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HABITAT PREFERENCES AMONG REPRESENTATIVE WINTERING AND BREEDING BIRDS OF THE CENTRAL OKLAHOMA FOREST-PRAIRIE ECOTONE

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CHAPTER I

INTRODUCTION

For centuries ornithologists the world over have been studying and trying to reach an understanding of bird distribution. Much of the work has always been, in essence, ecological, though only recently have such terms as "biomes" and "biotic communities" been widely used. Breeding birds have received the most attention by far. Lack (1933) studied the effects of afforestation on the breeding bird population of a sandy heath area in Britain. Lack and Venables (1939) directed a group of observers (members of the British Trust for Ornithology) in a general inquiry concerning the habitat distribution of British woodland birds. Southern and Venables (1939) made observations in Swedish Lapland on the habitat selection of birds in a subarctic birch forest. Bird (1930) summarized briefly the distribution of common birds found in several major aspen parkland habitats in central Canada. Van Deventer (1936) analysed the habitat preferences of four species of winter birds in western New York. Kendeigh (1946) investigated the breeding bird population of a beech-maple-hemlock community on the Helderberg Plateau, New York.

Kendeigh (1941) observed the distribution of breeding birds in a tall grass prairie plot in Iowa. Beecher (1942), while censusing the breeding birds of a 482-acre area of marsh and upland near Chicago, studied the relationship of vegetation to nest site, shelter, food supply, etc.

Pitelka (1941) and Odum (1945) discussed the distribution of birds in relation to the major vegetational types in this country; both reiterated the concept that with few exceptions birds are not restricted to particular species of plants but rather to vegetation of a particular "life-form." Odum stated:

> ...many species have distinct preference for coniferous forests, but it may not make much difference whether it be spruce, fir, or hemlock. Thicket birds select brushy growths of a specific density rather than of a particular shrub species. Grassland birds may be equally at home in beard grass, mesquite grass, or bluegrass, if the stands are of the same general density or appearance. More adequate means of measuring the importance of this "structural" feature of the vegetation are needed.

Ornithological Study in Oklahoma

Many persons, from Thomas Nuttall and Thomas Say to the compilers of today's Christmas censuses, have studied birds in Oklahoma. The ornithological work accomplished between the very beginning (1719) and 1931 has been reviewed in detail in the state's principal bird book, Margaret M. Nice's "The Birds of Oklahoma" (1931). The history of ornithology at the University of Oklahoma has been reviewed by Johnson (1952). Two major ornithological enterprises are now under way: a fully illustrated "Birds of Oklahoma" by Frederick M. Baumgartner and Marguerite Baumgartner, of Oklahoma A. & M. College, and a "Check List of Oklahoma Birds" by George M. Sutton, of the University of Oklahoma. In connection with the latter work about a dozen county check-lists are being prepared by as many

observers.

Purpose and Scope

Because of its unique geographical position and great variety of habitats, the state of Oklahoma offers unusual opportunities for students of ornithology, especially in the fields of taxonomy and ecology. Since vegetation is a prime determiner in the distribution of birds, broad ecotone areas are of special interest. Here there is a variety of strongly contrasting habitats. The present problem is an attempt to determine the pattern of distribution of wintering and breeding birds in central Oklahoma through study of the habitat preferences of several species in many vegetational types or "life-forms" of the forest-prairie ecotone. In the present state of knowledge such a study, though necessarily of a general nature, is probably of more value than a concentrated study of a few species or vegetational types. Much supplementary information is presented concerning stratification, feeding habits and food, general climatic effects, etc. These topics, all of which are related in greater or lesser degree to the distribution of birds, are discussed under each species. The summarizing discussions at the ends of Chapters III and IV are concerned principally with the central problem stated above.

Methods and Materials

It was apparent from the beginning that a full discussion of all species of birds known to winter and breed in central Oklahoma would not be feasible. Consequently, a method had to be devised whereby I could determine (a) which species were representative of the forest-prairie ecotone, and (b) what habitat factors were of greatest importance to

these birds. For the study of wintering birds I systematically surveyed two large tracts which I felt included most of the major vegetational types within the ecotone, and for breeding birds I censused three forest plots and one prairie plot. The words "survey" and "tract" are used here only in connection with wintering birds, "census" and "plot" only with breeding birds. The vegetation within the forest plots was nearly uniform, but these plots were chosen purposely because they were close to several other vegetational types (forest edge, open fields, wooded ravines within the savannah, etc.). The prairie plot, chiefly open pasture, and by far the largest of the plots, had within it several vegetational types.

The tracts and plots were believed to be representative of the ecotone, vegetationally speaking, so the 41 species of wintering birds and 43 species of breeding birds encountered on or near these study areas were, at least to some extent, representative also. Discussion of these birds goes considerably beyond the information obtained in my systematic study of the tracts and plots. While those data are of considerable interest and serve as an effective check, my concepts are not based solely, or even in large part, on them. Observations made on numerous field trips since 1952 form the primary basis for most of the discussions. Species notes have been kept since 1952; the majority of the observations were, however, made in 1954-55.

For identification of trees I carried a pocket manual (Phillips et al., 1950). Special tools employed were: telephone lineman's climbing irons; a small machinist's mirror, with adjustable handle, for looking into cavities; a home-made sighting device for calculating heights of trees, nests, etc., from tangents of measured angles. More detailed accounts of methods and materials are given later in the paper.

CHAPTER II

THE FOREST-PRAIRIE ECOTONE IN CENTRAL OKLAHOMA

The Vegetational Regions of Oklahoma

Detailed accounts of the vegetation of Oklahoma have been given by Bruner (1931), Duck and Fletcher (1943), and others; a generalized summary of these follows. Approximately the easternmost fifth of Oklahoma is covered by well-developed oak-hickory forest not unlike the deciduous forest of the eastern United States in growth form and general appearance. In the state there is a decrease in amount of annual precipitation from east to west, and one finds correspondingly less luxuriant forest from east to west. Thus the well-developed forest grades into forest which is not only composed of fewer numbers of tree species, but also is progressively dwarfed in stature, so that before reaching the halfway point one would pass through a belt of what, in its original condition, was true savannah[1]. Disturbed as it has been by civilization, the savannah has largely been replaced by oak-hickory scrub forest. Within the scrub oak are variously-sized open prairie "islands," which become more frequent to the west. About halfway across the state this condition of

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[1]As used here the term "savannah" refers to open stands of mature trees, with grass undercover, as applied by Oosting (1948) to the fire-maintained coastal plain subclimax of the eastern United States.

intermixed scrub oak and grassland gives way rather suddenly to tall grass or true prairie. The abrupt transition results primarily from a change in available water in different soil types; scrub oak predominates on sandstone soils, grass on soils of limestone and shale origin.

The tall grass prairie is characterized chiefly by bluestems, Indian grass, switch grass, and by an abundance of forbs (non-grassy herbs). Overgrazing has, in various degrees, altered the condition of the prairie; in the extreme case, it has reduced the original vegetation to short grasses such as buffalo grass and the gramma grasses. Due both to disturbance by man and to variations in local edaphic and physiographic conditions, numerous and various grass communities occur throughout the prairie. Farther west there is, as a result of increasing aridity, a gradual change from the tall grass to the mixed grass prairie, the latter characterized by an intermingling of short grasses with scattered growths of several taller species. In the extreme northwestern portion of the state and in the entire panhandle, the mixed grass prairie gives way to the short grass-high plains.

In the floodplains of the major rivers and on sand deposits on the north sides of the rivers, most of which flow in a southeasterly direction, tongues of eastern deciduous forest extend far out into the prairie. Although westward the trees decrease in size, luxuriance, and number of species, these ribbons of forest are more or less continuous well into the western portion of the state, becoming intermittent and eventually quite sparse where the rivers flow through the short grass-high plains.

The Oak-Hickory Savannah

Two major plant formations are found in Oklahoma, the Deciduous Forest and the Grassland. The former occupies most of the eastern half of the state and is represented chiefly by the oak-hickory association; in the Ouachita Mountains of the southeastern corner occurs the relatively small oak-pine association which is separated from the northeastern Ozark climax oak-hickory forest by a rather narrow strip of oak-hickory savannah. The savannah connects to the west with an unbroken north-south belt fifty or more miles wide running completely through the state. The approximately 17,600 square miles of savannah include fingers reaching as far west as Major, Woodward, Dewey, and Comanche counties (Duck and Fletcher, 1943). It is continuous with the "cross-timbers" of Texas, and extends northward a short distance into Kansas. The topography of the savannah is rough, due to the differential weathering of alternate layers of shales and resistant sandstones, but rolling plains and alluvial flats occur in the valleys of the larger streams (Blair and Hubbell, 1938). On the east the savannah is bounded for most of its length by the climax oak-hickory forest, the border not being sharp since one vegetational type changes gradually into the other. In contrast, the western boundary of the savannah is quite distinct, occurring with the rather sudden transition from sandy soils to clay soils. In Cleveland County this boundary is about three miles east of Norman and runs more or less directly north and south.

The savannah is characterized by a scrubby growth of blackjack oak, Quercus marilandica, and post oak, Q. stellata, usually associated with lesser numbers of black hickory, Carya texana. The word "savannah"

is used here in reference to the present-day scrub forest which occupies the area in Oklahoma once characterized by open stands of mature trees, with grass undercover. It should be pointed out that in the undisturbed original condition the same species of trees were of substantial size and their density was such that a team and wagon could be driven easily among them; the ground cover was little bluestem, Andropogon scoparius, big bluestem, A. gerardi, and other species depending on the site (Duck and Fletcher, 1943). Few undisturbed savannah tracts remain, especially in the western portion. The present abundance of scrubby oaks, which in many localities are almost impenetrable, is due chiefly to overgrazing and other major disturbances, and is characterized by many saplings and seedlings of the two oaks with which are commonly found winged sumach, Rhus copallina, smooth sumach, R. glabra, buckbrush, Symphoricarpos orbiculatus, green briar, Smilax bona-nox, and other shrubs and vines.

Especially in the northern and southern parts of the state, islands and strips of grassland are found among the groves of scrub trees. Much of the native tall grass has been overgrazed to such an extent that little remains. The grass has been replaced by a sparse cover of weeds. Here, as in the true prairie farther west, small groves of persimmon, Diospyros virginiana, occur in some places.

The Tall Grass Prairie

The tall grass or true prairie lies immediately west of, and is distinctly differentiated from, the oak-hickory savannah. Like the savannah, it is a generally north-south belt, and it occupies a little less than half of the western portion of the state. Its eastern boundary

is the savannah, its western the general area of intergradation with the mixed grass prairie. Thus the tall grass prairie occupies the Redbed plains region and part of the Gypsum Hills and Wichita Mountains, and comprises an area of about 20,500 square miles (Duck and Fletcher, 1943). The true prairie of Oklahoma represents the southern extension of the grassland area (Stipa-Koeleria association of Bruner, 1931) extending northward into Canada; the whole area is one of marked fluctuation in precipitation and temperature, strong and desiccating winds, and relatively low humidity.

For the most part the natural vegetation consists of a mixture of such species as little bluestem, big bluestem, Sorghastrum nutans, and Panicum virgatum. In the western portion of the tall grass prairie such short grasses as Buchloe dactyloides, Bouteloua gracilis, and B. curtipendula gradually appear. In addition, an abundance of legumes, composites, evening primroses, etc., are found. Due to the use of most of the land for agricultural and grazing purposes, there are today many communities representing the various stages in succession on disturbed land. Few acres remain which approach the original tall grass prairie type.

Numerous intermittent water courses of differing sizes drain both savannah and prairie; the smaller are generally referred to as ravines, the larger as bottomlands. Those in the vicinity of Norman flow eventually into the South Canadian River. The prairie landscape is broken by the trees, often quite large, which line the ravines. Bottomlands of the larger streams, as, for example, Little River, are used in part for agricultural purposes, but also contain well-developed

forest plots.

The Ecotone Concept

The generalized concept of the ecotone is that of a transitional zone between two vegetational types. According to Odum (1953) it is "a junction zone or tension belt which may have considerable linear extent but is narrower than the adjoining community areas themselves." Carpenter (1938) differentiated between a "first order" ecotone and a "second order" ecotone, defining the former as "the general area between two major climaxes, as between forest and grassland," and the latter as "the boundary communities in an ecotone of the first order, as forest edge communities in the general transition zone between deciduous forest and prairie."

As emphasized by Allee et al. (1949), it is essential to understand that the ecotone is a zone of competition between communities and that its stability is directly affected by changes in the biota of the adjacent communities. Since in the ecotone may be found organisms characteristic of the overlapping communities plus those organisms peculiar to the ecotone itself, the density and numbers of kinds of plants and animals is often higher in the ecotone. The tendency toward increase in variety and density of organisms in the ecotone is the "edge effect" which has been shown to be especially applicable to bird populations. An extensive uniform community, having little edge as compared to several similar but smaller communities with total area equivalent to the large one, would probably contain fewer species and individuals of birds; plots containing several different community types are likely to have a higher

nesting density and variety than areas of uniform vegetation. That is, in effect, the total amount of the edge is increased. Beecher (1942) was able to demonstrate an almost linear positive relationship between nesting density and number of community types (up to four) in a large heterogeneous plot near Chicago. The relatively high density of breeding birds on campuses, in parks, etc., can be explained largely by the high proportion of edge, i. e., number of feet of edge per unit of area, due to a greater variety of vegetational types.

The Ecotone in Central Oklahoma

Bird (1930) stated that "two types of parkland may be recognized in central North America, one between the eastern deciduous forest and the true prairie, which is characterized by oak and hickory groves, and one between the northern coniferous forest and true prairie, which is characterized by aspen groves. Each represents an ecotone or area of stress between a forest and a grassland formation." It is of course the former type into which the parkland or savannah considered here falls. Duck and Fletcher (1943) stated: "The Post Oak-Blackjack game type represents the forest-grassland ecotone and contains dominants from both the deciduous formation and the grassland formation."

Indeed, the savannah is characteristic of an ecotone in that it includes patches and strips of grassland extending into, and existing within, the forest areas. However, I have taken the viewpoint that the ecotone between forest and grassland in Oklahoma includes not only the savannah but also the tall grass prairie. The deciduous forest extends far into the prairie along the ravines, in the streambeds, and in other

places where there is more soil water available for plant growth than in the higher prairie. Since the true prairie in Oklahoma is itself an overlap area of grassland and forest, the view that it too may be considered part of the ecotone seems justified. In this regard, Shelford (1945) stated:

> The boundary between two biomes is often tortuous, with narrow extensions ("fingerings") of each biome penetrating the territory of the other. Often this is related to topography, the extensions of one biome being on higher ground than those of the other. A transition, or ecotone, is commonly a complex of these narrow extensions rather than a mixture on the same area of the plant and animal species characteristic of two or three biomes. This is especially true of biome boundaries of the Transition zone area and may be seen also along the boundary between the deciduous forest and grassland.

In the present paper, the "first order" ecotone in central Oklahoma is therefore considered to consist of both the oak-hickory savannah and the tall grass prairie. "Second order" ecotones are mentioned as they concern individual species of birds.

CHAPTER III

WINTERING BIRDS

In addition to general observations of wintering birds throughout a large part of Cleveland County and in the northeastern portion of McClain County, concerted and systematic surveys were made of two sizeable tracts. In the Diehm tract, three miles east of the present easternmost boundary of the city of Norman, forest of several types predominates; the Rucker tract consists chiefly of grassland.

Diehm Tract

The Diehm tract is irregular in shape and somewhat less than 160 acres in area (Figure 1). The owner, Mr. F. W. Diehm, kindly granted permission for unrestricted use of the property which lies within the western half of Section 36, T9N, R2W, Cleveland County. The tract itself is part of the oak-hickory savannah; its western border adjoins the tall grass prairie which extends westward. The general topography, typical of the savannah, is that of uplands cut by small drainage gullies running into a wooded ravine which itself completely traverses the tract in a general north-to-south direction. Heavily grazed pasture adjoins the forest both to the east and west of the tract's northern half.

