower buds of the tree. In 1958 orchard orioles were seen or heard on the area almost daily in late May and June, but in the intervening seven years none was recorded.

*Icterus galbula* (Linnaeus)

**Baltimore Oriole**

*Status.*—Moderately common summer resident in general area but not known to breed on Reservation.

*Habitat.*—Groves of large deciduous trees.

*Movements.*—Earliest appearances over several years were: April 28, 1951; May 16, 1952; May 6, 1953 (one seen three days earlier at Ottawa, 30 miles south); May 4, 1954; April 27, 1955; May 12, 1956; and May 1, 1957. In each instance the earliest record was of a male, and males may have arrived a little sooner than females. In no instance, so far as known, did Baltimore orioles remain on the area through the nesting season. Records were chiefly from May (19 different dates) and from August (15 different dates), with relatively few between (June 20 and July 16, 1954; July 31, 1955). The species must have found conditions unsuitable for nesting, for those individuals that had stopped on the area soon shifted elsewhere. The reappearance in August probably coincided with the end of the nesting cycle, at least for those individuals involved, which shifted away from their nesting territories as conditions changed there and became less favorable.

In 1953 the August visitation involved a pair and one or more fledglings that were still dependent. These orioles appeared abruptly on August 21; thereafter they were seen or heard daily through the remainder of the month, and from time to time in early September (last record on the fourteenth). The records of this group encompassed an area of 2.1 acres. In 1955, after the first appearance on April 27, a male which probably was the same, was present continuously until May 18. He was singing almost continually during the first few days, but on May 4 he abruptly became much less vocal and remained so during the latter part of his stay. The area encompassed by his movements was approximately 10.6 acres, in the shape of an elongate ellipse, with its long axis 1200 feet from end to end, extending along woodland edge.

In 1957, on the Rockefeller Tract, a cottonwood near the house was much used by an oriole and nesting may have been attempted there.
Euphagus carolinus (Müller)

Rusty Blackbird

Status.—Regular transient in migration in spring and autumn; occasional in winter.

Habitat.—Swampy areas of boreal forest in nesting season; in winter range, which includes region of this study, requires such areas as open fields or closely grazed pastures, because of habit of foraging on ground.

Movements.—On October 21, 1948, several were seen and on the morning of October 25 a flock of several thousand settled in the grove at the edge of a hilltop field. These blackbirds may have stopped to forage in the heavily grazed pastures which at that time still had livestock in them. Soon afterward the livestock were removed, and the blackbirds were never again seen in such numbers.

The two December records were of lone birds; on December 16, 1953, a male was seen foraging at the edge of a frozen pond, and on December 2, 1955, a juvenile was foraging with a flock of starlings and robins beside the headquarters building. This was in the yard where grass and weeds had been cut the preceding summer. On January 28, 1957, when the ground was snow-covered, a flock of 35 was seen at the northwest corner of the Reservation, and foraging in an adjacent field of milo stubble. On October 19, 1955, and November 12, 1954, southward migrating flocks passed over. On November 3, 1948, and November 20, 1951, flocks were seen resting in the headquarters area. In spring, March 11, 14, 22, 23, and 24, 1955; March 14 and 16, 1956; April 9, 1954; and April 3 and 5, 1955, rusty blackbirds were seen in compact flocks on the Reservation. These flocks invariably came to the area in late afternoon, attracted by the dense ground vegetation providing favorable cover for roosting. A compact flock would often perch for 10 minutes or more, chattering and singing, and would shift from tree to tree several times before finally going to roost.

Quiscalus quiscula (Linnaeus)

Bronzed Crackle

Status.—Regular migrant in spring and autumn, but usually as transient flying over area without stopping.

Habitat.—Short ground vegetation, permitting easy walking and an unobstructed view, perhaps is the one requirement that is consistently lacking on the Reservation, making it unattractive to the
grackle, which is a common breeding species locally on farmlands and suburban areas.

**Movements.**—The only definite record of the grackle stopping on the Reservation was obtained on April 4, 1951, when a flock of more than 2000 were foraging in a hilltop field of brome grass. In flushing they split into two groups that flew west across the area. Within the next few hours a large flock was seen several times maneuvering over different parts of the Reservation. These grackles flew in a compact mass, and as they flushed or turned, their wingbeats produced a roaring sound. While on the ground or perched they kept up a chattering that was audible half a mile away.

In contrast, those that were passing over on migration were flying parallel, strung out on a broad front. Often they were flying with redwings. On October 31, 1952, at 9 A.M., a large flock passed over headed south. On February 14 and 16, 1954, several were seen flying high headed northeast. On March 2, 1954, a flock of several hundred, on a front more than 100 yards wide, passed over headed north.

**Molothrus ater (Boddaert)**  
Cowbird

**Status.**—Common summer resident.

**Habitat.**—Groves along edges of bottomland fields are preferred on Reservation in spring and summer, but probably every part of area is used to some extent.

**Movements.**—Ordinarily cowbirds are present on the area only during the nesting season. An unusually late record was November 7, 1949. A group of 30 or more was in a thicket at the edge of a field, and many of them were feeding on the fruits of dogwood (*Cornus drummondii*). These were probably transients from farther north, that were passing on migration. Flocks of cowbirds winter in the region of the Reservation, but they stay about farmyards and pastures, where there are cattle or other livestock, and none has been seen on the Reservation. These wintering flocks presumably are from farther north in the species' range.

In early spring each year, newly-arrived singing males appeared abruptly on the Reservation. Within a few days their numbers were much augmented by new arrivals and females began to appear. As compared with other kinds of breeding birds on the area, cowbirds were notable for the wide variation in time of ap-
pearance from year to year. Over a seven-year period earliest dates of appearance were: April 14, 1951; March 24, 1952; March 13, 1953; March 28, 1954; March 31, 1955; March 22, 1956; and March 13, 1957. The earliest appearance, March 13, 1953, was somewhat different from those of other years, as three males were seen perched close together feeding on leaf buds, and not singing. On the following day others were seen flying over. On March 16 two were seen on the area, and from March 30 onward they were seen frequently.

Cowbirds were most conspicuous on the area in April, May and June. They were usually seen in small groups of two or three females and a somewhat larger number of males. These groups moved about from tree to tree, usually over an area of several acres, the males singing, displaying, and jostling each other for position. From time to time one bird or several might separate from the sexual aggregation and leave in strong direct flight. For the groups seen near the Reservation headquarters, the destination was obviously a pasture on the farm west of the Reservation, a distance of .5 mile to one mile. Only rarely were cowbirds ever seen on the ground on the Reservation, and the rank vegetation seemed to create conditions unfavorable for their foraging. Occasionally they were seen feeding in trees, but probably they obtained most of their food in pastureland beyond the limits of the Reservation, and came there only for breeding. As the season advanced, throughout most of the summer, the aggregations were seen much less frequently; cowbirds seen were mostly females, which were silent and furtive in behavior, lurking in thickets and crowns of trees. Although a high proportion of all birds' nests on the Reservation are parasitized by cowbirds, fledgling cowbirds have rarely been noticed on the area.

**Piranga olivacea** (Gmelin)

*Scarlet Tanager*

*Status.*—Recorded on Reservation only as spring migrant.

*Habitat.*—Deciduous forest.

*Movements.*—My only record of this species was obtained on June 13, 1951, when a pair was seen flying across a field to a large elm near the Reservation headquarters, a few minutes before sunset.
Piranga rubra (Linnaeus)

Summer Tanager

Status.—Moderately common from late April to early September; several nesting pairs each year.

Habitat.—Deciduous forest and edge.

In most instances pairs were observed in dense woods of predominantly oak-hickory type, but they also foraged frequently in more open groves of elm and walnut adjacent to the denser woods. The males tended to choose as singing stations large trees somewhat apart from the main woodland. Several large honey locusts in fields near woodland edges were the most used singing stations of different males.

Movements.—Earliest recorded dates for several years were: April 27, 1951; April 26, 1952; April 28, 1953; April 24, 1954; April 30, 1955; May 4, 1956; and April 30, 1957. In every instance the first individual noted was a male, and possibly the males arrive a little earlier than the females. Nest-building was observed in 1953 (Fitch and Fitch, 1955:48). Only the female carried material, but the male stayed nearby. Some of the stems used were collected on the ground beneath the nest, but nest-building for the first few days proceeded at a leisurely pace. The female was first observed at the nest site on May 11. By May 18 she was observed carrying stems for the nest foundation. Building continued at an accelerated rate through May 24. Much of the nesting material was gathered along a ravine at the edge of woodland 200 feet from the nest.