The upland oak-hickory forest varies in nature. West of the

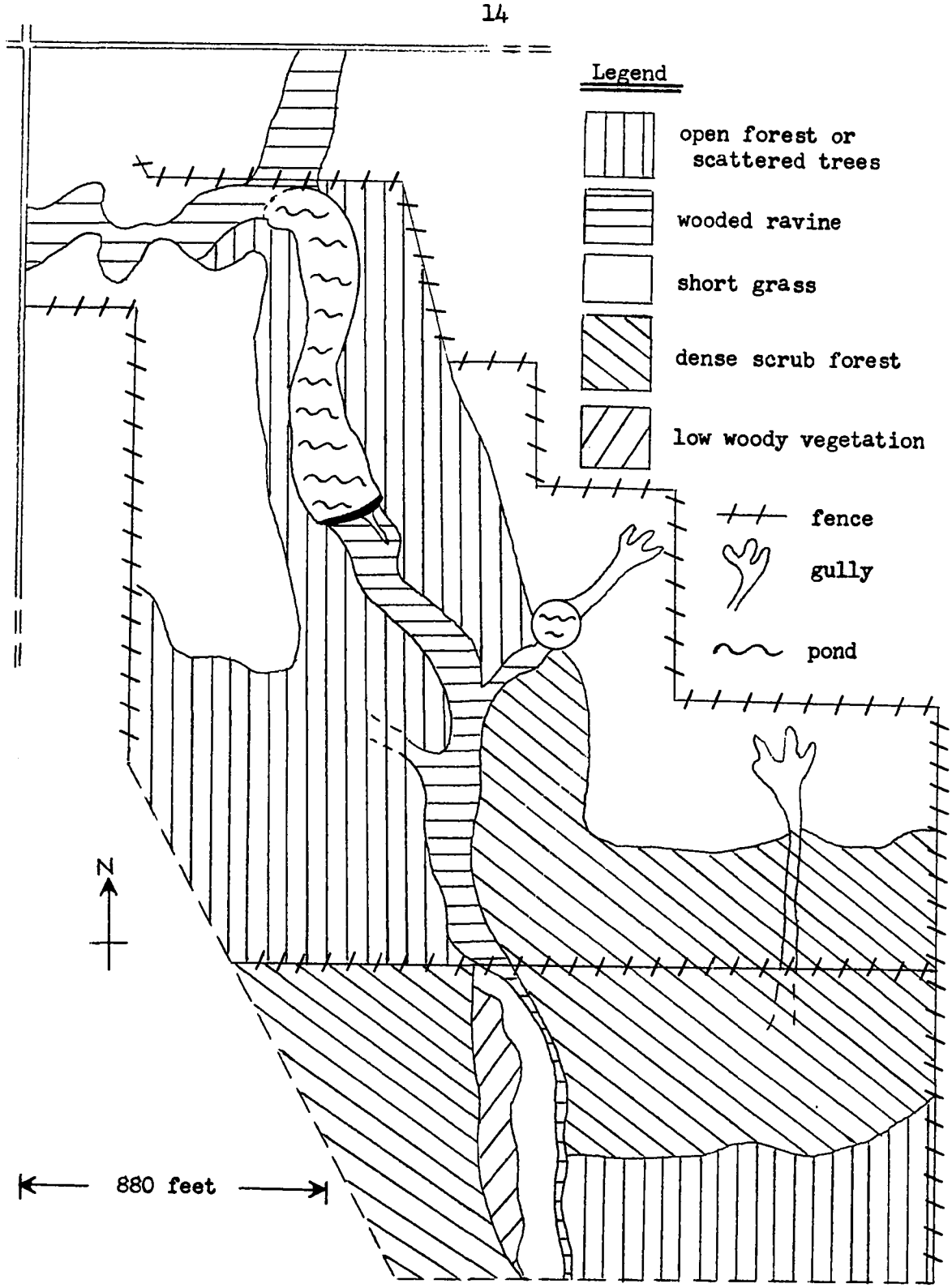

Figure 1. Wintering Bird Survey. Diehm Tract. November 17, 1954, to March 29, 1955.

ravine most of it is rather open, with little undergrowth of shrubs and saplings; in some places the trees are widely scattered. In contrast, a portion east of the ravine is definitely scrubby in appearance, consisting of small trees; this type of vegetation is difficult to walk through because of the thick growth of numerous oak saplings. (A portion of it was censused in June and July, 1955, for determination of the breeding bird population.)

The ravine supports a growth of trees along most of its length. Somewhat less than a third of it (approximately 225 yards) has been converted into an elongate farm pond by construction of a large earthen dam. For a distance below the dam the ravine is as much as 75 feet wide at points where short tributaries join. Water flows intermittently through the narrow, ditch-like channel which cuts through the ravine floor. Characteristic of the more mesic character of both savannah and prairie ravines, the chief trees are well-developed American elm, Ulmus americana, cottonwood, Populus deltoides, chestnut oak, Quercus muehlenbergii, and black hickory. Many of the trees support vines of green briar, Virginia creeper, Parthenocissus quinquefolia, and grape, Vitis sp. Post and blackjack oaks on the ravine banks are less stunted than those of the adjacent upland forest.

The ravine passes along the foot of a rather steep incline in the southernmost third of its course through the study tract; here there is no broad floor, but only a narrow, deeply cut watercourse, lined on each side with tall trees, chiefly cottonwood and elm. To the east there is an immediate transition to oak forest; to the west is an open area about 150 feet wide in part of which there is a dense growth of low woody

vegetation, including winged sumach, smooth sumach, green briar, and oak saplings. South of the Dilhm tract the ravine continues in a southeasterly direction for about two miles to the point where it flows into Dave Blue Creek, a major tributary of Little River.

From November 17, 1954, to March 29, 1955, I undertook systematic observations of the wintering bird population at the tract. Data were gathered during 19 separate surveys; the usual interval between successive surveys was six days, the maximum 11 days. In order to insure adequate and comparable coverage of the various vegetational types in the tract, a more or less definite route was consistently followed during each survey; the time spent on each survey averaged about two hours. All observations were made while I walked at a delayed, rather uniform pace (one to two miles per hour), and, although most surveys were undertaken between eight o'clock and noon, some were made later in the day so that a knowledge of bird activity throughout the daylight hours could be gained. Climatic conditions varied considerably during the several months, from clear sunny days when the ground was dry to dark overcast days when several inches of snow covered the ground.

So that the information in this paper may be readily used by future workers, I have arranged the data chiefly by species of birds, in phylogenetic order within each heading. Due to the research methods necessarily employed in a study of this nature, the quantity and quality of data are not equivalent for the various species.

The central problem in my investigation has been the determination of the distribution, i. e., the habitat preferences, of the birds found within the central Oklahoma forest-prairie ecotone; consequently,

this is the basic theme in the following discussions of the wintering birds at the Diehm tract. For each species information is included concerning: (1) the vegetational types (vegetational niches) in which it occurs; (2) its frequency and manner of occurrence; (3) its numbers in relation to other species present. Additional data, collected by myself primarily, are presented when available concerning: (1) feeding habitats; (2) refuge level (stratification); (3) intra- and interspecific relationships; (4) current distribution in Oklahoma.

Birds not identified to my satisfaction are omitted from consideration. In general, only those species which I recorded on four or more surveys are discussed, other species being regarded as "accidentals" or "strays." Some resident birds, especially cavity-nesters and birds of prey, initiate breeding activity before March 29, the date of the terminal survey. Species whose names are marked with an asterisk (*) are further discussed in the section on the wintering avian population at the Rucker tract.

Species Occurring at the Diehm Tract

Buteo jamaicensis.* The Red-tailed Hawk breeds throughout the state and winters commonly in the plains region. At the Diehm tract I recorded it on four of the surveys. On February 8, one circled, screaming, high over the southwestern corner; on January 12, February 15, and February 22, I flushed an adult from a small group of tall trees (possibly from the same tree) on the ravine bank at the northwestern tip of the large pond. On February 22, I searched the surrounding area in an attempt to locate an occupied nest or one from the preceding breeding season,

but found none then or subsequently. One hawk may have used this particular spot as a regular winter perch; here it had an almost unrestricted view in all directions--especially to the west and south. On each occasion the flushed bird flew almost directly west over open fields; such consistent behavior lends support to my belief that I saw the same bird time after time. In December 1952, I noted a large old nest in a tall tree almost exactly one mile south of the "perch" along this same ravine.

My many winter records of the Red-tailed Hawk in central Oklahoma reveal that the bird inhabits both the open prairie and the open savannah at that season.

Colinus virginianus.* While the Bob-white is resident throughout most of the state, it is irregular in distribution. On many long field trips in central Oklahoma I have failed to record it at all, yet at one time or another I have flushed coveys or single birds from virtually every vegetational type in the region, including the interior of well-forested areas. Usually it prefers fence rows, forest edges, wooded ravines, and roadside thickets offering cover, yet not so dense as to preclude immediate flight. At the Diehm tract, I recorded the Bob-white only twice. On December 11, a solitary bird flew from the base of a shrub near the edge of open oak forest. On January 24, a covey of eight flushed from under shrubs and small trees in the open area near the south end of the tract and flew eastward through the row of tall trees lining the ravine and into the open forest beyond.

Megaceryle alcyon. The Belted Kingfisher breeds throughout the state. For its nest-burrows it requires banks, but these are not always near water. In Cleveland and McClain counties I have seen it in winter

at large farm ponds stocked by man with fish and studded with dead trees which provide perches. At the Diehm tract I saw it January 12 and January 24, a single bird on each occasion.

Colaptes auratus.* In central Oklahoma the Yellow-shafted Flicker is likely to be seen at any time of year; it requires large trees for nesting or roosting. Because of its wariness it is usually seen at long range in winter, and often it is not distinguishable from the Red-shafter Flicker, Colaptes cafer. This wariness may account in part for its desertion of urban areas during winter in favor of the rural woodlands. That it obtains ants from the ground in winter has been proved repeatedly by G. M. Sutton's collecting of specimens, but it feeds also on fruits of such plants as poison ivy, Rhus radicans, chinaberry, Sapindus drummondii, and Virginia creeper, and it probably eats such insects and their larvae as it finds.

On the Diehm tract, I recorded this flicker on only seven of the 19 surveys, and invariably I saw solitary birds. On five consecutive trips, between January 12 and February 15, none was in evidence. I saw no more than one per survey except on March 1, when two were present. Two factors appear to explain the seeming scarcity of both species of flickers at the tract. First, flickers seem to require mature trees twenty-five feet or more tall, plus adjacent open fields. In central Oklahoma these conditions are met chiefly at the edges of bottomland forests (or in thinly wooded bottomlands) and along ravines which extend into the prairie. At the Diehm tract this type of habitat is found only at the northern end of the ravine where most of the flickers occurred. Second, they are silent and quite wary during the colder months.

Colaptes cafer.* The Red-shafted Flicker inhabits central Oklahoma from late September to late April. One may expect to see it regularly at this season in the westernmost portion of the savannah, particularly in the wooded ravines in the prairie region. My notes indicate that it is less abundant than its sister species, Colaptes auratus, but that its behavior is identical. Indeed, hybrid flickers have been collected in Cleveland County; individuals are not infrequently seen which appear to have plumage characters of both species, in varying degrees, and it seems likely to me that the percentage of hybrid flickers is higher than now realized.

I recorded the Red-shafted Flicker at the Diehm tract November 7, December 15, December 23, and March 15, a single, wary, bird on each occasion. On November 14 (not a regular survey day), Richard R. Graber and I observed one fly to a lower limb of the solitary giant cottonwood standing just south of the east-west fence crossing the tract. This tree seemed to be especially attractive to birds of many kinds, notably woodpeckers, Robins, and Blue Jays.

Dryocopus pileatus. The Pileated Woodpecker is a bird of well-developed forests. It is found in eastern Oklahoma wherever such forests predominate, and is especially common in the southeastern counties. In the oak-hickory savannah region it is restricted to wooded floodplains and bottomlands. In central Oklahoma, I have never seen it in the stunted upland oaks.

Although the Diehm tract has no extensive, well-developed forest, there are large trees along the ravine and its tributaries, and among these, on November 7, December 23, January 2, and January 12 I saw the

Pileated Woodpecker, a single bird on each date.

What I have observed of this species leads me to believe that it wanders over a wide area in winter, venturing up wooded ravines in the savannah. The Diehm tract's ravine runs into Dave Blue Creek, whose bottomland forest is like those along the larger streams in the savannah. I found no "workings" of the Pileated Woodpecker on the tract; this I regard as further evidence that the tract is on the very fringe of the species' normal winter range.

The rest of my winter records of this woodpecker are chiefly from Cleveland County bottomlands. The records are: January 2, 1954, one seen along Little River nine miles east of Norman; November 1, 1954, one seen in the Hog Creek bottoms near Stella; February 28, 1955, one seen on the Oliver Wildlife Preserve in the South Canadian River floodplain two miles south of Norman. I have never seen the bird, nor would I expect to see it, in the wooded ravines well out on the prairie. Big trees are its home; among them it finds shelter, roosting places, and food in winter.

Centurus carolinus.* Like the Pileated Woodpecker, this is a bird of the taller trees. However, the Red-bellied Woodpecker not only is more abundant where the ranges of the two species overlap in Oklahoma but it ranges much farther west. It is also common in urban areas, farm woodlots, orchards, etc., throughout much of its range.

At the Diehm tract, I recorded the Red-bellied Woodpecker on every survey except those of December 11, January 2, and January 24. The bird was undoubtedly present even on those days. I saw or heard it along the ravine, observing that it showed a decided preference for the upper

stout limbs of the tallest trees. A favored habitat was the large elms, oaks, and cottonwoods lining the southern third of the ravine. Two or three individuals probably wintered in the ravine, for on several of the surveys I saw two birds there. The first date on which I encountered more than two birds was March 15, when at least four were in a relatively short section of the ravine just below the dam. This and observations elsewhere lead me to believe that the Red-bellied Woodpecker's breeding season starts about the middle of March in central Oklahoma.

The vertical range through which this woodpecker feeds in winter is tremendous; normally it tends to remain twenty or more feet above ground, but I have seen it feeding as low as two feet above ground. Much depends, of course, on where the food is. The species is especially fond of chinaberries and pecans in winter.

Melanerpes erythrocephalus. The Red-headed Woodpecker winters locally in the vicinity of Norman; during the winter of 1954-55 one of these spots was within the Diehm tract. In and along the edge of the larger pond stand about a dozen dead trees from which most of the branches have fallen. Oaks 25 to 50 feet high grow on the adjacent banks, and in the ravine, both below and above the pond, are several large cottonwoods. Such groupings of large trees are evidently attractive to this woodpecker, for on my several surveys of the tract, I never failed to record the species here and on December 15 I saw six (two adult and four immature birds). This statement is the more significant in view of my failure to find the Red-headed Woodpecker on any of several winter trips to various parts of the Norman area during the winter of 1954-55. After the middle of January I saw no more than two per survey; one pair remained all

spring and probably nested. A gray-headed immature bird which I collected on January 24 from 35 feet up in a cottonwood is now in the University of Oklahoma Museum of Zoology collection (No. 1958).

As with several other woodpeckers, the winter food of this species is primarily plant fruits. On November 7, I watched an immature bird caching acorns from a 25-foot post oak in crevices of a large dead cottonwood about 100 yards below the dam. Every two to five minutes it made a round trip, plucking an acorn from the oak, carrying it to the cottonwood about 150 feet away, and pounding it into crevices at places where major limbs had broken off, 30 to 40 feet above ground. Several Blue Jays were also plucking acorns from this oak and carrying them out of sight. I last saw this woodpecker (or one in identical plumage) in the vicinity of the dead cottonwood on January 12. I never saw it removing or feeding on a cached acorn, nor did I see any other bird or mammal of any sort attempting to feed on, or carry off, any of the woodpecker's larder.

Other "spots" of Red-headed Woodpecker concentration during winter were certain cottonwood groves northeast of Norman. In one grove seven miles from town, on January 2, 1954, were at least eight birds, most of them immature. The groves were in depressed areas within the savannah, and were neither in nor near water.