When the young tanagers in the nest were just one week old, they climbed out along the limb nearby, and one by one fell into tall grass. At this stage they had only begun to feather out, and were almost helpless. After spending three days in the grass near the nest, they were sufficiently developed to fly into nearby trees. The whole family then soon shifted to the wooded ravine 200 feet or more from the nest tree, and were seen there frequently in the following three weeks.

The territory within which most of the activity of the pair of tanagers was limited, was measured as 4.3 acres, in a broadly elliptical area, which was mostly in an open grove of large American elms at the edge of woodland. From time to time, however, one or both
birds were observed well beyond the limits of this usual area. The seven most outlying points encompassed an area totalling 20.8 acres. Lack of territorial pressure probably encouraged these birds to wander frequently beyond their home area. Each year at least six pairs of summer tanagers nested on the Reservation, but their territories were so well spaced that no more than one at a time could be heard singing. Encounters between members of different pairs were never observed, and must have occurred relatively seldom. Each year singing ceased abruptly in the second week of August. My latest records are on September 27 (1953 and 1957).

Richmondena cardinalis (Linnaeus)

Cardinal

Status.—Common resident, using every part of Reservation except extensive open fields; populations fluctuate from year to year and from season to season; greatest numbers present in winter; migrational shift of populations evidently occurs from summer to winter.

Habitat.—Dense thickets in edge situations adjacent to woodland and fields are preferred. Thick thorny shrubs such as osage orange, crab apple and honey locust are favorite nesting sites. Dense woodland edge, and thickets along roads and creeks provide shelter and resting places, but cardinals forage in a wide variety of situations, and utilize many different food sources.

Movements.—In late autumn each year cardinals suddenly became more abundant and conspicuous. Unusual concentrations, probably made up mostly of new arrivals, were noted on: November 8, 1948; November 14, 1951; October 29, 1952; November 30, 1953; and October 17, 1955. Even larger concentrations were sometimes noted in late winter at times when weather was unusually severe, and ground was snow-covered. The extent of population shifts in response to extremes of weather was not determined.

Cardinals sing throughout the year, but singing is at low ebb in November, December, and January. It occurs only on clear, still mornings when weather is unusually mild. Singing tends to increase throughout February, although it is temporarily stopped by wind, low temperature, snow, or rain. By early March males are beginning to establish territories.

In winter individuals are highly tolerant, and several may feed or perch in proximity. However, aggregations are drawn together
by food supply, shelter, or other attractions, rather than by sociability. Usually each individual is more closely associated with other small passerines, such as Harris sparrows, tree sparrows, song sparrows and juncos than with members of its own species.

On November 30, 1953, when a group of cardinals had gathered in a spot exposed to the early morning sunshine, there was brief singing, and a male chased a female persistently. Several other males, excited by the pursuit, were trailing along, chiefly to harass the first male, it seemed, rather than to catch the female.

For the cardinals live-trapped in winter, distances between successive captures averaged 413 feet for 49 marked males, and 565 feet for 31 records of females. Home ranges of 12.2 acres for males and 22.9 acres for females are indicated. Not included in this computation are three exceptionally long movements (one of a male and two of females) of nearly half a mile each. These are thought to represent shifts in range. For those intervals including one or more summers between successive captures, distances averaged no more than for intervals within the same winter.

Approximately the first week of March the males, having established territorial singing stations, become increasingly intolerant. A typical encounter was observed on the morning of March 8, 1957, at the edge of woodland. Two males were hopping about briskly, with crests erect and tails jerking, within a few feet of each other, occasionally giving metallic chirps. When one would fly, the other would follow close behind. There was no actual contact. Usually the chase led back and forth along the edge of the woods in an old diversion ditch, but occasionally the birds crossed a narrow field to edge of woodland on the opposite side, 150 feet or more away.

For a period of weeks stress increases as males defend their newly established territories against the encroachment of neighbors, and against the wintering cardinals still wandering over home ranges in the general area. However, territoriality develops gradually. Singing and hostile behavior is most noticeable in early morning. Later in the day the males may relax their vigilance and mingle with others with little indication of intolerance. In periods of stormy weather, territorial behavior may be suppressed entirely. Formation of pairs occurs only after the males are thoroughly ensconced on their territories. Females still ranging freely over their large winter ranges, are followed and courted by the males whose territories they cross. In competition for mates actual fights are frequent, along with intimidating displays and pursuits. On March 9,
1954, two males that were chasing the same female stopped to fight violently. They fluttered near the ground, sparring, their wings rattling together. In the period March 16 to 19, 1952, two males having newly established territories along the edge of the woods near the Reservation headquarters were observed frequently. Their territorial centers seemed to be about 150 feet apart. Each often strayed into the other's territory and was chased back, the pursuer usually stopping abruptly near the same place, where a mutually accepted boundary seemed to be situated. After such a pursuit the males would stop a few yards apart, each on his own side of the boundary. They would watch each other, flicking their tails and uttering clicking notes, then would fly to high perches and sing. A female seemed to be staying in the general area, ranging over both territories, and she was the object of frequent pursuits, sometimes by both males simultaneously. She would fly rapidly from tree to tree and bush to bush, along the ravine in the edge of the woods avoiding the males with frequent quick turns. In these pursuits the males became so preoccupied as to forget defense of their territories, but occasionally one would dart at another. Once a second female, which had been watching with excited chirping, interposed herself, so that all four birds were strung out in a line, the two males bringing up the rear.

On April 16, 1952, an encounter was observed between four cardinals which seemed to consist of a male chasing a prospective mate, and an established pair whose territory was violated in the course of the pursuit. The paired female was not chased but she followed the pursuit with hostile behavior directed largely toward the unattached female. The paired male followed the other male and from time to time intercepted him and engaged him in short fights. The wrangling continued for approximately half an hour that the birds were watched. On April 22, 1955, when persistent scolding attracted my attention, I observed a male trying to head off a female and drive her back into the area presumed to be his territory. A second male was interfering. Occasionally the two males closed in and struck at each other. Much of the month of March is spent in such maneuvering.

By early April most cardinals are paired. An unusual feature of territoriality in this species is the singing of the female. On occasion, persistently singing birds assumed to have been males turned out to be females. Paired females have been heard to give a burst of song in reply to each burst of the male, as he sang from a nearby territorial perch.
No territories of cardinals were actually measured. The somewhat secretive habits of the birds in the season of nesting made it difficult to follow their movements. Nine intervals between occupied nests ranged from 220 feet to 560 feet and averaged 391. That this distance was somewhat representative of the diameter of a territory was borne out by the distances measured between adjacent singing males in 169 instances. This distance between the singing males averaged 416 feet indicating an average territory of 3.1 acres if it be assumed that the territories are circular and have common boundaries.

Brewer (1955:141) recorded an average area of .37 acre (.31 to .45) covered by five cardinals in a swamp thicket habitat in southern Illinois. The small size of the "minimum home range" obtained by Brewer, in this and other instances probably result from inadequately small series of records.

**Pheucticus ludovicianus** (Linnaeus)

Rose-breasted Grosbeak

*Status.*—Regular migrant or transient in spring, some stopping on the Reservation for periods of days or weeks, but not known to nest.

*Habitat.*—Deciduous forest and parkland situations are occupied in the breeding season. On the Reservation it has been seen and heard chiefly on a northwest slope in mesic mixed forest, with ash, hickory, elm, chestnut oak and black oak, and in a willow grove at the pond.

* Movements.*—Seen or heard on the following dates: 1951, April 30; 1952, April 29 and 30, May 17 and 22; 1953, May 19; 1954, May 15; 1955, May 8, 9, 13, 14 and 16; 1956, April 26, 28, 29, May 2, 4, 5, 7 and 26. It is noteworthy that each year all had disappeared by June 1, although they seemed to be settling down and establishing territories in May. Often those seen were feeding and moving about in pairs. On April 30, 1951, two males were eating leaf buds of ash in the same tree. Similarly on May 7, 1956, two males were feeding together in the same tree. On other occasions, pursuits were seen, but on May 5, 1956, three pairs were feeding together in a willow grove, all within a 50-foot radius, with no sign of hostility. Abundant larvae of chrysomelid beetles on the willow leaves made this an attractive feeding place. Probably all those seen on the Reservation were recent arrivals, which had not yet settled down permanently or established territory.
Guiraca caerulea (Linnaeus)

Blue Grosbeak

Status.—Summer resident on areas immediately adjoining Reservation, but rarely crosses boundary.

Habitat.—Brush.