Dendrocopos villosus.* While not rare, the Hairy Woodpecker, a resident of forested areas throughout the state, is certainly less common than its congener, the Downy Woodpecker. Due to its wariness and habit of flying long distances when startled, it is more often heard than seen. In the Diehm tract I recorded it on only 11 of the 19 surveys.

Never did I see more than one bird on a survey except on February 8, when I saw two. On December 15 I entered this note: "It seems unlikely that there are now more than three or four of this bird in all of the Diehm tract." On December 23 I estimated that the Hairy was about one-fifth as plentiful as the Downy.

The Hairy Woodpecker prefers the larger trees in ravines and lowland areas and occasionally visits larger trees in upland oak areas. I have seen it, as I have the two species of flickers, flying over the open prairie or scrub forest passing from one ravine or streambed to another. Occasionally it visits large trees of urban areas. Unlike the Downy, which feeds on branches and even among the small peripheral twigs, the Hairy keeps to the trunks or limbs at least two to three inches in diameter.

Dendrocopos pubescens.* The Downy Woodpecker is the most abundant and most nearly cosmopolitan woodpecker of the state. In central Oklahoma one can expect to find it wherever there are trees. It feeds on the trunk and also among the larger limbs and small peripheral twigs. Indeed, it frequently may be seen on stout vines and dead stalks of the taller weeds, e. g., Helianthus, Vernonia, etc.

At the Diehm tract I saw Downy Woodpeckers on every survey except those of November 19 and March 8. Usually I saw two or three individuals per survey, never more than three.

Both the Downy and the Hairy seemed to prefer the taller trees along the ravine, but I found the Downy in a variety of other vegetational types, from the interior of the dense scrub oak forest to areas of widely scattered trees. I have often seen or heard it along streets in Norman.

My observations over several winters indicate that while the Downies do not go about in flocks or even pairs, they are often associated with other species, e. g., Parus carolinensis, Parus bicolor, in small wandering groups.

Cyanocitta cristata. The Blue Jay is found in Oklahoma at all seasons, but many winter birds are believed to move northward out of the state in spring. Like the Robin, Turdus migratorius, it nests principally in towns, in so far as its Oklahoma range is concerned. It is a woodland bird, of course, and its fondness for acorns in winter leads it to oaks. It is, indeed, one of the few truly characteristic birds of the monotonous stretches of post oaks and blackjacks. It is irregularly abundant in the Norman area in the season of migration. Whether any Blue Jays of central Oklahoma are truly resident remains to be determined through a careful study of banded birds.

At the Diehm tract the Blue Jay was one of the most abundant winter species. I saw about ten birds (smallest number: five) during each survey, except on February 22 when I saw none. Except on November 7 (perhaps also November 19), when the fall migration was still in progress, they foraged in loose flocks, the individual birds many rods apart but within easy hearing distance of each other. Martin, Zim, and Nelson (1951) stated that the staple plant food of the Blue Jay is acorns; this food habit doubtless is correlated with the preference of the species for the taller oaks in the upland forest at the tract. However, I found Blue Jays along the main ravine also. On November 6 (not a regular survey day), I watched two Blue Jays and a Red-headed Woodpecker, with no apparent enmity between them, plucking acorns from the same post oak, while

Carolina Chickadees, Parus carolinensis, pecked at the acorns on the lower limbs and ground, as though attempting to open them. In the main, the Blue Jays remained between 20 and 40 feet above ground; I would place their refuge level within the same vertical range.

During the non-breeding season, this species can regularly be seen in the upland oak areas and in the wooded ravines of both savannah and prairie. However, its occurrence in the forests of the South Canadian River floodplain and in the bottomland forests within the savannah is sporadic. During trips to the Hog Creek bottomlands, about 15 miles northeast of Norman, I detected none on September 12, 19, 26, and November 1, 1954; yet, on October 5 and 17 of the same year, the species was abundant, in flocks of up to 20, both in the bottomland forests there and in the adjacent upland oaks.

Corvus brachyrhynchos.* The Crow is found throughout Oklahoma the year round, but it is doubtful that birds which breed in the state also winter here. In any event, capture of banded birds has proved that many winter Crows have moved into Oklahoma from the prairie provinces of Canada. Being wary, the species almost never alights in heavily vegetated areas such as the floor of well-developed forest; but one may expect to encounter it in any open or semi-open habitat. Great winter roosts are a notable phenomenon of central Oklahoma.

Although I recorded from one to six Crows during 16 of the 19 surveys, most of the individuals were flying over the tract hence were not, strictly speaking, part of the avian population. Many Crows fed in a field of winter wheat a short distance south of the tract. Only twice did I find Crows actually within the tract, six on January 2 and five

on January 12. They were perched in large solitary trees near the southern boundary.

Parus carolinensis.* Resident over the state except for the panhandle, the Carolina Chickadee is less noticeable in summer than in winter because it becomes secretive when nesting. It is distributed throughout the ecotone wherever trees, shrubs, or vines are found, whether in urban or rural areas.

Although showing a preference for the open upland oak forest, this species also inhabited the two other major forest types in the Diehm tract--the dense scrub oak and the strips of trees lining the ravines. It is indeed one of the few arboreal species which I found regularly in the forest interior in winter; the other species were restricted to the forest edge or to areas of scattered trees. I recorded the Carolina Chickadee on every survey. Usually I found groups of three to five; the average total number of birds per trip was twelve, a figure exceeded only by Parus bicolor and Junco hyemalis. I did not find the chickadees regularly at particular spots; the birds must have roamed widely. Many times I observed a chickadee pecking at an acorn. On examining these acorns, I discovered that many were inhabited by insect larvae identified by Dr. Cluff E. Hopla as larvae of curculionid weevils.

I found it impossible to establish a refuge level for this species, except that it is above the ground; individuals paid little attention to my presence even when I attempted to put them to flight.

Parus bicolor.* The Tufted Titmouse, primarily a bird of the eastern United States, does not range quite so far west in Oklahoma as the Carolina Chickadee. Indeed the two birds are in many ways similar

in behavior and habitat. On the Diehm tract I found them both on every survey in the upland oaks primarily, though the titmouse showed a preference for the taller mature oaks. Too, the titmouse seldom ventured onto the very ends of branches or leaf petioles in its incessant food gathering. In respect to the size of branches visited, there is somewhat the same relationship between P. carolinensis and P. bicolor as between Dendrocopos pubescens and D. villosus.

Generally speaking, I saw more titmice than chickadees, 16 titmice per survey being my average. As did the chickadee, the titmouse went about in small flocks, though I saw solitary individuals occasionally. As a rule the titmouse did not mix with other species. It fed at all levels and revealed no definite refuge level. The scolding of this species is perhaps the most frequently heard bird sound in the forest in winter.

Certhia familiaris.* The Brown Creeper is transient throughout Oklahoma. Some individuals winter in the state. Strictly dependent as it is upon trees for food and shelter, it is most common in well-wooded areas. Since it is inconspicuous, it may be much more common than has been supposed. It seems to be strictly solitary, feeding as though unconcerned with other birds which may be nearby. It spends most of its time on the trunks, infrequently visiting the larger branches.

My records of the Brown Creeper at the Diehm tract are all of single birds in trees of the main ravine, never in the upland forest. I saw one individual each on my surveys of December 15, December 30, January 2, February 1, February 8, and February 22. It seems unlikely that more than six were in the tract at any one time; probably most of them

fed along the ravine. On the basis of all my winter observations, I conclude that, as is true for arboreal birds in general, the Brown Creeper has no preference for particular species of trees, but visits elms, cottonwoods, oaks, etc., alike, and that other factors such as growth-form, availability of food, general environment, etc., are more important in determining what particular trees a given bird species visits most frequently.

Thryothorus ludovicianus.* Wherever found, the Carolina Wren is a strictly non-migratory bird of deciduous forests. In Oklahoma it is especially common in the southeastern part of the state, yet is common locally along the wooded ravines and floodplains extending westward into the prairie. Each individual wren probably remains within a relatively small area throughout its lifetime.

In the Diehm tract the Carolina Wren showed a marked preference for thickets and for areas of brush and weeds in or adjacent to the main ravine. I recorded at least one bird on 14 of the 19 surveys. Several individuals probably inhabited the tract constantly, although I failed to see or hear any on January 12, January 24, and February 1. This species often makes its presence known through its calls or songs; yet for several years I have noted the tendency of this usually vociferous bird to be relatively silent during most of January and early February in central Oklahoma, thus perhaps accounting for my not listing it on the above dates. Occasionally, as on November 7 and December 11, I encountered it in upland oak forests. For refuge it always flew into piles of brush or thick vegetation. Its refuge level is therefore dependent on the height of the brush piles or living shrubbery.

Turdus migratorius.* The Robin winters over most of the state but is decidedly uncommon in southern and western Oklahoma during the breeding season. The southern limits of the winter range of the species' eastern races are believed to be not far south of Oklahoma, so some Robins may actually spend the entire year in Oklahoma.

From November to early March I found the Robin regularly on the Diehm tract, usually in small, loose flocks of up to ten individuals. On January 24 I watched a concentration of about 30 of the birds in a grove of small persimmons which projected about 50 feet into pastureland. They were feeding on the fallen ripe fruits; I observed one bird carry a persimmon in its beak across the open field toward the forest to the east. On November 11, 1952, I discovered about 100 Robins feeding noisily on wild grapes which hung from large elms along a ravine three miles southeast of Norman. Especially during days of inclement weather, groups of this species can often be seen feeding on berries of juniper, Juniperus virginiana. Possibly the juniper leaves provide some protection from cold winds.

The Robin is not a bird of the forest interior, but rather prefers "edge"--ravines, areas of scattered trees, campuses, etc. Although it moves over the countryside in small flocks, it tends to congregate in winter at areas such as this which offer an attractive food source. In general, whenever I found a large flock of Robins, the birds were feeding on some choice food. The bird moves out of urban areas into the surrounding woods only during the winter. Although it may feed while on the ground, it seldom ventures far from trees, except when flying over open fields from one wooded area to another. This affinity for trees may be

correlated with its invariable habit of flying to them when alarmed, usually to limbs twenty to thirty feet above ground.

Sialia sialis.* The Eastern Bluebird inhabits Oklahoma at all seasons but individuals which breed are probably replaced by birds from farther north in winter. It is found along highways, fence rows, electric lines, and the edge of the forest in winter, an important requirement being exposed perches from which it can look for insect food.

At the Diehm tract I saw Eastern Bluebirds on 13 surveys, within the forest only once. On December 30, three were flying from tree to tree in the rather open forest west of the ravine. Since at the time seven to ten inches of snow covered the ground, these birds may have been forced to search for food in places they do not normally visit. Most of my records at the tract were from places immediately adjacent to the open fields--the northern end of the ravine, the fences on the western and eastern borders of the tract, the electric lines bounding the tract to the north and west, and the forest edge. Although I recorded the species on only 13 of the surveys, it was probably present around the fringes of the tract all winter (and probably throughout the year). An adult male collected on February 22 (U. O. M. Z. 1959) was infested with Mallophaga, easily seen against the brilliant blue feathers of the neck and head.

The Eastern Bluebird subsists to some extent on fruits in winter. Since it is fond of mistletoe berries, it often frequents elms and other mistletoe-bearing trees in town as well as in the country.

Regulus regulus. The Golden-crowned Kinglet migrates through and winters in central Oklahoma. I have recorded it from early November to early April, usually no more than three or four birds on a given trip

to the savannah, the bottomland wood plots, or the floodplain forests. In feeding behavior it resembles the Carolina Chickadee in that it searches for insects among the small outer twigs and branches.

At the Diehm tract I recorded the Golden-crowned Kinglet on every survey except those of November 7, January 24, and February 15. I saw an average of about three individuals per survey. Usually the birds were in a loose group or company, feeding in the same or adjacent trees. The species showed no obvious preference for a certain kind or size of tree. I found it most frequently in the upland open oak forest, but observed it on several occasions in the dense scrub forest and in the well-developed trees of the ravine. It searched for food eagerly, especially on the colder days. Occasionally I saw it with the Slate-colored Juncos, Carolina Chickadees, and Field Sparrows.

My Cleveland County records of the Golden-crowned Kinglet indicate its presence in several other types of forest communities--in the scattered cottonwoods and elms of the Hog Creek bottomland near Stella, in the area of junipers on the banks of the South Canadian River near Noble, in the cottonwood-elm-ash floodplain forest (Oliver Wildlife Preserve) near Norman. I have no records of its occurrence in the wooded prairie ravines. It sometimes visits urban areas having many trees.

Richmondena cardinalis.* The Cardinal is an abundant and strictly non-migratory bird throughout the main body of the state. Although it sometimes nests well within the forest, it is a bird of the "edge" in winter. It is especially common in areas having growths of dense shrubs.

At the Diehm tract I never failed to record at least two individuals; the average per survey was somewhat more than seven. Although

I found the Cardinal in open upland oak forest on several occasions (never far from a green briar thicket, a pile of brush, or some other dense vegetation into which it flew when alarmed), I did not once detect it within the dense scrub oak forest. The majority of my records are from areas of scattered trees, from the ravine, from exposed brushy areas, and other "edge" localities. Frequently I saw Cardinals flocked loosely with other species, notably such fringillids as juncos and Field Sparrows. On the basis of several observations, I place the refuge level of the Cardinal at five to twenty-five feet above ground; the level of any individual depends of course on the height above ground of the dense vegetation which it uses for refuge.

Spinus tristis.* The Common Goldfinch inhabits central Oklahoma the year round, but it is decidedly more common in winter than in summer. Banding studies of individual birds will be necessary to determine whether any of those which winter remain to breed.

At the Diehm tract the Common Goldfinch preferred the northern third of the main ravine, an area adjoining open fields. I recorded it throughout the winter, though on only eight of the surveys. Often I saw it with juncos, Field Sparrows, Cardinals, and other small passerines, but it moved about in flocks independently of the other species. Usually it fed above ground level on seeds borne in heads or on stiff stalks. On December 30, when most of the ground was covered with several inches of snow, I watched five Common Goldfinches feeding with a mixed group of sparrows in one of the few spots of bare ground, about fifty feet from trees of the ravine. Such unusual climatic conditions cause a concentration of mixed flocks in the few spots where food can be obtained.

Winter flocks which wander widely over the forest-prairie ecotone would often pass unnoticed were it not for the easily recognizable notes uttered by the flying birds. Although I have not found this bird within dense forests or within large plots of pure grassland, I have encountered it in nearly all intermediate vegetational types--scattered trees, wooded ravines of both savannah and prairie, open forests, high weeds in disturbed areas, etc.

Pipilo maculatus. The Spotted Towhee is common in central Oklahoma in winter and during the season of migration. I have found it in several wooded areas--the floodplain of the South Canadian River, in bottomlands, and in the larger prairie ravines. It is a bird of brush piles, dense shrubby undergrowth, and weeds; being secretive, it sometimes has to be "squeaked" out of its retreat.

At the Diehm tract I found it in areas of open forest or along the ravine, usually in man-made piles of brush. I recorded it on 11 of the 19 surveys, from one to four individuals per survey. Only once did I find it definitely associated with another species; on March 1 one was with a flock of about ten Harris's Sparrows. On December 15, February 8, and March 15 I saw two Spotted Towhees in the same brush pile. Two seen on March 22 were both males. I saw very few towhees that I knew to be females.

Junco hyemalis.* A winter visitant throughout the state, the Slate-colored Junco is by far the most common species of the puzzling Junco complex in central Oklahoma. I recorded this bird at the tract during all surveys except one; the number of individuals varied from less than five to more than a hundred per survey, probably indicating

that the flocks tend to wander considerably. From November to the third week in February, I found it regularly in only two places--the narrow strip of oaks just west of the large pond, and the area of saplings and scattered trees just west of the ravine at the southern edge of the tract. Usually I found it feeding not actually in the trees, but in the short grass near the trees. On February 22 I saw it for the first time in the eastern part of the tract. From that time on, the flocks seemed to be spread over the whole tract, though they kept principally to the forest edge or to more open parts of the woods.

The Slate-colored Junco is a "forest edge" species of prairie ravines, of open bottomland and floodplain forests, indeed, of any wooded or shrubby area where the vegetation is not dense. It is almost exclusively a ground feeder, feeding on small seeds principally, and it goes about in flocks. I have not seen juncos farther than about 200 feet from trees or other stout vegetation, to which they invariably fly for refuge. Often a few Field Sparrows or Tree Sparrows are seen with junco flocks.

Spizella arborea.* The Tree Sparrow, a winter visitant over the whole state, is not a bird of the trees, as the name would suggest, but of thickets along the forest edge. I have never seen it in the forest; it seems to regard trees, bushes, and shrubs merely as convenient places of refuge. Like the Common Goldfinch it often feeds above ground level among seed-bearing annuals. It also feeds on the ground.

On the Diehm tract, I found Tree Sparrows only along the extreme western boundary. Here the trees bordered the open fields, the transition from eastern forest to western prairie being abrupt. I found the bird principally in the northernmost portion of the tract where the wooded

ravine projects into open fields, and almost invariably I found it with flocks of Slate-colored Juncos. The Tree Sparrows, when flushed from the ground, tended to fly up to perches less than fifteen feet above ground, a refuge level somewhat lower than that of the juncos.

I recorded the Tree Sparrow on only nine of the surveys and never saw more than five on a survey. I did not see it at the tract after March 1 although I saw it repeatedly in the Norman region later than that. It appears that the Diehm tract did not meet the optimal habitat requirements of this sparrow.

Spizella pusilla.* The Field Sparrow breeds and winters locally throughout Oklahoma. West of the savannah it is less common, according to my observations, than the Tree Sparrow, with which it is often seen. Although I have seen it in open fields, it seems to remain in the vicinity of trees, shrubs, and brush piles. It feeds on the ground principally, flying into brush piles or trees when disturbed.

On the Diehm tract the Field Sparrow was present throughout the winter; I recorded it on 14 of the 19 surveys, never more than 12 per survey. Although I encountered small flocks occasionally, I saw the species regularly at only two places in the tract--at the north end of the main ravine, and in a field north of the small pond. In the former place I usually saw from one to several individuals with a mixed flock of Slate-colored Juncos and Tree Sparrows. The three species exhibited no antagonism toward each other, either while on the ground or in the adjacent trees. In the latter place I often flushed from three to ten Field Sparrows. Here a deep erosion gully which funnels water into the pond was lined with oak saplings. The sparrows invariably flew to these

saplings or into one of the several small piles of brush in the floor of the gully. Only once or twice did I see Tree Sparrows or juncos at this particular place.

Zonotrichia querula.* The Harris's Sparrow winters abundantly in central Oklahoma. Like some other species which breed far to the north, it arrives in the Norman area about the first week of October and remains until the last of April.

I recorded Harris's Sparrow in the Diehm tract on only four surveys--December 30, February 1, February 8, and March 29, never more than ten individuals on a survey. It was among shrubs, brush, and vine-covered trees along the northwesternmost part of the ravine, a place also frequented by Cardinals and several other fringillids. I searched hard for this bird elsewhere in the tract, but in vain.

The Harris's Sparrow seems to have a special liking for scattered clumps of dense vegetation in open woodlands. Throughout the winter of 1954-55, on the Oliver Wildlife Preserve two miles south of Norman, I repeatedly saw a loose flock of 20 to 50 birds. They stayed in a scattering of elm, oak, and chittamwood trees, many of which were overgrown by green briar and grape vines; they did not move into the well-developed floodplain forest immediately to the north and west, nor did they visit the open fields nearby.

Zonotrichia albicollis. The White-throated Sparrow is a common transient through central Oklahoma. It winters locally, usually in small numbers. It inhabits most of the ecotone except for the interior of the well-developed forest and the open grassland.

On the Diehm tract it was common in November and December, less

so in January and early February, and apparently absent thereafter. I recorded it on eight surveys, seeing from one to fifteen individuals per survey. I saw it principally in small companies (two to five birds) in the extensive piles of brush along the edges of upland oak forest and in the ravine. All of the approximately 15 White-throated Sparrows seen on December 15 were in one flock flushed from an isolated group of oak saplings in an area of scattered trees west of the ravine. They flew as a group into the taller oaks nearby and, keeping in the lower branches, moved away from me westward into another ravine not in the study tract. I was surprised to find this brush-inhabiting sparrow in such an exposed habitat.

Rucker Tract

Approximately the same size (about 160 acres) as the Diehm tract, most of the Rucker tract lies in the southeast quarter of Section 8, T9N, R2W, Cleveland County, two miles north of Norman; it extends for a short distance into Section 17 (Figure 2). The tract is part of a ranch owned by Mr. Robert H. Rucker, who kindly gave me permission to use his land. The tract is entirely within the tall grass prairie and includes three major vegetational types: grassland, abandoned (formerly cultivated) field, and wooded prairie ravine. Most of the land slopes gently toward the west; drainage is into Little River, about one-half mile north.

The northern third, approximately, is abandoned field. The higher ground here supports a fairly dense growth of wire grass, Aristida sp., while broomweed, Gutierrezia dracunculoides, and other stout composites thrive on the narrow strip of low, level ground in the extreme north-

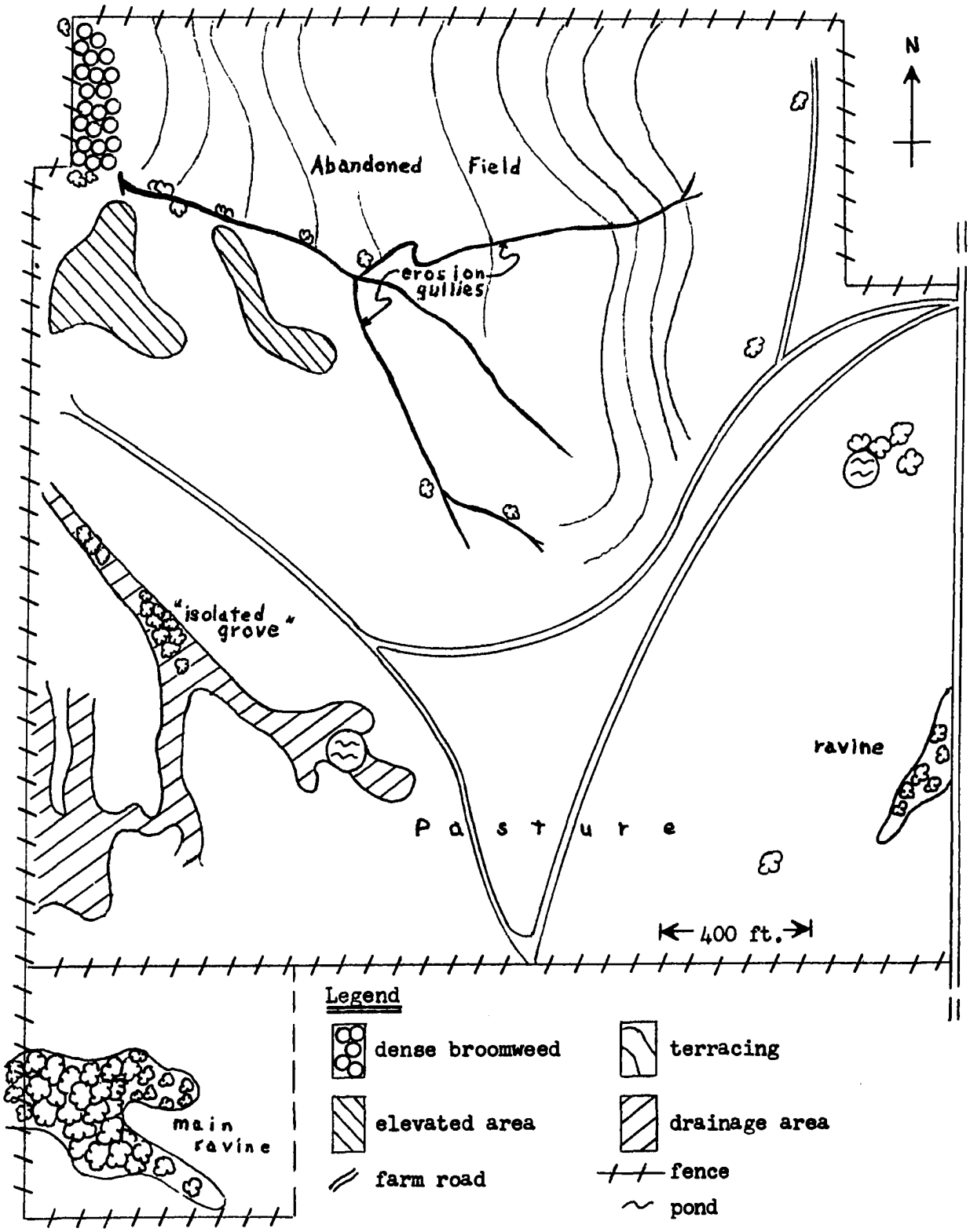

Figure 2. Wintering Bird Survey. Rucker Tract November 14, 1954, to March 24, 1955.

western part. Traversing the field is a series of deep erosion gullies along which are scattered a few small trees (Figure 3). In the extreme southwestern part is a characteristic prairie ravine, well-wooded with American elms, many of which are overgrown with green briar. The general appearance of the ravine is similar to that of the prairie ravines of the Diehm tract.

The rest of the tract is moderately overgrazed. According to Mr. Rucker, this grazed part has never been plowed and only infrequently been mowed. Prominent grasses of the higher portions are Andropogon gerardi, Bromus sp., Bouteloua gracilis, and B. curtipendula, of the drainage areas, Sporobolus asper and Andropogon gerardi. A few small rocky areas support relatively little grass.

The western portion of the pasture area drains into a broad, shallow ravine, at the head of which a farm pond has been constructed. Some distance below the pond are two small groves--primarily American elms and hackberry, Celtis laevigatus, up to 40 feet tall, but also smaller Kentucky coffee-bean, Gymnocladus dioica, and buckthorn, Bumelia lanuginosa. The rest of the ravine is covered principally with Sporobolus asper, green briar, saplings, and low bushes. The trees here are at least 300 yards from any others and for that reason are collectively referred to in this paper as the "isolated grove."

Between November 14, 1954, and March 24, 1955, I made 16 surveys of the wintering bird population at the Rucker tract, usually at weekly intervals. Although the general climatic conditions were similar to those of the forested Diehm tract, thermograph records revealed that the minimum daily temperatures were a few degrees (Fahrenheit) lower, and maximum

Figure 3. Aspect of abandoned field at Rucker tract in March, 1955.

temperatures a few degrees higher in the prairie; it was apparent that the wind velocity was almost constantly greater in the prairie.

Except that my pace was one to two miles per hour faster, the methods of observation and recording of data were as similar as possible to those used in the surveys of the Diehm tract. For each species of bird the following data are presented: (1) vegetational niche; (2) frequency and manner of occurrence; (3) numbers in relation to other species present. Other information is included when pertinent.

Species marked with a number sign (#) are discussed also under "Diehm Tract."

Species Occurring at the Rucker Tract

Buteo jamaicensis.# I saw the Red-tailed Hawk on January 16, January 26, February 12, February 17, and March 24, a single bird on each date. The individual seen on February 17, a very dark bird, flew into a tree in which three Crows were perched. The individual seen on March 24, again a dark bird, was mildly chased by a Harrier. This Red-tail may possibly have been nesting in tall trees along Little River, half a mile north of the tract, but it did not scream at me. No breeding central Oklahoma Red-tail thus far collected or observed has been anything but a "normal light phase" bird.

Buteo lagopus. The Rough-legged Hawk winters regularly in Oklahoma. I have seen it as early as November 19 (1954) and as late as March 24 (1953). It prefers open country with few trees.

My notes contain no mention of its occurrence within the savannah, but it probably winters in limited numbers there. I did not see it

within the Rucker tract. On November 19, 1954, I saw one soaring just west of the Diehm tract. The species tends to remain in certain favored localities. On January 10, January 11, and February 7, in 1953, I saw one in the immediate vicinity of a large winter blackbird roost, three miles east of Goldsby, McClain County. On December 21, 1953, and January 7, 1954, Richard R. Graber and I saw a "dark phase bird" flying over an open field in this same area. On November 24 and 25, 1953, I watched a bird hovering in a strong wind over the open grassland of the North Base, one mile north of Norman. Here rodents were plentiful.

Circus cyaneus. The Harrier is common in winter throughout Oklahoma. At the Rucker tract I recorded it on eight of the 16 surveys, but on only two surveys did I see a gray adult male. Because of the species' habit of patrolling an area time after time, I was usually not sure how many birds I was seeing. On November 14, however, I saw a bird of each color. Seldom did I see a Harrier over the abandoned field in the northern third of the tract. The birds kept principally to the pasture and the treeless low drainage areas supporting a dense growth of grass. In these grassy areas small rodents probably are common.

The Harrier is characteristic of open grasslands throughout central Oklahoma; one may expect to see it in winter in the prairie and in open areas of floodplain and savannah. It is not as wary as other hawks in winter and may closely approach a motionless or partly concealed observer. It flies low, with head turned downward at right angles to the body, watching for prey. It is attracted to places where there is much animal activity, e. g., prairie dog colonies, winter blackbird roosts, fish hatcheries, etc. One seldom sees it in the act of capturing prey,

but one may often see it feeding on the carcass of some bird or mammal killed by a car on the highway. Often one flushes it from concealment in tall grass. Twice have I see it perched above ground--on a telephone pole, eight miles northeast of Norman, September 26 and October 5, 1954.

Falco sparverius. The Sparrow Hawk inhabits Oklahoma throughout the year. It prefers open country to forest, perching on telephone poles and other high, exposed places. It is commoner in winter than in summer.

I saw it on the Rucker tract on February 3, February 12, and March 24, on each date a single bird flying (sometimes hovering) over the prairie. I have seen it repeatedly in winter in and near Norman. A favored Cleveland County habitat is the broad, nearly treeless floodplain northwest of town.

Colinus virginianus.# I recorded the Bob-white on five surveys, as follows: November 14, a covey of 12 flushed from foot-high vegetation in an open field; November 23, a covey of eight flushed from foot-high weeds at the edge of the northeastern pond; December 8, two coveys of eight each, one in a deep gully, the other in a depressed area; January 6, a covey of 12 flushed from small trees and shrubs at the edge of the main ravine; March 17, a covey of seven seen in the small eastern ravine. The birds tended to inhabit well-sheltered areas during cold weather (as on December 8 and January 6). The seeming absence of the Bob-white from the tract during mid-winter (January 16 to March 17) may have been due to its movement into the larger ravines offering protection from the cold winds. On December 31, Mr. Fowler, ranch foreman, told me that the Bob-white population had become very irregular, whereas earlier in the fall it had been large. On April 7 and April 21 (after the regular

surveys) I found Bob-white in coveys of seven and eight, respectively. Perhaps, with the advent of warmer weather, it was moving back into the open prairie.

Charadrius vociferus. The Killdeer inhabits Oklahoma at all seasons, but no one knows to what extent it is migratory. It spends much time near water of course; but in winter, when it goes about in flocks, it often feeds in extensive alfalfa fields or in heavily grazed areas. I saw it flying over the Rucker tract on five winter surveys: a group of three on November 14, a single bird on February 24, two together on March 3, a flock of five on March 17, and a single bird on March 24. Not once did I see it on the ground.

Bubo virginianus. The Great Horned Owl is resident over much of the state where there are tall trees. In winter it is more frequently heard than seen. Although this bird was undoubtedly present all winter, I did not see it on the tract until January 26 when I caught a glimpse of one flying swiftly along the main ravine. Undoubtedly this was one of a pair whose nest I found in the ravine on February 24; the nest held two eggs which, I calculated, had been laid in early February.

This owl is widely distributed over the ecotone in groups of tall trees: in floodplain forests, wooded ravines of both savannah and prairie, and even in some of the upland oak forests. During January, 1955, we heard up to three on each visit to the winter blackbird roost, 15 miles southeast of Norman; the owls, like several Red-tailed Hawks and Harriers, were attracted by the great numbers of birds at the roost, but I obtained no direct evidence that any of these predators preyed upon the blackbirds.