A wooded slope of north and west exposure adjoining the west edge of the Reservation, was bulldozed in late winter of 1949. By 1952 the area had grown up into a thicket, with numerous stump sprouts of hickory, oak and elm, high weeds, and with the partially burned debris of uprooted trees piled at the bottom of the slope. Grosbeaks were first definitely recorded in 1952, and were present regularly thereafter.

Movements.—Two pairs were present on the brushy strip west of the Reservation in 1955 and 1956. The male of one pair was frequently seen along a 250-foot stretch of road, perched on telephone wires and occasionally his mate was with him. The territory was at least 200 feet wide, and thus included a minimum area of 1½ acres. Farther south along the road a second pair was often seen, but a stretch of some 350 feet intervened where none was recorded.

Passerina cyanea (Linnaeus)

Indigo Bunting

Status.—Common summer resident, late April through September.

Habitat.—Low thickets in or near fields with grass, weeds or cultivated crops provide the preferred habitat of the indigo bunting. From 1948 through 1958 conditions have steadily improved for the bunting, because thickets have encroached into formerly pastured areas. These thickets, of crab apple, honey locust, osage orange, elm, and a few other trees, have created abundant shelter and nesting sites for the buntings. The most dense population of buntings noted was on a north slope just west of the Reservation, wooded until 1948, when it was cleared by bulldozing. The piles of broken tree trunks, limbs and roots were partly burned. In the next few years saplings of oaks, hickories and other trees sprang up in large numbers. Also, there were many vines and thick weeds, so that by June, 1955, the area was an almost impenetrable tangle.

Movements.—Earliest recorded occurrences of the indigo bunting for the period 1952 through 1957 on the Reservation were in early May each year, the third, fourteenth, ninth, second, fourth and
fourth. Singing was chiefly in May and June, but continued into early August. My latest record is for September 15, 1953.

Despite the abundance of indigo buntings on the area, it proved difficult to trace out the territory of any one individual because of their shyness and frequent flight, and the difficulty of recognizing individuals. One territory, measured on the basis of 15 recorded movements within it, was 2.7 acres. In 32 instances the distances between adjacent singing males were recorded, and they varied from 1300 feet to 110 feet, averaging 504 feet. A territory of this latter diameter would cover approximately 4.6 acres. Brewer (1955:141) recorded an average area of only .26 acre (.15 to .52) for five indigo buntings in swamp thicket habitat in southern Illinois.

**Passerina ciris** (Linnaeus)

**Painted Bunting**

*Status.*—Rare, probably occurs on Reservation only as summer transient.

*Habitat.*—Brush and woodland edges.

*Movements.*—The only recorded occurrence of this species was obtained on May 14, 1950, by Mr. and Mrs. Bert Chewning. The bunting was heard (but not seen) singing at the edge of a brushy, south-facing slope where the woodland adjoined a meadow.

**Spiza americana** (Gmelin)

**Dickcissel**

*Status.*—The dickcissel is one of the most abundant of breeding birds in the general area. Since 1948, when the Reservation consisted of woodland, closely grazed pasture and cornfields, plant succession has proceeded. Certain areas have grown up to tall grass and weeds and have become favorable habitat for dickcissels.

*Habitat.*—Grassland.

Under modern conditions in northeastern Kansas most dickcissels nest in fields of wheat, barley, oats, or alfalfa. Singing stations are provided mainly by fence posts and by telephone wires at the fields' margins, and the singing males tend to be rather regularly spaced. On the Reservation dickcissels have become abundant in an old field that was sown to seeds of native grasses in 1949 and has taken on the aspect of a prairie since then, with tall grass clumps (big bluestem, little bluestem, switch grass, Indian grass, side-oats grama) in varying density interspersed with goldenrod and other
Weeds in patches, with numerous saplings of elm, locust and other trees.

It is noteworthy that dickcissels are more numerous on parts of this field where a mixture of several kinds of grass had been planted than they were on parts where the several kinds were growing in separate strips.

In 1953 a single pair of dickcissels nested in the field of brome grass and bluegrass with numerous small trees, near the Reservation headquarters. In the years 1953 through 1955 another pair had a territory which included part of a field of bluegrass and brome, and part of a formerly cultivated field with stunted giant ragweed, and large patches of foxtail grass. In 1954 and 1955 several pairs were located in the southwestern part of the Reservation in a field of brome and bluegrass with thickets of saplings, adjoining an oat field.

**Movements.**—Arrival dates for the years 1951 through 1957 were April 30, May 3, May 4, April 29, May 1, May 2, and May 6. Within a few days after the first arrival males were abundant and conspicuous, spending much of their time singing from territorial perches. No dickcissels have been seen on the area after the end of July. If they remain on the area at all, they must become extremely silent and secretive.

Because of their tameness, and the open nature of their habitat, dickcissels could be studied, with respect to territory, more readily than any other species of bird present on the Reservation. While singing, they would often allow approach to within 25 feet, and when flushed, they would usually show no alarm but might move only a few yards, to a nearby perch. By following such an individual from perch to perch for a short time, it was easy to determine the approximate extent of its territory. Nine territories investigated in this way ranged from 1.4 to .5 acres and averaged .9 acre. In 14 instances the distances between adjacent singing males, where the habitat appeared to be continuous, varied from 450 to 60 feet and averaged 296. Assuming that this distance represents the diameter of an average territory, an area of 1.6 acres would be represented. Presumably the discrepancy between this figure and the .9 acre of territories actually measured results in part from the fact that some territories were incompletely recorded, and in part from the fact that there are some unoccupied spaces between territories. Therefore, an intermediate figure of approximately 1 ¼ acres may be most typical.
The largest territory measured, one of 1.4 acres, was in the meadow of brome grass near the headquarters, a habitat different from the tall-grass prairie where most of the dickcissels were observed. In the absence of competition this pair tended to cover a larger area than they would have otherwise. Records are far more complete for this pair, than for any of the other pairs observed. The territory of 1.4 acres was plotted from 30 locations, many of which were used many times by the birds during the course of observations. Occasionally the male was noted to sing from perches well beyond the limits of the area usually occupied, in each direction. The total area encompassed by these outlying points totalled 5.6 acres, but obviously most of this area fell outside the regular territory (Fig. 23).

Fig. 23. Territory of a pair of dickcissels in June and July, 1953. So far as known the female kept to the relatively small central area, but the singing male, in the absence of competitors, often wandered to outlying stations. Lines show observed movements.

The pair first appeared on this territory on June 10, 1953, probably after an unsuccessful nesting attempt elsewhere, because more than a month had elapsed since arrival of dickcissels and establishment of territories in the general area. Each time the male sang, the female answered with a low buzzing sound. The female was seen carrying nesting material on the morning of July 9, and in the
afternoon of the same day the nest was found completed with one egg in it. By July 14 the clutch of four eggs had been completed, and hatching occurred on July 23-24. The nest was robbed on July 31, and on the following day the adults had left the territory.

On a few occasions, singing males that were followed too persistently and caused to take alarm, moved somewhat beyond the limits of their territories, with accompanying change in behavior. Ceasing to sing, they would skulk through low vegetation, instead of perching on the highest and most exposed perches available, as is usual with singing males.

Elsewhere in the general region, telephone wires at the edges of grain fields provide the most favored territorial perches. In the prairie area where most of the pairs were studied on the Reservation, there were no trees other than saplings. A telephone line along the north edge of the Reservation, on the edge of the prairie tract, therefore provided the best perches for singing males and it was used regularly by all those having territories along the north edge of the field. It was used also by several others whose territories did not adjoin the edge, unless a narrow corridor of travel to and from the wire be considered part of the territory.

In this area where several pairs lived in adjacent territories, pursuits were frequent, but usually they were brief and did not involve actual fighting. So far as observed, these territorial pursuits involved only the male.

Carpodacus purpureus (Gmelin)
Purple Finch

Status.—Occasional transient in winter.

Habitat.—On the Reservation purple finches were most often seen near the pond, which was the focal point of their activity. Stands of sunflower and other weeds attracted them, the seeds supplying an abundant food source. At other times, in fall, they were seen foraging in treetops, probably for dried fruits and berries.

Movements.—Purple finches recorded on the Reservation were usually travelling in small groups in high, rapid flight and they were among the most vagile of all birds in the area. Also, they were more wary than any except raptors and water birds, and generally would not permit approach closer than 200 feet. Twenty-two specific records were distributed as follows: October—8, November—6, December—3, January—1, February—none, March—2,
April—2. Earliest fall records were October 8, 1956; October 15, 1955; October 24, 1954; and October 15, 1957. Latest spring records were April 2, 1955, and April 12, 1956.