Colaptes auratus.# Both species of flicker occasionally fly over

the open prairie, stopping momentarily on elevated perches, but they usually remain in areas having large trees, i. e., wooded prairie ravines, etc. I saw single Yellow-shafted Flickers at the tract November 14, December 8, January 26, and March 24. Two were in the tall trees of the main ravine, one in an isolated tree at the edge of a gully, one along a fence row. A flicker seen on November 23 and one seen December 20 may have been this species.

Colaptes cafer.# Of the two wintering flickers, the Red-shafted Flicker is the less common in central Oklahoma. I saw it twice at the Rucker tract: two birds on November; one on January 16, in the main ravine.

Centurus carolinus.# At the Rucker tract I saw the Red-bellied Woodpecker twice in the main ravine: one bird November 14, one bird March 17. In the larger ravine about a mile southwest of the tract, I found the species more abundant. Here there were many tall trees, living and dead. This species, in contrast to the flickers, does not venture out over wide stretches of open prairie, but remains in the well-wooded areas.

Dendrocopos villosus.# On the Rucker tract I saw the Hairy Woodpecker only on February 12, a single bird flying along the main ravine, but I saw it near the tract on several occasions in cottonwoods and elms growing around the dams of the older farm ponds. It should be counted as part of the winter bird population in the tall grass prairie of central Oklahoma.

Dendrocopos pubescens.# I saw the Downy Woodpecker at the tract on four surveys, always in the trees of the main ravine; one bird on

November 14, one February 3, two (perhaps three) March 17, and two March 24 (both males, the testes of one found to be slightly enlarged). This species, like the Hairy Woodpecker, visits groups of trees about the older farm ponds west of the savannah, but it spends most of its time in well-wooded areas.

Eremophila alpestris. The Horned Lark is resident throughout Oklahoma in level or gently sloping areas of very low vegetation or none (plowed fields). At the Rucker tract I recorded it on all but four surveys. Up to the middle of February I saw it in flocks of three to five. On February 3 I saw a flock of about 20. That was a harsh, overcast day with strong constant wind, intermittent rain, and (during my survey) temperature between 38° and 40° F. From February 17 on I saw five or fewer larks per survey, single birds which usually flew up from short grass. On the tract I saw larks principally among wire grass in the abandoned fields and in high rocky areas of the pasture where the vegetation is less than an inch high. Neither of these preferred habitats provided insulation or protection from the wind.

In the vicinity of Norman pairs are formed and nests built early; the earliest nest of which I have record held four eggs on March 31, 1954.

Larks go about in flocks throughout the non-breeding season, but the flocking is accented during harsh weather and when snow forces the birds to feed in areas swept bare by the wind. On December 31, 1954, when several inches of snow covered most of the ground, Richard R. Graber and I found a concentration of at least 100 larks plus two Mourning Doves, several meadowlarks, a few Lapland Longspurs, and many English Sparrows on the bare ground around cattle-feeding bunkers near the Rucker farm

buildings a half mile south of the tract.

Corvus brachyrhynchos.# I recorded one to many Crows on all surveys except those of December 20, February 24, and March 3. On several surveys I saw only flying birds. On and after February 17, I heard Crows "mobbing" Great Horned Owls which had an occupied nest in the main ravine. The single Crow I saw on March 24 flying low over the tract may have been one of a pair which built a nest in a 25-foot buckthorn tree several yards south of the tract. I found this nest on April 7, on which date it appeared to be newly completed.

Parus carolinensis.# I saw one to five Carolina Chickadees on every survey except that of December 20. Invariably I found the species among trees, a favorite haunt being the main ravine. On January 26 and February 12 I found at least two birds in the isolated grove; however, on February 3, an overcast day with strong wind (temperature 38° to 40° F.), I found none there. On February 17, I saw two chickadees in a solitary tree at least 200 yards from any other woody vegetation in the northeast corner of the tract. This observation provides evidence that the species sometimes flies over open prairie. A favorite feeding place is a stand of tall dead weeds, but stands of this sort are usually among, or near, trees. The chickadee is one of the most common and widespread birds of the ecotone.

Parus bicolor.# I saw the Tufted Titmouse infrequently at the tract, and only in the main ravine: November 14, March 10, and March 24--never more than five individuals per survey. While the Carolina Chickadee is spread throughout the wooded parts of the ecotone, the Tufted Titmouse occurs principally in the savannah and the floodplain forests.

Thryomanes bewicki. Bewick's Wren is believed to be a resident, i. e., non-migratory, species, but it is much more noticeable in summer than in winter. It is a bird of the underbrush, though it requires an elevated song-perch. At the Rucker tract I found it on six surveys, always in wooded ravines. On February 12, March 3, March 17, March 24, one bird was at the head of the main ravine among small trees, green briar thickets, and shrubs near abandoned oil well machinery and buildings; it scolded on the latter two days and may have nested there later (my earliest nest record in central Oklahoma: April 2, 1955). Another bird was present about 75 yards farther down the ravine on March 3 and March 17. In the small ravine (vegetation principally low trees, shrubs, and vine thickets) in the eastern part of the tract, I saw one bird on December 20 and February 17; this ravine leads into a large wooded ravine across the road to the east where I heard other individuals.

Bewick's Wren, though not abundant, is widespread over the ecotone wherever brush or undergrowth occur in either urban or rural areas. I have never seen more than two individuals in any given place during winter.

Thryothorus ludovicianus.# I saw the Carolina Wren only in the main ravine: two birds November 14, one bird January 6, and one bird March 17. I never encountered it in the isolated grove nor in the small eastern ravine. In winter this species is seen in the underbrush of low, well-wooded areas throughout the ecotone, occasionally in town.

Turdus migratorius.# I found the Robin on eight of the 16 surveys. During early winter the few birds I saw were in the main ravine: five birds November 14, two birds December 31, two birds January 6. These

Sturnus vulgaris. The Starling is found throughout the state the year round. In central Oklahoma it winters abundantly, but it breeds in smaller numbers and principally in urban areas. I recorded it on only two surveys actually within the tract, though I saw many more in the fields surrounding the tract. On December 8 a flock of at least 250 birds was feeding in the pasture, and on January 6 I saw a flock of at least 100 birds; the flocks seemed restless, periodically breaking up into smaller groups, then re-forming.

The numbers of Starlings wintering in the Norman area appeared to vary considerably from 1952 to 1955, and the distribution of the flocks has been irregular. On November 27, 1952, a large number--at least 5000 individuals--invaded the campus; all except a few left within a day or two. At the 1952-53 winter blackbird roost (six miles northeast of Washington, McClain County, within the floodplain of the South Canadian River) Starlings comprised no less than 30 per cent of the birds; in contrast, less than one percent of the birds at the 1954-55 roost (15 miles southeast of Norman, within the savannah) were Starlings. At the earlier roost Starlings, when flushed from the grass, almost invariably flew as a group high into nearby trees, while Red-wings usually moved into low trees or into the grass at a distance; the two species seemed to intermingle freely when actually roosting. On the Christmas Bird Census of January 2, 1955, only about 900 Starlings were counted within a radius of seven and one-half miles of Norman. During the whole winter of 1954-55 I saw few flocks of more than 50 birds, distributed widely over the ecotone but primarily west of the savannah and seldom at the same places on succeeding days. Although I frequently saw, in rural areas, a few Red-wings or meadowlarks with the

Starling flocks, the latter species fed and flew more or less independently.

Sturnella magna and S. neglecta. The Eastern Meadowlark is resident in all except the northwestern counties of the state and the panhandle. The Western Meadowlark winters abundantly in central and western Oklahoma, and nests in the western half. Here its breeding range overlaps that of the Eastern.

Both meadowlarks inhabited the Rucker tract throughout my winter surveys. I recorded from about 20 to about 250 (total of both species) per survey. Since the two species are indistinguishable in shape and color in the field, my identification was based only on the distinctly different songs. (Many workers believe that identification by song is dubious. For example, on April 26, 1953, I collected a bird having a thoroughly "Eastern" song, then found yellow in the specimen's malar region.) I heard from one to about 25 Eastern songs per survey, none on December 31 and February 24. The number of Western songs varied from one to about 30 per survey, though I heard none on December 31, January 6, January 16, February 3, February 12, February 24, and March 24. Usually I heard more Eastern songs than Western, but the ratio varied considerably and I am not at all sure that the Eastern Meadowlark was actually commoner than the Western.

The amount of meadowlark singing seemed to vary, roughly, with the severity of the weather. On February 3, an exceptionally harsh, overcast day, I saw at least 150 birds yet heard only one song, an Eastern. Occasionally I heard distinctly "hybrid" songs. The two species seemed to intermingle freely until early March. By the second week of March I

encountered only widely separated singing Easterns. The Eastern Meadowlark starts nesting in early April in the Norman region. At this time the Westerns are still in flocks. The Westerns leave by mid-April.

Meadowlarks are abundant in places having little or no woody vegetation, and seldom occur within the wooded savannah of central Oklahoma. They feed principally on the ground but often perch on and sing from fences, stout weeds, trees, etc. I have often seen flocks perched high in trees in early morning before the sun's rays reached the ground.

Agelaius phoeniceus. The Red-wing inhabits Oklahoma at all seasons; as a breeding bird it is, however, decidedly local. The size of the wintering population varies considerably in Cleveland County from year to year. I saw the Red-wing on only three Rucker tract surveys: a flock of about 10 flying birds on November 14 and February 12, and several small flocks totaling at least 100 flying birds on January 16. Although I saw no Red-wings feeding or resting within the tract, often I watched them feeding in a farmyard half a mile to the south.

In central Oklahoma the Red-wing flocks winter principally west of the savannah; I have seen them feeding in winter wheat and corn stubble, about cattle corrals, and in heavily overgrazed pasture. The few Red-wings which winter in the savannah frequent cultivated fields and pasture. When flushed, the flocks alight in trees or on wires, poles, etc.

Central Oklahoma's winter blackbird roosts are notable. The flocks form each evening from about mid-December to early February. More than a million blackbirds roosted in a relatively small area six miles northeast of Washington, McClain County, in 1952-53. About 25, 000 birds composed a roost fifteen miles southeast of Norman in 1954-55. The two

roost areas were similar both topographically and vegetationally. Each was an elongate depression or shallow valley, on the floor of which was a dense growth of coarse grass and a scattering of small trees and shrubs. On the periphery of each roost area were mature trees up to 80 feet in height. These shallow valleys were comparatively windless, but the temperature at night was, because of cold air drainage, somewhat lower than that of adjacent elevated areas. Unlike roost areas in other sections of the country, these two roost areas were entirely devoid of standing water.

Richmondena cardinalis.# I saw the Cardinal on eight surveys--in the main ravine except on November 23 and February 17, when I saw it in the small eastern ravine. Both ravines have a brushy understory. Except for November 23, when a concentration of at least five (both males and females) was present in the small ravine, I saw no more than two individuals per survey.

Spinus tristis.# On the first seven surveys (up to mid-January) I found small flocks (up to ten birds) of Common Goldfinches feeding here and there among the stout dead stalks of such forbs as Helianthus along ravines and fence rows, or flying over open pasture. After mid-January I recorded the bird less frequently but in larger flocks: on February 3 a flock of 23, and on February 24 a flock of about 35, on fence wires along the western border.

Passerculus sandwichensis. The Savannah Sparrow is well distributed in winter over the central Oklahoma ecotone in open and semi-open areas. I saw it on eight of the 16 Rucker tract surveys, usually in loose groups of two to five birds, and I never identified more than seven on

any one survey. Occasionally I flushed it from deep grass in the pasture, but its favorite habitat was the tall weeds along fence rows or at the edge of ravines. On February 24 I saw two with several Tree Sparrows in the "broomweed area" at the northwestern corner of the tract. Both of these species, when alarmed, fly up to perches within 15 feet of the ground--fence wires, shrubs, lower limbs of trees, etc.

The Savannah Sparrow is very common in the vicinity of Norman. It is especially fond of dense grass and of weeds growing along fence rows and in places which have been disturbed by heavy grazing, plowing, etc. When not feeding it often flies up to low, exposed perches.

Passerherbulus caudacutus. Leconte's Sparrow visits Oklahoma only in winter, but its distribution and habitat preferences are not adequately known. It seems to fluctuate considerably in abundance.

On January 6, George M. Sutton and I flushed a small weakly-flying sparrow--probably this species--from dense grass 12 to 18 inches high in one of the tract's drainage areas. On November 14 (1954), about one-fourth mile south of the tract, Richard R. Graber flushed a bird which he thought was this species; it was in dense wire grass.

In central Oklahoma I have found this sparrow restricted to places having such growths of dense grass. During the winter of 1953-54 it was common in the taller grass and weeds at the North Base; on November 11, G. M. Sutton saw at least 200 (an unusual concentration) there, and other persons, including myself, saw at least half a dozen on each visit to this open, treeless field until March 20. The following winter (1954-55) the birds were absent there: cattle had grazed over the entire field, leaving the grass no more than a foot high, very little of which

was dense. I have only one record of the species from the savannah: on January 6, 1955, R. R. Graber saw several at the Lexington Public Hunting area, 15 miles southeast of Norman.

Junco hyemalis.# I found flocks of five to 25 Slate-colored Juncos throughout the winter (11 of the 16 surveys). Usually they were in the trees and shrubs of the main ravine or feeding in the adjacent field. On November 23 I saw a flock of five with several chickadees in the shrubs and low trees of the eastern ravine; on December 20 I saw at least two juncos in the same place. Only on February 3 did I find juncos in the "patch" of dense broomweed; the lowness of the area and denseness of the vegetation may have provided some protection from the exceptionally strong, cold wind blowing that day.

Spizella arborea.# I saw the Tree Sparrow on nine surveys, from five to 15 birds per survey, and none after March 10. I found it principally in the underbrush along the edge of the main ravine, sometimes with Slate-colored Juncos; in low weeds and green briar just west of the isolated grove; among dead stalks of broomweed and other stout weeds in the northwestern corner of the tract; and--on February 3, February 24, March 10, all exceptionally windy days--among weeds in the floor of the narrow, steep-sided gullies in the northern part of the tract. At all these places grew scattered 10- to 15-foot trees (higher along the main ravine) into which the birds flew when flushed.

Spizella pusilla.# The Field Sparrow winters irregularly in wooded and brushy parts of the central Oklahoma ecotone. I saw it on only one survey of the Rucker tract--a flock of five, January 6, in the main ravine.

Zonotrichia querula.# A flock of about ten Harris's Sparrows inhabited the main ravine; usually the birds frequented thickets and vine-covered trees at the very edge, though occasionally I saw one singing from a high, exposed perch. I recorded the species on seven surveys (November 24 to January 19), not at all from January 26 to March 10.

Discussion of Wintering Birds

Composition of the Wintering Population

The wintering avian population in central Oklahoma is composed of two major elements, winter visitants and residents (Table 1), each of which may be further subdivided into two basic categories.

TABLE 1

COMPOSITION, DISTRIBUTION, AND MANNER OF OCCURRENCE OF WINTERING BIRDS

Name of bird	Resident	Winter visitant	Diehm Tract	Rucker Tract	Both tracts	Solitary	Usually in flocks	
							Seldom in mixed flocks	Often in mixed flocks
Red-tailed Hawk	x				x	x		
Rough-legged Hawk		x		x		x		
Harrier		x		x		x		
Sparrow Hawk	x			x		x		
Bob-white	x				x		x	
Killdeer	x			x			x	
Great Horned Owl	x			x*		x		
Belted Kingfisher	x		x			x		
Yellow-shafted Flicker	x				x	x		
Red-shafted Flicker		x			x	x		
Pileated Woodpecker	x		x			x		
Red-bellied Woodpecker	x				x	x		
Red-headed Woodpecker	x		x				x	
Hairy Woodpecker	x				x	x		

TABLE 1--Continued

Name of bird	Resident	Winter visitant	Diehm Tract	Rucker Tract	Both tracts	Solitary	Usually in flocks	
							Seldom in mixed flocks	Often in mixed flocks
Downy Woodpecker	x				x	x		
Horned Lark	x			x			x	
Blue Jay	x		x				x	
Crow	x				x		x	
Carolina Chickadee	x				x			x
Tufted Titmouse	x				x		x	
Brown Creeper		x	x			x		
Bewick's Wren	x			x		x		
Carolina Wren	x				x	x		
Robin	x				x		x	
Eastern Bluebird	x				x		x	
Golden-crowned Kinglet		x	x				x	
Loggerhead Shrike	x			x		x		
Starling	x			x			x	
Eastern Meadowlark	x			x				x
Western Meadowlark		x		x				x
Red-wing	x			x			x	
Cardinal	x				x		x	
Common Goldfinch	x				x		x	
Spotted Towhee		x	x				x	
Savannah Sparrow		x		x			x	
Leconte's Sparrow		x		x			x	
Slate-colored Junco		x			x			x
Tree Sparrow		x			x			x
Field Sparrow	x				x			x
Harris's Sparrow		x			x		x	
White-throated Sparrow		x	x				x	

*Distributed widely over the ecotone but not found at Diehm tract.