**Spinus pinus (Wilson)**

**Pine Siskin**

**Status.**—Occasional transient.

**Habitat.**—In breeding season, northern forests, usually associated with coniferous trees.

In its more southern winter range the species may prefer conifers also. No conifers are present on the Reservation, and in any case the area is, in general, unattractive to siskins, which have been observed there on only a few occasions.

**Movements.**—In the first week of November, 1954, siskins were seen many times at the pond where they were attracted by sunflower patches, and were feeding on the seeds. Again in late October and November, 1955, siskins were abundant at this same place and at a fallow field on the east side of the Reservation, where there were patches of sunflower.

**Spinus tristis (Linnaeus)**

**Eastern Goldfinch**

**Status.**—Common resident, using every part of Reservation; moves about freely, and numbers vary markedly according to season and food supply.

**Habitat.**—Activities are concentrated about weedy fields. Seeds of sunflower seem to be the one most important food source, and are used throughout the fall, winter, and early spring. Seeds of various other composites are used to a lesser extent. Since 1948 when formerly cultivated fields produced their first crop of pioneer annual weedy vegetation, the quantity of sunflower has steadily decreased, because this plant is most characteristic of the early stages of secondary succession. As a result, the area is used less by goldfinches. The dwindling sunflower patches continue to be focal points of their activity. In late March and April, when seeds of elm are maturing and are still on the trees, they are preferred food, and large restless flocks of goldfinches are much in evidence, moving about in the treetops or maneuvering over them.

**Movements.**—Goldfinches have not been recorded on the area in the months of February or June. While they doubtless visit
the area occasionally at all seasons, they are relatively scarce in winter and summer, and are much more frequent in September and October, and again in late March and early April. Those present in fall are seen singly or in pairs, while those present in spring are in large roving flocks attracted to the area by the abundant supply of elm seeds for food. Occasionally at this time of year they may be among the most abundant of birds present. Nesting activity has been noted chiefly in August and September. In August, 1954, several were noted in different places circling and singing at heights between 100 and 200 feet over hilltop grassland areas. In September, 1953, a pair nested in the headquarters area. Frequently they flew over the territory, in circles of perhaps 200 yards diameter, keeping a little above the level of the treetops. To forage, these goldfinches almost always left the Reservation, and on many occasions were seen to make flights of at least half a mile west or north to pastures and cultivated fields. Sometimes both members of the pair travelled together on these foraging expeditions, but more often they travelled alone. On September 14, a family group of five was seen maneuvering over the territory, and on September 15 a group of seven was noted flying toward the same area. In mid-October, 1954, goldfinches seen foraging in sunflower patches were in pairs.

Stokes (1950:114) studying the goldfinch's nesting habits in a dry marsh near Madison, Wisconsin, found territories were only 95 feet in diameter in an area of favorable habitat. He found that the territory, including the nest site, did not necessarily provide food, water, or nesting material. Territorial defense was strongest at the beginning of the nesting cycle, and was much reduced by the time the young had hatched. Nickell (1951:450) found three nests within a 50-yard radius in a dry swamp habitat, and concluded that the species is highly tolerant. His findings contrasted with those of Drum (1939:71-72) in a different type of habitat. The latter author found that territories were vigorously defended by the male, and sometimes also by the female, and that feeding areas were sometimes a mile or more from the nest.

**Pipilo erythrophthalmus** (Linnaeus)

Red-eyed Towhee

*Status.*—The towhee is moderately common throughout most of the year on the Reservation. However, the breeding population present in summer is of a subspecies different from the one present in winter. It is not definitely known whether there is seasonal over-
lapping between the summer and winter populations. Representatives of both populations may be present for a short time in April. Towhees have not been definitely recorded in September; there may be a period in autumn when neither population is represented on the area.

**Habitat.**—Blackberry thickets at or near the edge of woodland seem to provide the essential habitat feature for the wintering population. The birds seem to do much of their foraging in the ground litter beneath these thickets, and in their daily routine they shift from one thicket to another, spending relatively little time in other situations. They are seen most often away from thickets at times when the ground is snow covered and food is scarce. In summer the same blackberry thickets are used by the breeding population, but these towhees also use a variety of other situations. Thickets of wild plum, crab apple, fragrant sumac, osage orange, and locust along roadsides, streamsides or woodland edge provide preferred habitat. Territories may also include parts of the woodland where the crown canopy is not continuous and there is underbrush.

**Movements.**—The earliest spring records of the recently arrived singing males for the years 1951 through 1957 were: March 19, March 28, April 19, April 4, April 14, April 14, and April 6. Late dates of singing for the breeding population are: August 21, 1953; August 13, 1954; and August 10, 1956. Each year territories were established in the area of the Reservation headquarters. Most complete information was obtained in 1953, 1954, and 1956. In each of those years sizes of territories covered by singing males were measured. In 1956 there were two contiguous territories of 6.7 and 4.4 acres, one consisting of two woodland edge areas separated by a field, and the other consisting of three such units (Fig. 24). The towhees crossed the fields from one to another of the thicket areas—a maximum distance of approximately 500 feet, but they did none of their foraging there and ordinarily they stayed in the edge of the woods. In 1954 the same area was divided between three territories, of 4.7, 2.4, and 1.9 acres, of which only the largest had separate units. In 1953 there were two territories with 6.2 and 4.2 acres, the larger divided into separate units. Pursuits were observed from time to time. Only males were involved. In at least one instance the same tree was used by two different males for singing, on different occasions. On 14 occasions the distances between males, in adjoining territories, singing and answering each other, were recorded. These distances ranged from 1000 feet to 100 feet and averaged 238. If this distance represents the average
Fig. 24. Territories of spotted towhees, as revealed by singing stations of males (dots) in 1954 and 1956. Activity centered in blackberry thickets about margins of a field. In 1954 territories were relatively large; one encompassed the entire east end of the field and adjoining woodland. In 1956 most of this area was divided between three smaller territories. Although the towhees usually kept to woodland edge tangles, they occasionally crossed open fields. Routes followed in two such crossings in 1954 are shown by arrows in upper figure.
diameter of a territory, the latter would cover approximately 4.1 acres. This figure agrees fairly well with the 4.4-acre average of the seven territories actually measured. In the nesting season of 1955 territories near the Reservation headquarters were not continuously occupied. Towhees arrived on April 13 and singing and chasing were noted frequently in the following three weeks. Then they disappeared from the area and were not recorded again until June 30.

On several occasions a surprising degree of tolerance was noted between cardinals and towhees, which might even sing from the same tree simultaneously with no indication of hostility.

Towhees wintering on the area were much more vagile than those present in summer. A series of 50 distances between successive captures in males averaged 492 feet (2080 to 40) indicating an average home range of approximately 17.4 acres. Females probably wander less widely. Of 16 towhees that were banded and recaptured, 11 were males, three were females and sex was unrecorded in two. One female was caught four times in succession at the same place, and nowhere else. Another female made a movement of 220 feet and then was caught twice in the same place, and the third female made a movement of 380 feet.

Barbour (1941:593) studied wintering populations of the red-eyed towhee in eastern Kentucky. He found them to be associated in loosely organized flocks. Only 23.7 per cent of the towhees in these flocks were females, and Barbour surmised that the females tend to migrate farther south than the males. One flock covered an area of approximately 31 acres, another 9.4 acres.

**Ammodramus savannarum** (Gmelin)

**Grasshopper Sparrow**

*Status.*—Occasional resident or transient.

*Habitat.*—Grassland.

* Movements.*—In the first week of June, 1958, one was seen and heard several times, singing in fields north of the buildings on the Rockefeller Tract. When followed, it moved about in an area approximately 500 feet in diameter, including parts of two fields that were formerly cultivated and the northwest part of the adjacent
pasture. In early July, two were singing in the northern part of the pasture. No grasshopper sparrows have been recorded on the Reservation.

**Passerherbulus caudacutus** (Latham)

Leconte Sparrow

*Status.*—Transient and temporary resident in spring and autumn, and occasionally in winter.

*Habitat.*—Dense grass.

* Movements.*—Specific dates recorded are: October 23, 1953; November 2 and 6, 1954; March 11 and 14 and October 21 and 23, 1955; several times from March 22 to April 14, 1956; and on March 12 and October 17, and October 24, 1957.

**Pooecetes gramineus** (Gmelin)

Vesper Sparrow

*Status.*—Occasional transient.

*Habitat.*—Meadows and fields; patches of bare ground seem to be essential.

* Movements.*—On October 14, 1949, two were seen in a hilltop field of brome grass near the quarry, in the wheel tracks where there was little vegetation. On April 10, 1957, one was watched as it foraged in an almost barren field at the south edge of the Rockefeller Tract.

**Chondestes grammacus** (Say)

Lark Sparrow

*Status.*—Occasional summer resident.

*Habitat.*—Meadows, pastures and short-grass prairies where there are occasional trees.

In 1948 and earlier, when livestock grazed the area keeping herbaceous vegetation cropped short, lark sparrows were of much more general occurrence.

* Movements.*—Earliest records are: April 7, 1952, and April 11, 1953. An old eroded upland cornfield in the northeastern part of the Reservation had lost most of its topsoil and become dissected with deep gullies in the nineteen thirties. By 1952 the vegetation was still sparse, consisting chiefly of three-awn grass, lespedeza, and bindweed; patches of bare ground remained. Because of its barrenness this area was still used by lark sparrows after they had disappeared from other parts of the Reservation. On June 11, 1952,
a pair seen in this field behaved as if they had a nest nearby. On June 11, 1954, in another part of the field, a bob-tailed fledgling was flushed, and the parents were nearby. On April 11, 1953, and May 29, 1955, lark sparrows were seen in the meadow near the headquarters. On the latter date a male and female were moving about together, and the male repeatedly chased away another male in different directions from an area of approximately 300 feet by 500 feet across a gully beside which there were several perch trees. On April 5, 1956, a group was seen foraging at the northwest corner of the Reservation where bluestem prairie had been burned off the previous month, and new grass was beginning to appear.

In 1957 lark sparrows were present in abundance on the Rockefeller Tract, in formerly cultivated fields and a pasture. Most arrived in the first week of May. One pair was observed and followed frequently in the second week of May, this pair moved about in an area that was 1050 feet across in one direction and 650 feet across in another. The entire area encompassed by the birds' movements was more than 15 acres, but foraging was concentrated in relatively small parts of it, usually within 100 feet of woodland edge, or of isolated trees. An adjoining pair had a territory 700 feet across, and they were seen to defend both boundaries against their neighbors. In foraging, the lark sparrows of a pair tended to keep within a few yards of each other as they wandered on open ground. When one flew the other usually would follow within a few seconds. Many territorial encounters were seen. The males were most active in these encounters. They would approach each other with wings drooping and tails spread, and such meetings usually led to fighting or pursuit. In one encounter between two pairs a male seemed sexually excited by the presence of the second pair. After each short flight he would momentarily mount the female.

Junco hyemalis (Linnaeus)

Slate-colored Junco

Status.—Regular winter visitor, usually most abundant of all birds during time it is present on area—early October to late April.

Habitat.—Chiefly open situations; fields, meadows and woodland edge.

There is some habitat shift according to weather conditions. The first juncos to arrive in autumn may be present while weather is still warm, and they tend to keep in deep shade in cool and sheltered situations. When ground is snow-covered they forage mostly
in open fields. To roost, the juncos of a flock usually settle in thick grass—most often they have been flushed from awnless brome grass which is the dominant grass on the Reservation. When fields are snow-covered many roosting juncos have been flushed (usually one at a time) from the protected niches beneath overhanging banks along ditches and gullies.

Movements.—From 1949 through 1957 the earliest records of juncos on the area in fall were: October 22, October 17, October 20, October 4, September 29, October 17, October 24 and October 11. Late records in spring include: April 23, 1950; April 8, 1953; May 6, 1954; April 22, 1955; April 20, 1956; April 25, 1957. A few stragglers remain in spring, weeks after most juncos of the wintering population have left. Likewise in early fall while weather is still mild, weeks before the main influx of wintering juncos, small groups appear.

In several instances the same banded individuals were caught on the area after an intervening breeding season. One male was recorded in each of four consecutive winters, but each winter most of the juncos caught were individuals not recorded in previous years. Of the juncos banded, many were never recaptured. A total of 76 were recaptured at new locations providing data concerning movements. For a total of 122 recorded movements (distances between successive points of capture), the average was 485 feet. Not included in this average are movements of five individuals recaptured after an intervening summer. Distances for these averaged 858 feet, probably indicating that returned migrants altered their home ranges somewhat, according to changed availability of food and shelter or other essentials. For 57 movements of males the average was 604 feet, indicating an average home range of approximately 26 acres, while for 47 movements of females the average was 434 feet, indicating an average home range of approximately 13 acres. These figures apply to the areas where individuals foraged, but do not necessarily include the places where these juncos roosted. Observations on flocks of juncos going to roost or those flushed after dark have suggested that they may travel beyond the usual daytime range to find a suitable roosting place. Loose flocks have been seen streaming across fields and hillsides and gathering in bushes or low trees before going to roost on the ground in thick brome grass. Occasionally in walking across fields of brome grass at night I have flushed juncos in large numbers in areas where none was to be found by day. These may have travelled considerable distances, even from beyond the limits of the Reservation, to find suitable roosting cover.
Spizella arborea (Wilson)

Tree Sparrow

Status.—Regular winter visitor, late October to April, exceeded in numbers only by junco.

Habitat.—Various types of open land and edge situations, usually where there are brush piles or thickets for shelter.

Old fields with weedy mixtures of herbaceous plants provide a type of foraging ground favored by the tree sparrow. Thickets whether at woodland edges or in open fields, are preferred escape shelters. Flocks of tree sparrows mingle with flocks of juncos, but the latter are somewhat more arboreal.

Movements.—Earliest fall records, 1951 through 1957, are November 3, November 12, November 13, October 16, October 29, October 26, and October 23. The latest definite spring record is April 10, 1957. On that date a large wintering flock was still present. Wintering tree sparrows are highly gregarious. Flocks of several hundred may move about and forage together. Often these flocks are mixed with juncos. The two species are sufficiently similar in their habits that they prefer the same type of food and cover, and they seem completely tolerant. Song sparrows also frequently intermingle in the flocks, although they prefer denser low cover and more moist situations. Less regularly, Harris sparrows, white-throated sparrows, cardinals, and towhees associate with the flocks.

A large flock of several hundred tree sparrows stayed in an area that included weedy fallow fields on the Reservation near its western edge and adjoining it, a milo field bordered on one side by an intermittent creek with weeds and brush, and on the other by a county road, and by thickets and debris from a bulldozed hillside. The milo field and bordering thickets comprised approximately five acres, and this was the headquarters of the flock, but their entire range covered a little more than 20 acres, along the creek, and adjacent areas of fields and thickets. The range was some 2200 feet long and 550 feet wide. The flock tended to keep together, concentrated in one small part of the range, and moved about slowly, usually following the line of brush along the edges of the field. Travelling from one part of the range to another the sparrows would move in small straggling groups.

In recaptured banded tree sparrows, distances between successive captures averaged 378 feet, indicating home ranges of approximately ten acres in winter.
Spizella passerina (Bechstein)

Chipping Sparrow

Status.—Migrant and occasional temporary resident in spring.

Habitat.—In the breeding season chipping sparrows choose for territories areas of parkland and groves, with short ground vegetation. Lack of such areas with suitably short ground vegetation seems to prevent establishment of a permanent population on the Reservation.

Movements.—In 1951, in the last week of April and the first two days of May, a chipping sparrow was heard and seen frequently, singing from a large elm beside the house at the Reservation headquarters. It soon disappeared from this area. In early May, 1957, one briefly established a territory on the Rockefeller Tract. This sparrow was nearly always heard singing from the same large elm, in the edge of woodland adjoining a cultivated field. It disappeared within a week of the time it was first noticed.

Spizella pallida (Swainson)

Clay-colored Sparrow

Status.—Occasional transient.

Habitat.—Thickets and woodland edges.

Movements.—The only record is of an individual foraging in short grass and weeds beside the Reservation residence at mid-day on April 29, 1951.

Spizella pusilla (Wilson)

Field Sparrow

Status.—Regular summer resident; one of most abundant birds from April till October.

Habitat.—Border between woodland and grassland, and especially former pastures and cultivated fields that are in process of growing up into thickets.

Since cultivation and grazing were discontinued on the Reservation in 1948, the habitat has steadily improved, as brush and saplings have encroached into the fields. Occasionally, field sparrows have been found established in woodland, where canopy was open and understory vegetation was not dense. So far as observed, they occupy open areas only where thickets are available.

Movements.—Field sparrows appear on the area earlier than any
other summer residents that do not spend the winter there. Table 3 illustrates the seasonal schedule.