Winter visitants are those species which spend all or part of the winter at a locality, but rarely if ever remain to breed. Such species as the Harris's Sparrow, Slate-colored Junco, and Tree Sparrow breed far to the north of Oklahoma; other winter visitants, such as the Song

Sparrow and Spotted Towhee, although not known to breed in central Oklahoma, nest nearby.

Resident species are those which occur at a locality throughout the year. The Carolina Chickadee, Cardinal, Carolina Wren, and Downy Woodpecker, all non-migratory forms, are true "permanent" residents in that the many individuals representing the several species remain here throughout the year. Such species as the Blue Jay, Robin, and Common Goldfinch are not residents in the true sense of the word since the breeding populations of these species present in central Oklahoma in the spring and summer are replaced or augmented during the winter by other populations which move in from the north in the fall. Much work with individually marked birds must be done before the true status of some of these "resident" species of this category can be ascertained.

Of the 41 species of wintering birds considered in this paper, 28 (about 68 per cent) are resident in one or the other sense, and 13 (about 32 per cent) are winter visitants.

General Distribution of Wintering Birds over the Forest-Prairie Ecotone

Since each bird species seems to have its own peculiar habitat or habitat niche, a thorough discussion of the distribution of all species over the central Oklahoma ecotone would involve some sort of re-statement concerning the habitat of each one. Nevertheless, if this fact is kept in mind, broad statements regarding species frequenting major vegetational types may be made and a general distributional pattern seen. The populations at the Diehm tract (principally forest) and the Rucker tract (principally prairie) included a total of 41 species; nineteen were common

to both tracts, eight were found only at the Diehm tract, and 14 were found only at the Rucker tract (Table 1).

All of the 19 species common to both tracts frequented some type of woody vegetation--shrubbery, trees, brush piles, etc.--in feeding, in perching, or for refuge. The presence of woody vegetation was not absolutely essential to the Bob-white, Eastern Bluebird, Common Goldfinch, and Tree Sparrow, and they sometimes occurred far from such vegetation. The Red-bellied Woodpecker, Tufted Titmouse, Carolina Wren, Robin, Cardinal, and Harris's Sparrow seemed to require a more or less extensive growth of trees, though not necessarily dense; at the Rucker tract I found them almost entirely in the wooded ravines or immediately adjacent to them. The rest of the species common to both tracts, the Red-tailed Hawk, both flickers, the Hairy and Downy Woodpeckers, the Crow, the Carolina Chickadee, the Slate-colored Junco, and the Field Sparrow, were not restricted to the well-wooded parts of either tract but occurred at times in the isolated trees and other scattered woody vegetation.

The Rucker tract did not provide the special habitats required by three species recorded by me at the Diehm tract--the Belted Kingfisher, Pileated Woodpecker, and Red-headed Woodpecker. I did not see and would not expect to see any of these in the prairie during winter. Five other species, the Blue Jay, Brown Creeper, Golden-crowned Kinglet, Spotted Towhee, and White-throated Sparrow, were similarly absent from the Rucker tract. In so far as central Oklahoma is concerned, these are savannah species, but I saw them occasionally in wooded prairie ravines, and I would not have been surprised to have found them in the main ravine of the Rucker tract.

Of the 14 species I recorded only at the Rucker tract, seven are restricted to the prairie or occur only rarely in the savannah. These are the Harrier, the Horned Lark, both meadowlarks, the Sparrow Hawk, the Killdeer, and the Loggerhead Shrike. Although I recorded the Rough-legged Hawk, Bewick's Wren, Starling, Red-wing, Savannah Sparrow, and Leconte's Sparrow principally in the prairie, they did frequent the savannah in lesser numbers. The Great Horned Owl is distributed widely in the wooded parts of the ecotone, but I did not happen to find it at the Diehm tract.

In general, I found the habitats of the South Canadian River floodplain not distinctly different from those of the prairie or savannah; consequently, the floodplain had no unique bird populations. None of the 41 species was restricted to the floodplain. In other words, the habitats of birds occurring in the floodplain were essentially the same as those of the prairie and savannah species. In both habitats the vegetation had the same "life-form."

In their search for food, etc., wintering birds move about considerably, some species over wider areas than others. None of the 41 species occurred exclusively in extensive areas of uniform vegetation; that is, all frequented edge habitats at one time or another in winter. Some resident species, e. g., the Cardinal, were virtually restricted to edge habitats in winter, though they often moved into the forest interior to nest.

Manner of Occurrence of Wintering Birds

Of the 41 species, I found that 16 (about 39 per cent) exhibited little or no tendency to form flocks (Table 1). (As used here the word

"flock" refers to two or more non-breeding individuals occurring together.) These were the birds of prey, the woodpeckers except for the Red-headed Woodpecker, the Loggerhead Shrike, and three passerines--the Carolina Wren, Bewick's Wren, and Brown Creeper. Several of the flocking species, such as the Carolina Chickadee, Blue Jay, and Robin, occurred either in loose flocks or as solitary individuals. Other species, as the meadowlarks, Slate-colored Junco, Red-wing, and Common Goldfinch, almost invariably formed closely-knit flocks. Only six species regularly flocked with other species--the Carolina Chickadee, Eastern Meadowlark, Western Meadowlark, Slate-colored Junco, Tree Sparrow, and Field Sparrow. No distinction is made here between true flocks, i. e., "voluntary" associations of individuals because of a gregarious urge, and flocks formed by congregations of individuals thrown together only because the environment which each bird individually seeks is limited (Wing, 1941).

CHAPTER IV

BREEDING BIRDS

Although I obtained much information on the habitat preferences of breeding bi ɜ in central Oklahoma through general observation, principally in Cleveland and McClain Counties, the core of this investigation was the censusing of several plots representing major vegetational types of the ecotone. These habitat types were: (1) upland oak forest, with open understory; (2) upland scrub oak forest, with dense understory; (3) well-developed bottomland forest; and (4) moderately overgrazed pasture. Birds breeding in edge habitats in the vicinity of the plots were also studied. Data obtained in the census of a fifth plot--lightly-grazed tall grass prairie habitat--were, I feel, insufficient to present a reliable picture of the breeding bird population therein, and therefore are not included as such in this paper.

Fish Estate Upland Oak Forest Plots

The two Fish Estate upland oak forest plots are rather alike in topography and vegetation. Together they represent a vegetational type between the original true savannah extreme and the dense scrub oak forest extreme. As part of a long-term investigation of the deciduous forest frontier, Rice and Penfound (1955) made during the summer of 1954 a census

of all woody plants with a DBH (diameter breast high) of three inches or more within the two plots. They described the tract within which the plots were located as follows:

> The stand upon which the census was executed is located 15 miles east and one mile south of Norman, Oklahoma. It is in the southwest quarter of section 25, T9N, R1E, Cleveland County. The 160 acre tract is on gently rolling topography, with a ravine traversing the western portion in a north-south direction. According to reliable information, the tract had never been cut over, had been grazed only lightly, but had been burned-over periodically. The stand is fairly dense with considerable woody undergrowth on the slopes and in the flats along the ravine, but is rather open with a good grass cover in the higher and drier portion of the tract.
>
> The dominants, as indicated both in the reconnaissance and in the census, are blackjack (oak), Quercus marilandica Muenchh., and post oak, Quercus stellata Wang. Common secondary species are (black) hickory, Carya texana Buckl., and black oak, Quercus velutina Lam. Twenty-three other woody plants, as well as numerous grasses and forbs, were encountered in the stand.

The two plots were parallel, about 100 yards apart, and rectangular, being much longer than wide; the area of the south plot was 4.36 acres, of the north plot 4.63 acres. As to the vegetation within the plots, Rice and Penfound stated:

> . . . the composition of the south and north plots varied somewhat although the order of abundance was similar. . . . In the south plot, there were considerably more blackjacks than in the north plot, whereas there were fewer post oaks, hickories, and black oaks. The number of trees per acre was greater in the south plot.
>
> Compared with most deciduous forest, the total basal area is very low (52.3 square feet) in the blackjack-post oak stand. Of the basal area for the entire stand, blackjack and post oak contributed over 86 per cent. Although blackjack trees outnumbered post oak trees by more than two to one, the basal areas of these species were similar in both plots. . . . This is correlated with the fact that only one per cent of the blackjacks, as against 28 per cent of the post oaks, possessed a DBH of 12 inches or over. Compared with the post oak, the blackjack had the higher basal area in the south plot but a lower value in the north plot. This reversal is due primarily to the lower number of blackjack trees in the north plot.

The axes of both plots run in a roughly east-west direction. In the north plot (145 feet by 1392 feet) the forest was fairly uniform

and contained relatively little undergrowth; about 100 feet east of the plot was grassy field, and about the same distance to the west was an open area cleared during recent exploration for oil. The trees in the south plot (145 feet by 1310 feet) were also of fairly uniform distribution; there was little undergrowth except toward the west end where the land sloped down toward a ravine. A little-used county road passed about 85 feet to the south of the east end of the south plot and approximately 350 feet south of the west end (Figure 4c). The dense vegetation along the north side of this road had a decided effect on the breeding bird population of the south plot.

Rice and Penfound delineated their plots by painting rings on boundary trees. Since it was essential that I record as exactly as possible the position of the birds, it was necessary to devise a grid system; this I did by hanging numbered strips of white cloth, weighted at the bottom end, at intervals of 50 feet along the previously marked boundaries, thus dividing the plots into squares approximately 50 feet on a side. I could, with little danger of duplication, record on a form the positions of nearly all the birds present.

The censusing of the Fish Estate plots was done between May 24 and June 15, 1955. Census dates are listed on Figures 4a and 5a. Each census was taken in the early morning, generally before the birds had ceased to sing. Though I found very few occupied or old nests, I obtained evidence that several birds were breeding on the plots or in the immediate vicinity.

In Figures 4a, 4b, 4c, 5a, 5b, and 5c, symbols are used to indicate the locations of the various species; small numbers adjacent

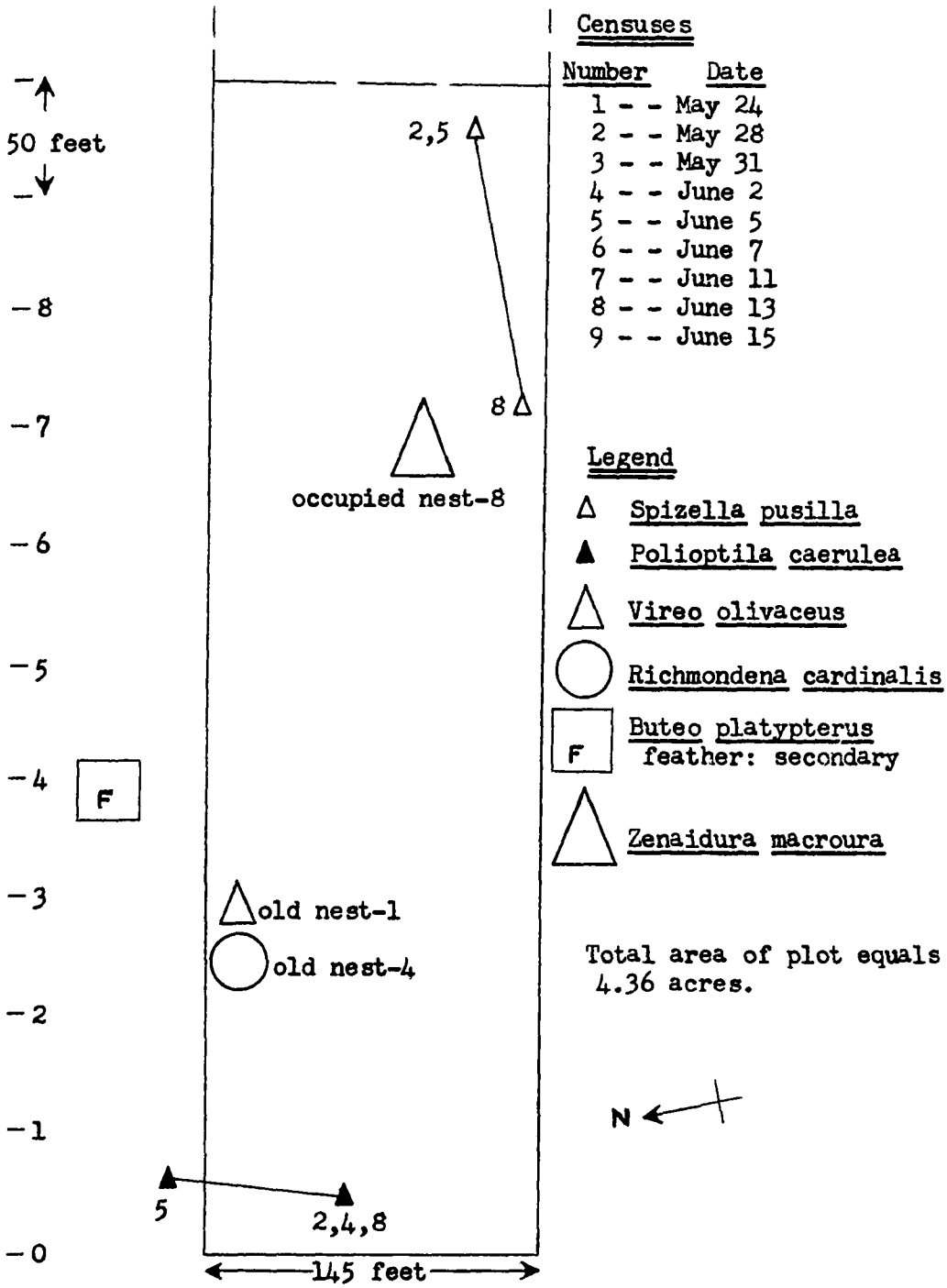

Figure 4a. Breeding Bird Census. Fish Estate Upland Oak Forest. South plot: western section.