Each year singing was first heard on mild sunny days of late winter. Such early season singing was of a peculiarly subdued quality. With the return of stormy or cold weather, singing stopped altogether for periods of days, or even weeks. In February and

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<td>1957</td>
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ejearly March the sparrows were present in small numbers, and newcomers might arrive gradually over a period of weeks. By mid-April most or all had arrived and established themselves in territories.

At this time of year males sing persistently from elevated perches wherever these are available in the territory. Males usually sing from perches five to twenty feet above the ground. In singing the bird is usually perched well inside the crown of the tree, and almost never perches on the top, unless it is a small sapling. Arrival of additional field sparrows makes necessary readjustments of territories as those established early are compressed. On March 26, 1954, only one field sparrow was present in the field near the Reservation headquarters. As it moved from tree to tree singing along woodland edge it was followed for a distance of 820 feet, indicating an unusually large territory. At times when the sparrows were present in normal numbers 500 feet seemed to be about the maximum diameter of any territory.

Even in April, territoriality may be temporarily suppressed in inclement weather. This was strikingly demonstrated when as many as six field sparrows were caught simultaneously in the same funnel trap in rainy weather. In rain singing stopped. The spar-
rows were reluctant to forage in their usual place, in high grass where their plumage might soon become soaked; instead they congregated in open places chiefly along the road. Several pairs might forage within a few square yards, with no evidence of hostility, although the area involved was within the territory of one pair and beyond the usual boundaries of the others. With the return of clear weather the sparrows withdrew to their established territories with resumption of singing, and intolerant behavior toward intruders. However, even in mild weather singing and territorial behavior was much more prominent in the morning and was partly suppressed later in the day, with some intermingling between different pairs.

The approximate extent of a territory could soon be determined by flushing a singing male from perch to perch. Within a few minutes he would make the circuit of his territory. Seven territories that were traced in some detail, in 1952, 1953, 1954, and 1956, averaged 1.6 acres (2.5, 2.2, 1.8, 1.6, 1.4, 1.0, .8). The largest were those that extended over open areas. Those that were relatively small were partly beneath trees and in brushy places.

In 1950, 38 pairs were located in an area of approximately 300 acres, the northwestern half of the Reservation. They tended to be linearly arranged in edges of fallow fields and former pastures bordering woodland. In a few instances there were intervals of hundreds of yards between pairs, but in most instances territories were contiguous and actual distances between the birds of adjacent pairs were 100 to 600 feet. For 46 such intervals the average was 320 feet. A territory of this diameter would cover 1.8 acres.

Territorial fighting and pursuits were seen frequently, especially in April. In 1954 a remarkably prolonged territorial quarrel was observed. On April 6, when the population was increasing rapidly through an influx of new migrants, two males were noticed perching and hopping about nervously within a few inches of each other, each trying to round up the other and force it back. There was no actual fighting, and neither bird would give ground. On April 13 two males, probably the same, were observed in the same area, and there were frequent long chases. Both males had been banded. The pursued sparrow, always the same, fled consistently but would not leave the territory. Several times the chase led to a female, who did not participate in the quarrel. After several hours the chase was still in progress. It was continued on the following day. Seldom more than a few seconds elapsed until the aggressor renewed
the pursuit, and the birds might be in motion 30 seconds or more before the next pause. As before, the pursued persistently remained within the disputed area, and the pursuer, so far as observed, did not press to the point of actual attack. Continuations of the pursuit were observed on the 16th, 19th, 20th, 23rd, 24th, and 26th. Whenever the pursuer flew back to the female he was followed by the other male, whose presence distracted him and disrupted the normal course of courtship and nesting. Eventually the pursuits became less spirited, with longer intervening pauses, during which the pursued, the pursuer and the female perched or foraged in close proximity. On the morning of April 26, the pursuing male was bedraggled in appearance, with feathers disarranged and some missing. Obviously the continuous tension was telling on him. The pursued showed no such effects. However, the pursuer may have become involved in fights with other outsiders and could not have maintained his boundaries against adjoining pairs while distracted by the rival within the area. Later the same day he was located singing in a more open and less favorable area beyond the limits of his former territory. It seemed that he had abandoned both territory and mate to the interloper whom he had failed to dislodge in two weeks of almost unremitting effort.

In 1953 the same territory contested by these two males was occupied by different individuals. The bob-tailed male was color-banded on April 6, probably soon after his arrival. On April 7 he was seen associating briefly with each of two different females, one of which had been color-banded. On April 8 he had obtained a mate, and the pair moved together about the territory. As they foraged near together on the ground, movements involved a steady advance of the male, and retreat of the female to avoid actual contact. When the male moved toward her for a few inches, the female would quickly hop away, maintaining her distance, and then would pivot around facing the male or standing broadside to him. However, whenever the male flew, she promptly followed. Later in the day the male became increasingly aggressive, and frequently would cause the female to flush and would chase her back and forth across the territory several times without pause. Finally he caught her, and both fell into the wet grass, fluttering and pecking. They lay sprawled and interlocked, fluttering feebly and pecking at each other for more than two minutes. The female broke away but immediately the male gave chase and caught her, and again they fell into the grass, interlocked, and remained there almost as long
as they had the first time. After disengaging, they flew to a foraging place preening and shaking, the hostilities ended. On the following day the female was no longer present. The male’s overly aggressive and hostile behavior may have caused her to desert the territory, and for several weeks thereafter the male remained unpaired.

Singing reaches a peak in April and tapers off later in the season. In April song may be heard at any time of day, or even at night. In June and July singing occurs chiefly at daybreak. Occasionally singing is heard in August and early September.

On several occasions the development and dispersal of broods were observed. On October 2, 1952, three or four fledglings of an unusually late brood, probably just out of the nest, were chirping within an area of a few square yards. On the following day they had shifted about 70 feet farther east and were more scattered, still concealed in high grass. The adults were delivering food frequently. On the following day they had moved still farther in the same direction. Two were flushed 200 feet and 270 feet from the original location. They were still bob-tailed (tails less than one inch long) and their flights were short and weak. On October 7 one was observed near the same place it was seen October 4. It had emerged from the grass, and was fluttering about in a bush as the adults came to feed it at frequent intervals. On October 8, one was near the same place perched ten feet above ground in a small tree, chirping steadily. The two other young were chirping in bushes 30 feet farther southeast. One hopped and fluttered along the ground to the base of the tree where the first young bird was perched, and an adult came and fed it there. Soon afterward the young that was perched ten feet high flew strongly for 100 feet west and within a few minutes made several more flights. Late in the afternoon all three young were assembled in the same tree. Their tails were about 1½ inches long. Later one young was seen following an adult as the latter moved about slowly, foraging on the ground in high grass. The fledgling’s peeping changed to more metallic chirps as the adult approached to feed it.

In the following two weeks the family group remained intact and the young and adults were often seen foraging together in or about a dry pond bed some 450 feet east of the nesting area, outside the original territory. By October 21 the fledglings’ tails had grown to full length, and the young birds were able to fly rapidly and strongly. They were moving about freely with no attempt at concealment. On October 24 the fledglings were foraging independently most of
the time though occasionally one would give a juvenal chirp. The young field sparrows were mingling freely with recently arrived juncos and song sparrows, and with field sparrows of other families.

**Zonotrichia querula (Nuttall)**

**Harris Sparrow**

*Status.—* Common winter resident, also migrant in spring and autumn.

*Habitat.—* Thick brush for shelter adjoining open land, with weeds or cultivated crops providing a food supply, are the chief requirements on the winter range in northeastern Kansas.

*Movements.—* In the winter of 1956-1957, a flock of these sparrows made their headquarters in several large brush piles where a grove of osage orange trees had been cut and bulldozed, on the southern edge of the Rockefeller Tract adjoining the Reservation. They foraged in an adjacent field of milo stubble, and ranged across this field to the brushy woodland edge, 900 feet north of the favored brush piles. Also they ranged 800 feet east of the brush piles, in thickets bordering the county road.

Of 71 Harris sparrows banded, only 11 have been recaptured. In eight recaptured within a few weeks of banding, distances (in feet) were as follows: 0, 0, 40, 50, 70, 180, 360, 1030. One that was caught at a brush pile on the Rockefeller Tract was brought to the Reservation headquarters for banding, and released there. Several hours later it was recaptured only 100 yards from the place of release, having remained in the vicinity instead of returning half a mile to the flock and home range. Two of those banded were recaptured in later seasons. One of these, banded March 17, 1955, was recaptured 600 feet farther along the same fence row thicket on February 3, 1956. The other, banded on January 22, 1955, was retrapped on January 28, 1957, 1800 feet away (near the brush pile on the Rockefeller Tract). Harris sparrows have been seen as early as October 5 (1953) in fall and as late as May 10 (1957), in spring.

**Zonotrichia leucophrys (Forster)**

**White-crowned Sparrow**

*Status.—* Occasional migrant.

*Habitat.—* Thickets, especially those at margins of weedy fields.

*Movements.—* On October 30, 1952, one was seen at the brushy edge of a ravine near the Reservation headquarters. On November 8, 1954, one was seen one hundred yards farther east at the pond.
One was trapped with a group of Harris sparrows on February 5, 1958. These are the only definite records for the area, but on October 21, 1951, several were seen in an osage orange thicket beside the county road near the southeast corner of the section.

**Zonotrichia albicollis (Gmelin)**

*White-throated Sparrow*

**Status.**—Regular migrant in spring and fall, and occasional winter resident.

**Habitat.**—On Reservation chiefly in woodland edge thickets.

**Movements.**—Autumn appearances in several years were: October 14, 1949; October 13, 1950; October 17, 1951; October 30, 1952; October 15, 1953. For a week or two after the first arrival these sparrows were abundant and conspicuous in such situations as brush piles, woodland edge thickets, and weedy margins of the pond, but they soon moved on. Spring influxes were noted on April 26, 1951; April 28, 1952; April 21, 1953; April 17, 1954; and April 25, 1956. These migrants were gregarious, and flocks of a dozen or more settled temporarily in thickets providing shelter and food, often remaining two or three weeks. Latest spring records are May 8, 1954, and May 4, 1956. The woodland edge thickets between the pond and the Reservation headquarters had a flock almost every spring. At times their song was one of the most prominent in the spring chorus. They were usually associated with Harris sparrows. Occasional individuals remain all winter in the same situations where flocks are seen in spring and fall. One banded on December 9, 1954, was recaptured regularly (14 times in all) up to April 10, 1955. The area encompassed by its records was 700 feet long and 150 feet wide. The flocks present in spring have often been seen feeding in trees, on leaf buds and seed clusters of elm, while in autumn seeds of weeds seem to provide most of the food.

Borror (1948:428) found that migrating white-throated sparrows settled temporarily in “stopover ranges” up to an acre or two in size (average of greatest distances between captures for 74 repeaters was 58 yards). Borror found that in fall the stay was somewhat longer and the range somewhat larger than in spring. Fischer and Gill (1946:407) in a report based on analysis of the data from 43,000 banded white-throated sparrows, found that returns from the birds banded while on migration were rare.
Passerella iliaca (Merrem)

Fox Sparrow

*Status.*—Occasional transient.

*Habitat.*—Woodland thickets.

*Movements.*—Recorded from the Reservation on only a few occasions. On November 5, 1954, several were seen in weed thickets near the edge of the pond. These birds must have settled temporarily in the vicinity, as they were seen frequently through November 17. R. W. Fredrickson reported seeing one on October 23, 1955. On March 1, 1956, one was seen at a weed patch beside the pond. It had perhaps stopped for the day at this place, as it was seen twice, with several hours intervening.

Melospiza lincolnii (Audubon)

Lincoln Sparrow

*Status.*—Regular transient and temporary resident.

*Habitat.*—Low, dense thickets in swampy places; on Reservation thick grass is usual habitat.

*Movements.*—Arrival dates recorded over several years were April 28, 1951; April 25, 1952; April 25, 1953; April 10, 1954; April 26, 1956. Curiously, none was seen in the spring of 1955. In 1952 one was banded and was caught a total of six times within the period April 27 to May 7. All captures were made with live-traps set for mice, and all were well within the area covered with traps in a 50-foot grid. The most remote points of capture were 500 feet apart; however all but the first capture were within a 30-foot radius. Although only one other banded Lincoln sparrow was recaptured (50 feet from the original site), the impression is borne out that individuals stopping on their northward migration settle for periods of days or weeks in small areas. Patches of foxtail grass (*Setaria viridis*) near the edge of woodland at the Reservation headquarters were much used by these sparrows in late April, 1956. When disturbed, they would fly back to brush a few yards away, and were seen at these small grass patches many times daily. In 1956 the sparrows were observed in much greater numbers than they had been in any previous year. One was seen on October 13, 1955, and in the last week of September, 1956, and on October 1,
many were seen at the foxtail patches near the headquarters. Another was caught many times at the same brush pile in late December, 1955, indicating that occasional individuals winter in the area.

**Melospiza georgiana (Latham)**

**Swamp Sparrow**

*Status.*—Rare migrant.

*Habitat.*—Swamps and marshes.

*Movement.*—R. W. Fredrickson reported one on April 14 and another on April 27, 1952. On several other occasions in late autumn swamp sparrows have been flushed from a patch of smartweed beside the dry pond bed.

**Melospiza melodia (Wilson)**

**Song Sparrow**

*Status.*—Regular winter resident, present in abundance from October into April.

*Habitat.*—Fields, meadows, and marshy places with dense ground vegetation satisfy the habitat requirements of the song sparrow in winter. Fence row thickets of dogwood, various saplings and vines are frequented, and brush piles provide preferred escape covert. Greatest concentrations were noted in marshy areas about the edge of the small pond, where there were tangles of smartweed, rice cutgrass, cat-tail and other marsh vegetation. In old-field areas with weedy mixtures, patches of foxtail grass (*Setaria* sp.) provided preferred types of food and shelter.

*Movement.*—From 1952 to 1957, inclusive, October appearances of immigrating song sparrows were on the 19th, 11th, 5th, 17th, 21st and 16th. Last dates of record, in April each year from 1953 through 1956, were the 24th, 10th (except for a transient heard singing on the evening of June 3), 20th, and 26th. Though requiring dense cover, a song sparrow having settled in its winter quarters requires only a small area. For 29 banded and recaptured song sparrows, distances between successive capture points, representing a total of 35 movements, ranged from 1040 feet to 40 feet and averaged 300 feet. Assuming this distance to represent an average home range radius, home ranges of approximately 6.8 acres are indicated. The records of one individual caught eleven times in the winter of 1953-54, encompassed 8.9 acres. Only one individual was recaptured in the same winter range after an intervening summer.
SUMMARY AND CONCLUSIONS

In this study of spatial relationships, 3 species of fish, 10 of amphibians, 24 of reptiles, 29 of mammals, and 167 of birds are discussed. In an area under observation so regularly and intensively as the University of Kansas Natural History Reservation, the negative evidence obtained through the lack of records of species that might be expected to occur is significant. For example, among the species recorded in Douglas County, or on all sides of it, but never recorded from the Reservation itself, there are five kinds of amphibians, 22 kinds of reptiles, 20 kinds of mammals, and 131 kinds of birds. Many of these are rare species which might be expected to appear only at widely spaced intervals, and several of them perhaps ultimately will appear on the Reservation. Another large group of species are those characteristic of extensive fluvial or marshland habitats that are not represented on the Reservation. A total of 81 species belong to this category. They include river turtles, water snakes, beaver, otter, mink, loons, grebes, herons, ducks, shorebirds, terns, and others. Among the mammals are eight species of bats which might be expected but have not yet been recorded because of inadequate sampling. Approximately 26 species are characteristic of prairie habitat, and presumably do not occur on the Reservation because of the limited extent, isolation, or unsuitability of the prairie relict there. About the same number of kinds are characteristic of deciduous forest habitats of the eastern United States (notably the warblers, among birds).

Among those species that have been recorded from the Reservation approximately half the total reach the area only as wanderers, and have no permanent population on the area. These include the tiger salamander, spadefoot toad, painted turtle, woodchuck, house cat, American rough-legged hawk, goshawk, bald eagle, killdeer, Franklin’s gull, barn owl, belted kingfisher, and a number of other kinds of birds that merely fly over the area, without stopping on it. Also included in this category are the great majority of individuals of Woodhouse’s toad, muskrat, starling, house sparrow, marsh hawk and perhaps a few others, although individuals of each of these kinds has been known to live on the Reservation.