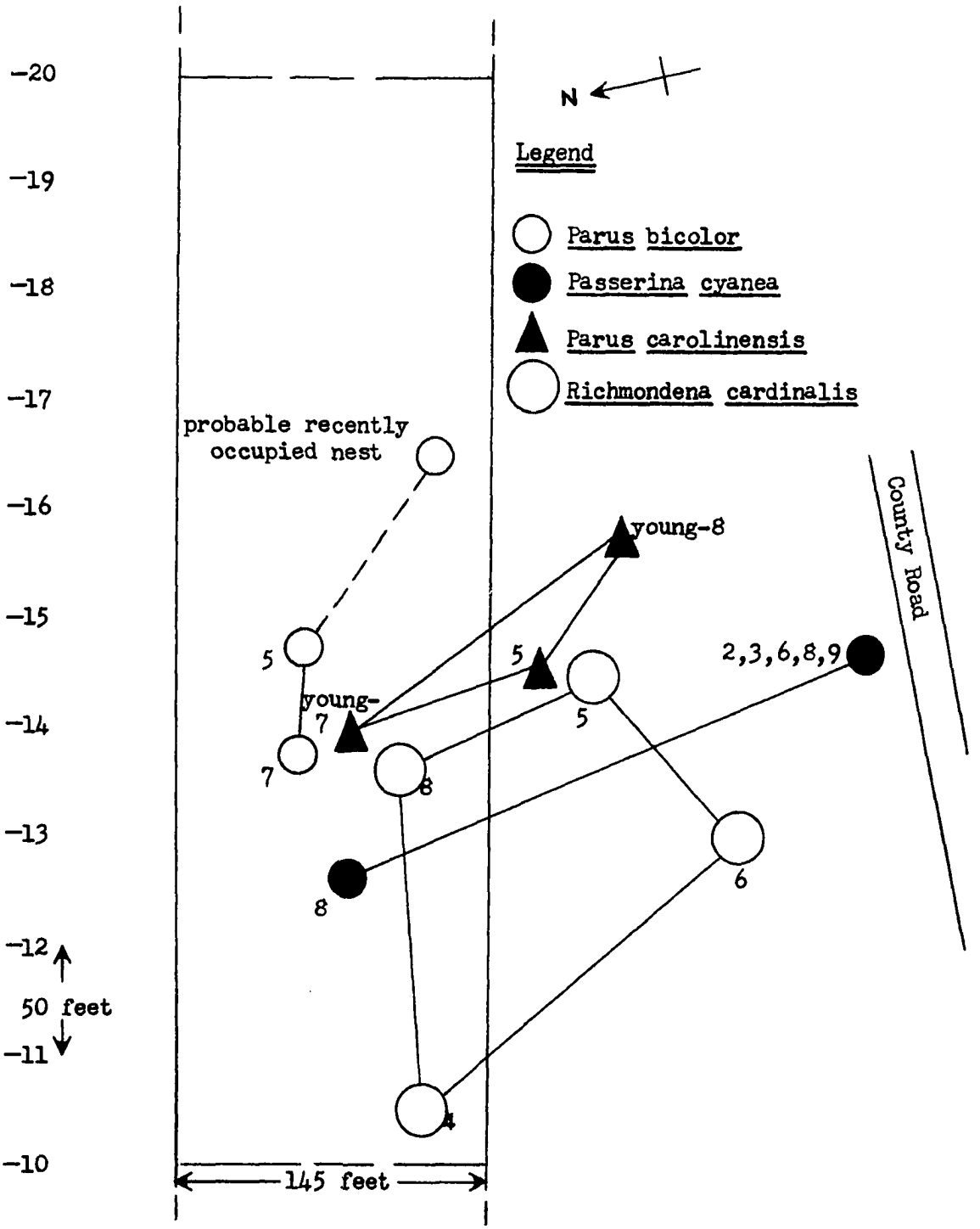

Figure 4b. Breeding Bird Census. Fish Estate Upland Oak Forest. South plot: central section.

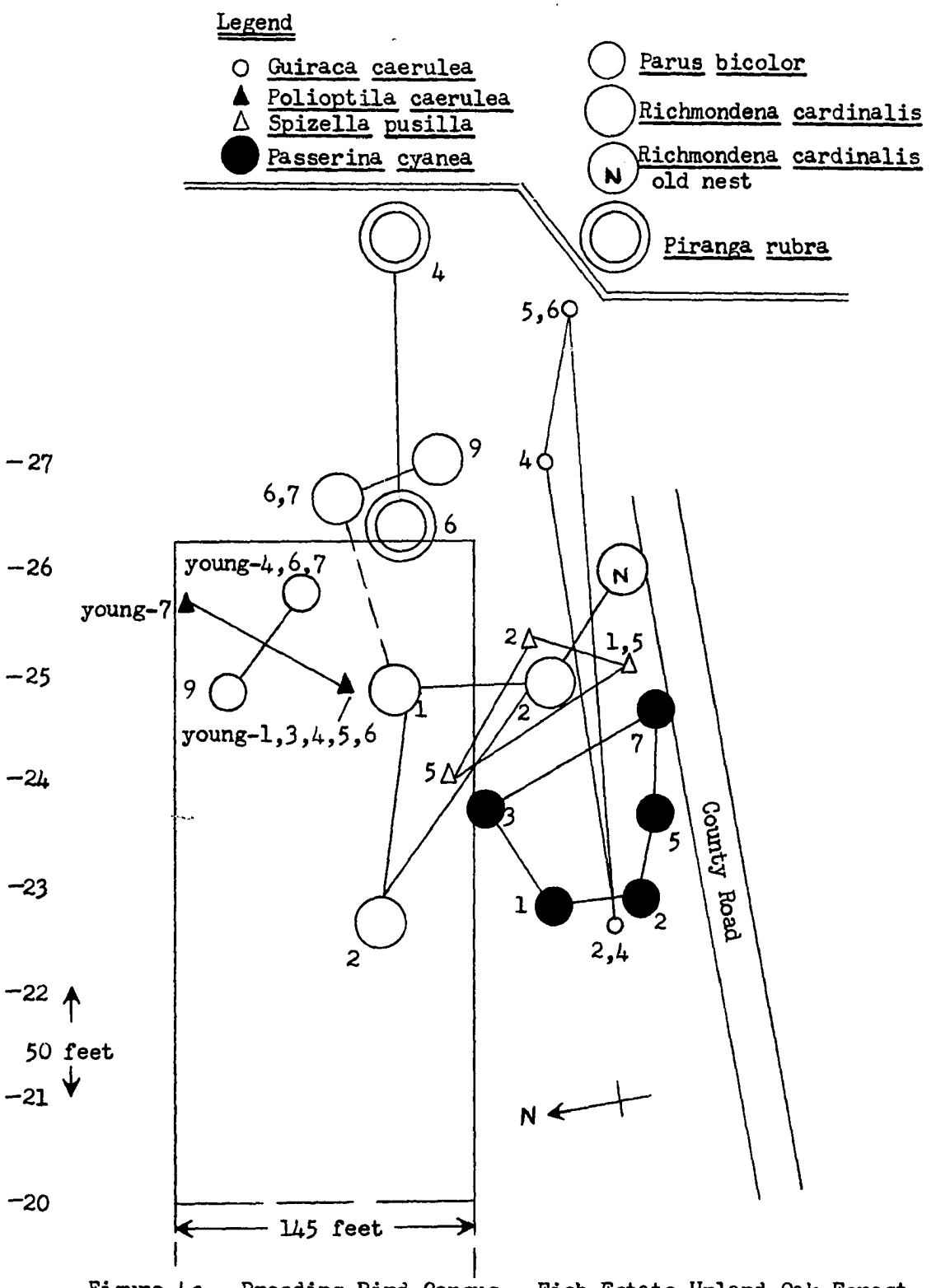

Figure 4c. Breeding Bird Census. Fish Estate Upland Oak Forest. South plot: eastern section.

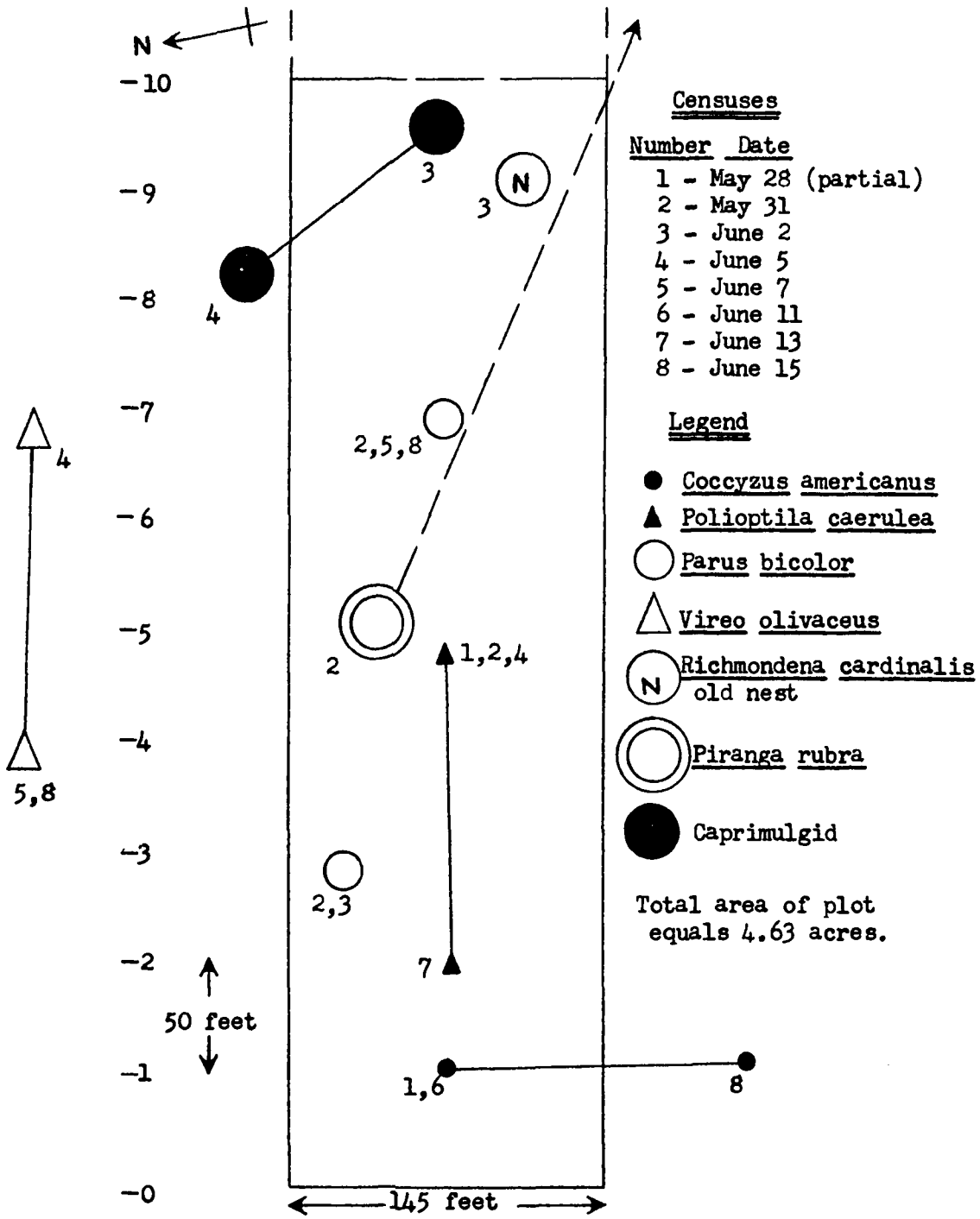

Figure 5a. Breeding Bird Census. Fish Estate Upland Oak Forest. North plot: western section.

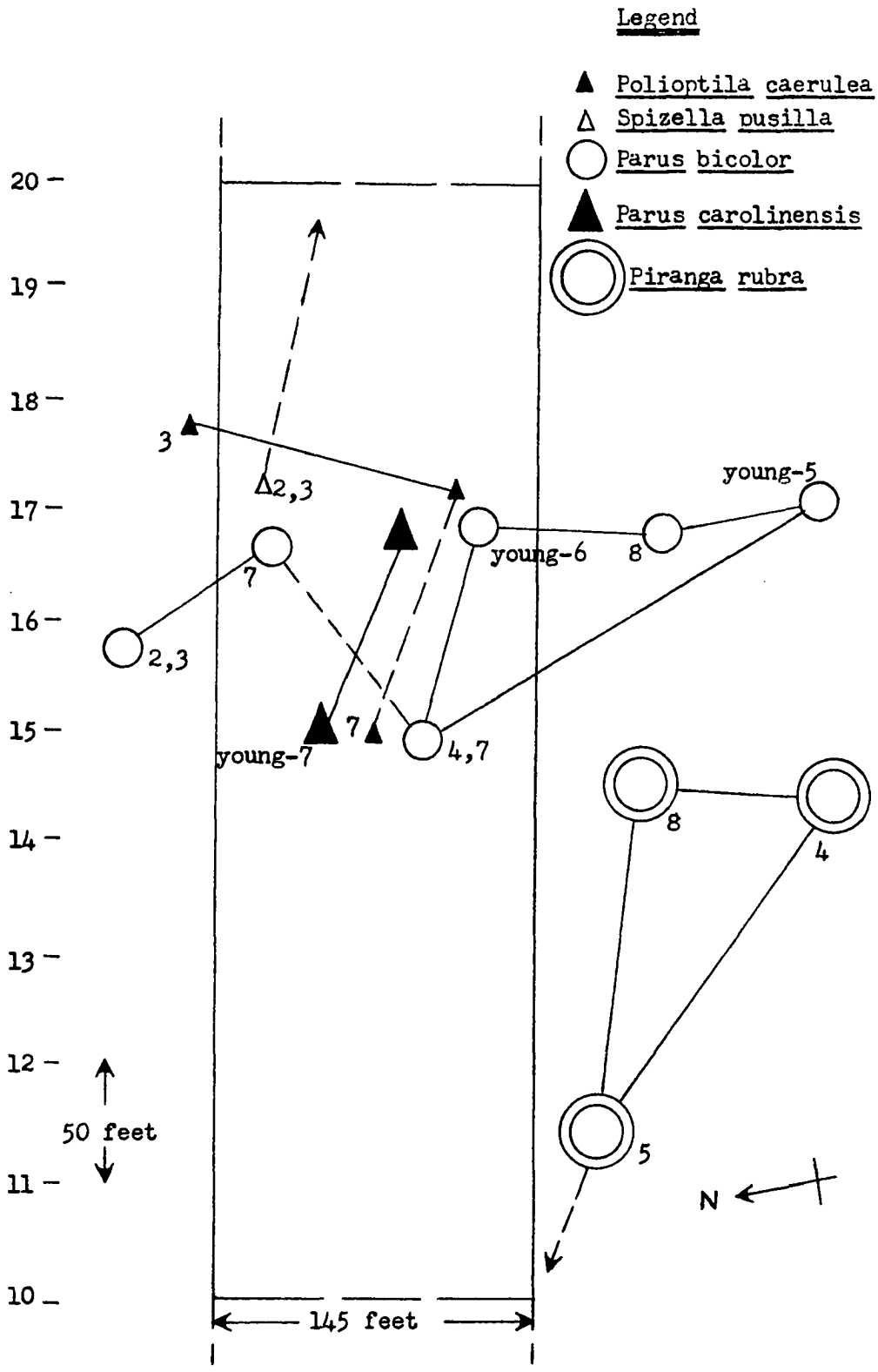

Figure 5b. Breeding Bird Census. Fish Estate Upland Oak Forest. North plot: central section.