There are few species, if any, which wander completely at random. However, there seems to be no clear-cut line of demarcation between those that habitually wander and those that occupy definite home ranges. All degrees of intermediacy have been found between the two categories. The snapping turtle may be considered
a typical representative of the species with strongly developed nomadic tendencies. At times individuals of various sizes and of both sexes wander for long distances up and down the intermittent stream courses. They also may frequent certain pools or ponds or sections of a stream, habitually using an available shelter or food supply. That a home range having definite boundaries exists is not demonstrable. In the bullfrog, leopard frog, narrow-mouthed toad, cricket frog and chorus frog, wandering tendencies are marked, and the animals' habits of staying at the same pool, or beneath the same rock, for periods of days or weeks may be forced upon them by drought limiting their movements, rather than by any affinity for the location where the animal happens to be. In the American toad and Woodhouse's toad, an individual returns regularly to the same diurnal shelter, over periods of days or weeks, at least, and emerging to forage in the evening, it may cover more or less the same area on successive occasions. However, even in these animals, the home range seems to have no definite limits, except where natural barriers prevent free movement, and wandering tendencies may at almost any time cause the toad to shift to a new area more or less remote from its former range.

In most kinds of lizards, snakes, small mammals, and birds for which sufficient data were obtained, the trend was somewhat similar, with varying degrees of attachment to a familiar area, but with, at best, vaguely defined boundaries that are subject to frequent alteration, and with occasional wandering. Dice and Clark (1953:10) have emphasized that one respect in which home ranges differ from territories is the poorly defined boundaries of the former, and they have suggested defining the home range in terms of the average radius, rather than as a definite area.

In a few species, notably the collared lizard, the larger snakes (Coluber, Elaphe, Agkistrodon), the blue jay, and (in winter) chickadee, titmouse, and cardinal, attachment to a home area is strong, and the same adult may remain for periods of years in approximately the same range. In these same species other individuals may wander, both frequently and extensively, and the average occupancy of an area is short.

Territoriality exists in most of the species of birds that breed on the area, and is less developed in the collared lizard, the woodrat and perhaps a few other kinds of small mammals. In its most typical form a territory constitutes a defended home range, and possession of a well defined home range is a prerequisite to ter-
ritoriality. All stages in the development of territoriality were seen in the numerous species investigated. In some, like the skinks (*Eumeces* sp.), the possession of a regular home range is associated with hostility (in the adult male, especially in the breeding season). Fighting is frequent, and the establishment of a true territory is perhaps prevented only by the retiring and secretive habits, which normally prevent detection of a rival until it has come within close range.

Among the birds there are relatively few kinds having permanent territories that live on the area; the red-tailed hawk, horned owl, barred owl, hairy woodpecker and Carolina wren are the most typical of those kinds that do have permanent territories. Even in these species territorial boundaries are flexible, and are subject to seasonal alteration. In other species, some of which may remain permanently mated, territorial boundaries are largely dissolved at times of year other than the breeding season. A pair may continue to use its former territory, but at the same time may mingle with other members of a social group, and range over a much more extensive area than the territory had encompassed. The blue jay, crow, tufted titmouse, black-capped chickadee, downy woodpecker and red-bellied woodpecker are among the best examples of this group. In contrast, only temporary and seasonal attachment to territory and mate is characteristic of the bob-white, mourning dove, Cooper’s hawk, bluebird and goldfinch among resident species. Most species of birds that breed on the area make annual migrations, abandoning both territory and mate. The territory seems especially subject to alteration, and may change continually in size, shape and position, according to immediate needs at the particular stage of the nesting cycle in these species that have only temporary attachment to it.

Size of territory is somewhat characteristic of each species. Among the migratory species, males that are early arrivals in spring may occupy unusually large territories; an instance is cited in the species account of the field sparrow. In this sparrow the breeding population increases over periods of weeks and the new arrivals must usurp parts of areas that are already occupied in order to establish their territories. The males or pairs that are established early are then subjected to increasing territorial pressure, with enforced retrenchment. In many other species, whose populations are sparse, including the barred owl, Carolina wren, bluebird, wood
thrush, Kentucky warbler, and summer tanager, a pair establishing a territory was usually subject to but little territorial pressure or to none at all, because territories seldom occupied adjoining areas. Even under these conditions, the pair usually tended to confine their activities to a relatively small central area, which perhaps should be considered the whole territory, but the daily routine was varied from time to time by visits to any of several outlying points.

For territories and home ranges alike, one of the chief factors determining size was the distribution of suitable habitat. Where the essential features of the habitat were scarce and scattered, the individual was forced to cover a relatively large area. This is well illustrated by the red-tailed hawk territories shown in Fig. 11; the one including a high proportion of cultivated land, unproductive of prey was consistently larger than the other. A more extreme example is provided by the territories of towhees shown in Fig. 24. Blackberry thickets at the edges of woodland were the essential features and the territory might include several of the thickets and also intervening areas of less favorable habitat—brush, groves, or even open fields. Towhees crossed the fields regularly in moving from one blackberry patch to another. Although they did not forage in the fields, they occasionally did stop in isolated trees to sing there. Therefore, part of a field might be considered part of a towhee’s territory, even though it furnished neither food nor shelter, and was significant to the bird only as an intervening space, to be crossed at some hazard. In the mourning dove and goldfinch, activities are still more extended; in some instances foraging areas are so remote from the nest that they could not be construed as part of the territory, and intermediate stages of all degrees exist.

Odum and Kuenzler (1955) have emphasized the ephemeral nature of territories in many kinds of birds, and have described fairly rapid alteration in size and shape. They imply that territories become progressively smaller later in the season, with the transition from nest building to incubation, to feeding of young. Most territories are established early in the breeding season, and the pair, having successfully defended their chosen area against interlopers during this stage, may not be required to withstand much territorial pressure in later stages. Rather, they may be free to wander through the original territory, and to concentrate on those parts of it that best satisfy their seasonal requirements.

In certain kinds of birds, exemplified by the raptors, phoebe, chickadee, titmouse and others, the members of a pair share more
or less equally in defense and utilization of their territory, and characteristically travel together. In other kinds exemplified by the horned lark, the redwing, the indigo bunting and the dickcissel, the sexes differ greatly in habits, and territorial defense devolves chiefly upon the male. He moves about more frequently and more conspicuously than the female, and usually covers a somewhat larger area. In mammals, although most are not clearly territorial, the same tendency toward a larger range in the male was manifest. In the opossum, fox squirrel, gray squirrel, deer mouse, and prairie vole, the male's range is markedly larger than the female's. In the cotton rat, harvest mouse, white-footed mouse and cottontail, the difference between the sexes, in size of area covered, is slight. In the larger snakes (garter snake, yellow-bellied racer, black rat snake, copperhead) the adult male's range is at least twice the size of the female's, and in the common lizards including collared lizard, Great Plains skink, and glass lizard, a comparable disparity exists. The six-lined racerunner seems to be a notable exception to the general trend, as the female's range averaged 40 per cent larger than the male's, in my sample.

In general, young animals ranged less widely than adults of the same species. As the young animal grows and becomes familiar with its surroundings, it gradually increases its range. Although individuals of some kinds of animals remain permanently near the place where they were born, dispersive wandering is characteristic of the young of most kinds. In amphibians dispersal occurs chiefly at the time of metamorphosis, and in reptiles it may occur after birth or hatching. In mammals the dispersal takes place after weaning, and in birds usually just after the fledglings have learned to forage for themselves.

Among the factors that determine size of home range, potential mobility of the animal is, of course, important, but the correlation is not close. The smallest home ranges, less than half an acre in area, were found in lizards, toads, voles, the woodrat, and the white-footed mouse—animals with limited capacity for rapid travel. Home ranges or territories in the size range of half an acre to two acres were found in the remaining small mammals, the short-tailed shrew, jumping mouse, cotton rat, harvest mouse, house mouse, and in several species of birds, mostly the smaller kinds, and especially those that live in thick woods or in dense ground vegetation—pewee, Bell vireo, gnatcatcher, long-tailed chat, blue grosbeak, and bob-white. Areas from two to ten acres in extent are occupied
by individuals of most kinds of small birds, by the cottontail, and
the ornate box turtle. Relatively large areas, ten to fifty acres in
extent, are utilized by the larger snakes, including the copperhead,
black rat snake, yellow-bellied racer, and common garter snake, by
certain birds, including those that are persistent fliers—the horned
lark, barn swallow, whip-poor-will, chuck-will's-widow and hairy
woodpecker—and by various small passerines on their winter ranges
when they are not territorial—junco, tree sparrow, towhee, chick-
adee, and titmouse. The opossum, fox squirrel, and gray squirrel
also have home ranges within this size range. Territories and home
ranges larger than 50 acres were found to be maintained by only
a few kinds of vertebrates, nearly all of them predators and all rela-
tively large. They include most, if not all, of the hawks and owls
living on the area (the screech owl is a probable exception), the
turkey vulture, the coyote, red fox, spotted skunk, and white-tailed
deer.

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