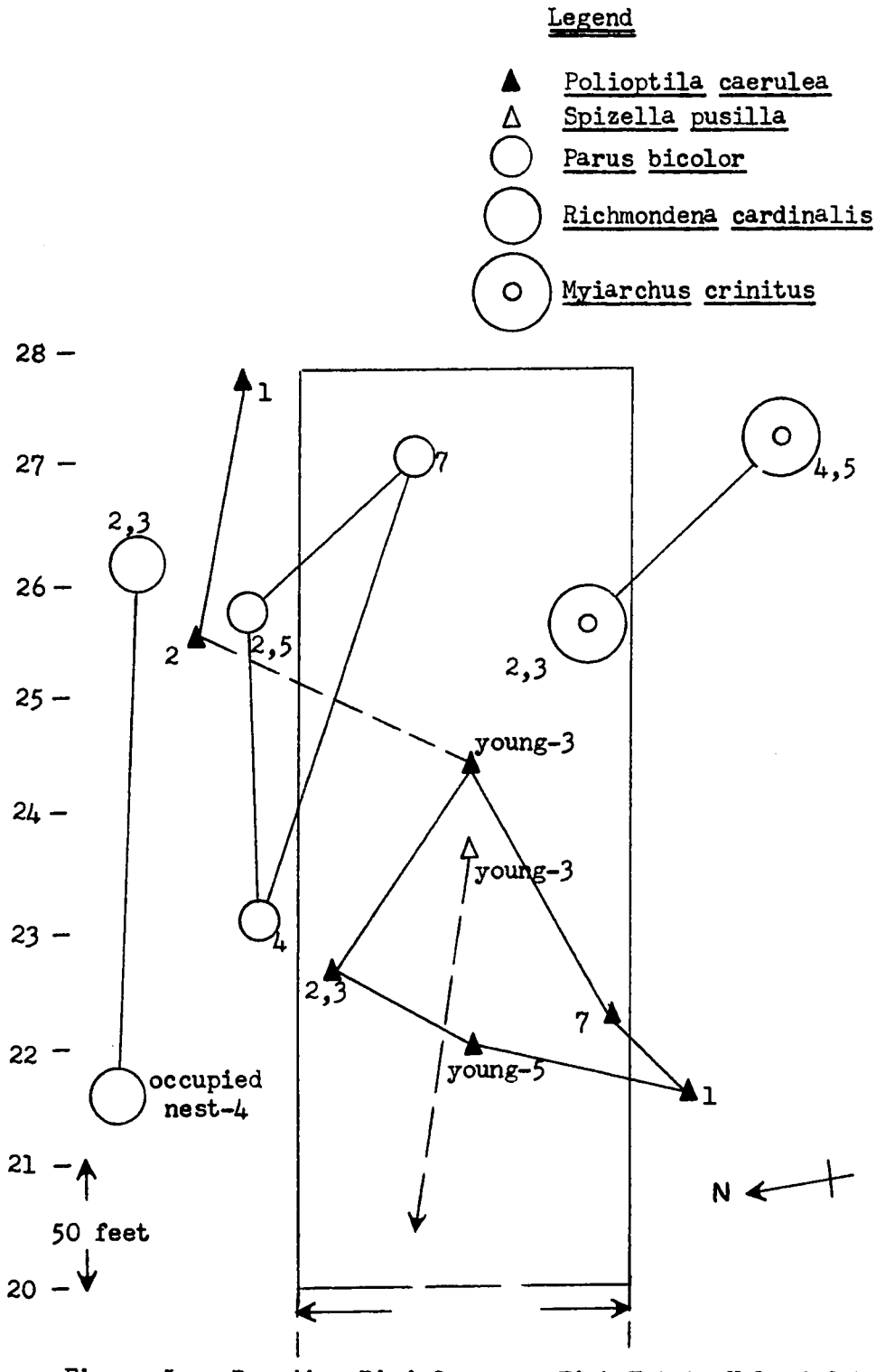

Figure 5c. Breeding Bird Census. Fish Estate Upland Oak Forest. North plot: eastern section.

to the symbols refer to the census number or numbers (listed on Figures 4a and 5a). Solid lines between like symbols indicate the likely repeated occurrence of the same individual bird or birds within a relatively small area; broken lines indicate questionable relationships. Although I encountered (and recorded on the original forms) many more individuals and several other species than are shown in the figures, only those birds are entered which regularly occurred at certain locations or which, for some reason, I believed to be worth mentioning.

The birds known or believed to be breeding within the plots are categorized as follows: (1) species known or thought to be breeding (occupied nests, repeated occurrence of singing males, recently occupied nests, food-carrying, etc.); (2) species possibly breeding (infrequent occurrence of singing males, old nests, etc.). In addition, species are discussed whose territories included some portion of the plots, and whose nests were probably along the forest edge or in the wooded ravine to the west.

Those species marked with an asterisk (*) are discussed further in a later section of this chapter.

Species Known or Thought To Be Breeding within the Plots

Zenaidura macroura. The Mourning Dove is a bird of edge habitat. It nests so seldom within the forest that I was surprised to find, on June 13, an occupied nest about 350 feet from the west edge of the south plot (Figure 4a) and about 400 feet from the forest edge to the south. The nest was in a post oak and it held two fresh eggs. During the entire census period I recorded the dove only three times within or immediately

adjacent to the plots; it cannot be counted as a regular inhabitant of the forest interior at any time of year.

The dove is one of the most abundant breeding birds in central Oklahoma. The peak of its prolonged nesting season (mid-March to late September) seems to be May and early June. With the exception of the nest mentioned above, all of the 32 occupied nests of which I have record were in areas of scattered woody plants, along forest edges, or in wooded prairie ravines. Although the dove nests in both urban and rural areas, it tends to start about three weeks earlier in town than in the country; this is probably correlated with the greater availability of food in the urban environment in early spring. Characteristic nesting habitats of this species are: tall planted trees in yards of residential areas; rows of 15-to-20-foot elms at edges of densely-wooded ravines; planted elms and junipers in parks and campuses; areas of isolated trees with tall grass undercover; groups of mature willows; apple and pecan orchards. Thus the dove nests in a great variety of edge habitats.

The vertical range within which the dove nests is considerable; in central Oklahoma I have found nests as low as three feet and as high as 20 feet. I have found no ground nests. Of 22 nests, 14 were less than ten feet up, three were between 15 and 20 feet, the average approximately 9.8 feet. In general, nests in urban areas were higher than those in the country. Most nests were in deciduous trees, junipers, and pines, but some were in stout vines.

Richmondena cardinalis.* Although I found no occupied nests of the Cardinal within the Fish Estate plots, I came upon much evidence of its breeding there. I found three recently-used nests within or near

the plots, and an occupied nest (three fresh eggs on June 7) about 135 feet north of the north plot (Figure 5a) six feet above ground in a small hickory. All of the nests were visible at a distance, were within ten feet of the ground, and were in trees not more than 15 feet tall in areas throughout which there was little underbrush. Several times at the south plot a male bird flew completely across my line of vision (several hundred feet in the more open places). The Cardinal was extremely rangy in this type of habitat. The territories or home ranges of three singing males seemed to lie partly within the plots; four males may have been present, but there is a possibility that the individual heard on June 7, 11, and 15, near the east end of the south plot may have been the same individual heard on May 24 and 28 within the plot, 150 to 250 feet west (see Figure 4c). The number of territorial males in the plots (total area 8.99 acres) was therefore 0.33 to 0.44 per acre. However, it should be pointed out that, as seen in the figures, they were not distributed uniformly within the plots. Cardinals were heard frequently also to the west of the plots in the ravine, and were probably nesting in vines and small trees there.

Parus carolinensis.* All the resident cavity-nesting birds of central Oklahoma start breeding early in spring. The Carolina Chickadee begins in March. On the Fish Estate plots I found it regularly (June 5, 11, 13, and 15) at only two places, and at these places I saw small flocks, presumably composed of parent birds and their young, identical in appearance. I failed to see any actual feeding of young. In the plots there were several nest cavities which could have been used by this species.

Observations over several years lead me to believe that, although

the chickadee nests in a variety of habitats, it prefers open areas with widely-spaced trees; this preference may account in part for the low breeding population at the Fish Estate upland oak plots.

Parus bicolor.* From early spring to late fall the insistent "peter-peter" of the Tufted Titmouse is the most frequently heard bird song in the upland forests and prairie ravines of central Oklahoma. Since, like the chickadee, it nests early and is probably one-brooded, the evidence for its breeding on or near the Fish Estate plots is the presence of family groups. One such group was regularly present in each plot; on several occasions (June 2, 7, and 11) I clearly saw the stub tails of the young birds. Singing birds, probably breeding individuals, were regularly recorded in four other locations within the plots.

Polioptila caerulea.* The Blue-gray Gnatcatcher returns to Cleveland County in mid-March, and is present in some numbers by March 25. By mid-April it is incubating eggs in its inconspicuous, usually high, nest. While some individuals may have had occupied nests during the censusing period, it is probable that most of the young had been fledged. I recorded this species regularly in the south plot only at the extreme eastern and western ends; fledglings were present in the group at the east end. A family group (feeding of young observed) remained within 150 to 300 feet of the east end of the south plot.

In central Oklahoma the gnatcatcher usually nests in open forests. Two occupied nests, both in the elm-ash floodplain forest two miles south of Norman (Oliver Wildlife Preserve), were more than 40 feet above the ground on limbs beneath which there was no understory of any sort.

Species Possibly Breeding within the Plots

Coccyzus americanus.* The Yellow-billed Cuckoo was present during each census at the Fish Estate plots; however, because of its secretive habits, its tendency to fly long distances when alarmed, and its somewhat ventriloquial singing, I was able to establish only one breeding location with any degree of certainty. Near the west end of the north plot in the vicinity of a large post oak, I saw a cuckoo on three censuses--May 28, June 11, and June 15; on June 15 I saw an individual carrying food.

In central Oklahoma the Yellow-billed Cuckoo's favorite habitat is woods having many large, mature trees.

Caprimulgus carolinensis.* On the north plot I twice flushed a caprimulgid--on June 2, about 450 feet from the west end, and on June 5, about 350 feet from the west end. My identification was based on the birds' flight, size, and general coloration. Since the Chuck-will's-widow is known to breed in upland forest during June (see under Diehm Scrub Oak Plot), it is possible that a pair was nesting on or near the Fish Estate north plot.

Centurus carolinus.* On May 15, while making my initial survey of the Fish Estate plots (to determine their suitability for censusing), I saw an adult Red-bellied Woodpecker at a hole in a large dead tree stump. Several such stumps and cavities were scattered over both plots. I saw the species once otherwise: a single adult on May 31. The population was low in this type of habitat during the breeding season (see under Ash Bottomland Forest Plot).

Molothrus ater.* I saw the Cowbird only twice at the Fish Estate

plots: a male flying over the south plot on June 2, and a male and female together in the north plot on June 5.

The Cowbird frequents virtually every vegetational type in the central Oklahoma ecotone; it is the only bird I found in all four different plots.

Piranga rubra.* Nowhere in central Oklahoma is the Summer Tanager a common bird. It breeds principally in the upland oak forests of the savannah but also along the edges of bottomland and floodplain forests. I saw it at only two localities on the Fish Estate: (a) just east of the south plot; and (b) immediately south of the north plot 250 to 450 feet west of the eastern boundary. In both of these places were exceptionally large post oaks. On May 31 I heard the alarm notes of a tanager in the north plot about 250 feet from the western boundary.

Spizella pusilla. Although previous observations of the Field Sparrow during the breeding season had caused me to regard this species as one preferring wooded prairie ravines, areas of scattered scrub oak, etc., its regular occurrence in both of the Fish Estate plots indicated the possibility that this species may also nest in upland open oak forest. On June 2 I saw a stub-tailed fledgling in the north plot, more than 100 yards in from the forest edge. The repeated singing of a male along the east end of the south plot suggested that it had a nest in the dense woody vegetation (principally oak saplings and green briar) along the edge of the nearby county road.

On June 11, 1955, three and one-half miles southeast of Norman, I discovered a Field Sparrow nest containing four fairly fresh eggs on the ground in a dense growth of Erigeron sp. stalks which were up to

three feet tall; the nearest tree was about 20 feet away at the head of a wooded prairie ravine. A nest (four fresh eggs) found on June 27, 1955, was three feet above ground in a 45-inch-high persimmon near the edge of a dense and rather large (about 50 by 100 feet) isolated group of persimmons and smooth sumach. Old nests found during the winter in a narrow strip of low woody vegetation between upland forest and open field (a "second order" ecotone consisting of saplings, smooth and winged sumach, dense tangles of green briar, and sparse grass undercover) provided further evidence that this sparrow nests primarily in edge habitats.

Species Probably Breeding in the Forest Edge or in the Wooded Ravine

Myiarchus crinitus. A few Crested Flycatchers inhabited the Fish Estate plots. I recorded the species regularly only at the extreme eastern end of the north plot, within 200 feet of the forest edge.

This flycatcher seems to prefer large, mature trees as a breeding habitat. It nests in cavities some distance from the ground. I have records of only two occupied nests. The first, found May 16, 1955, was in a dead limb about 20 feet above ground in a living American elm (35 feet tall, 18 inches DBH)--one of a small group of elms, buckthorns, and oaks growing in a shallow drainage area within 75 feet of a densely-wooded savannah ravine three miles east of Norman. The second, found May 24, 1955, was 22 feet above ground in a large solitary dead tree (25 feet tall, 11 inches DBH) standing in a small ravine in the upland open oak forest in the eastern part of the Diehm tract. The nest-tree was within 100 yards of the forest edge to the northwest; it stood in a small opening and was ringed by tall elms, tall blackjacks, black

hickories, and redbuds, Cercis canadensis.

During the breeding season (principally May and June), I have seen this flycatcher in wooded prairie ravines, in the vicinity of farm buildings, in such open elm-ash-cottonwood forest as the Oliver Wildlife Preserve, in floodplain cottonwood parklands, about large farm ponds, on the campus, and in the older residential districts of Norman. All of these habitats have, in common, tall, mature, deciduous trees. While the nest proper may be in dense woods, the bird obtains some food in open fields and areas of widely-spaced trees throughout the breeding season.

Thryothorus ludovicianus. I recorded the Carolina Wren only on May 28: two silent birds, probably a pair, in the north plot. They had probably nested thereabouts.

The species inhabits wooded savannah ravines, floodplain and bottomland forests, and, to a lesser extent, the larger wooded prairie ravines. It is most abundant in floodplain forests. In 1954 two occupied nests were found on the ground in elm-ash-cottonwood floodplain forest (Oliver Wildlife Preserve) two miles south of Norman. The first, discovered on March 18 by Charles C. Carpenter, held one fresh egg that day. The nest was under a slab of wood (about eight by 36 inches) in a well shaded place approximately 80 feet from the forest edge and 50 feet from a large, fallen cottonwood in which the male sang. The second I found on April 11 near some fallen trees on the steep bank along the northern edge of the floodplain. It was well concealed among dead leaves and contained four eggs. My notes of April 14 (1954) state: "Judging from the [number of] singing males, there are probably four to six . . . nests in Oliver's Woods."

Vireo olivaceus.* Although I never saw nor heard the Red-eyed Vireo on the Fish Estate plots, I did find an old nest 150 feet east of the western boundary of the south plot and I heard it singing in the ravine to the west of both plots (see further discussion under "Ash Estate Bottomland Forest Plot").

Guiraca caerulea. I observed the Blue Grosbeak only along the county road near the east end of the south plot. I saw it most frequently in or near low, dense, woody vegetation within 150 feet southeast of the plot (Figure 4c), and I suspect that it was nesting there. Its territory probably included a small part of the plot.

Nests built close to the ground, among such dense, broad-leafed plants as smooth sumach and dock, Rumex sp., are not easy to find. On May 28, 1953, in a wooded ravine in Norman ("Macy Street ravine"), I found a nest, two and a half feet above ground, in a dense growth of dock. It held one Cowbird egg and three grosbeak eggs, and was tilted slightly due to the differential growth of the dock stems to which it had been anchored. A nest found by George M. Sutton on June 9, 1955 (three small young), five miles northeast of Norman, was within a few feet of a section line road. It was two feet above the ground and was attached to a smooth sumach plant and wild grape vine. Dense vegetation (about four feet tall) consisting chiefly of sumach, grape, and Johnson grass, Sorghum halepense, shaded it well; it was within a few feet of a small redbud.

The grosbeak breeds widely over the central Oklahoma ecotone in edge habitats; singing males, fledglings, etc., may be encountered along forest edges or in areas of scattered woody growth in upland, bottomland, floodplain, and, especially, wooded prairie ravines.

Passerina cyanea.* The Indigo Bunting I saw or heard repeatedly at two places between the south plot and the county road (Figures 4b and 4c). I have no doubt that it nested in the dense growth of saplings beneath large oaks just north of the road, and that the territories of two or three pairs extended into the plot.

If the species is to breed in central Oklahoma it must find: (1) a dense growth of low woody plants in the transitional zone (ecotone) between extensive woodland and a comparatively open area which need not be extensive; (2) exposed high song perches. Both of these requirements are well met at the sides of roads cutting through or adjacent to upland oak forests, and, perhaps to a lesser degree, at the edge of bottomland forests.

Species Possibly Breeding in Wooded Ravine

Buteo platypterus. The Broad-winged Hawk is not known to breed regularly in central Oklahoma, yet there seems no reason why it should not nest in the well-developed forests of bottomland and floodplain, or even along the larger wooded ravines within the savannah. On June 11, near the west portion of the south plot (Figure 4a), I discovered a flight feather (a remex, apparently molted normally) of this species; the presence of this feather on this date suggested the possibility of a nesting pair in the vicinity.

Diehm Scrub Oak Forest Plot

The Diehm scrub oak forest plot is part of a large tract ("Diehm tract") in which I conducted a survey of wintering birds (Chapter III). The plot is rectangular, about 210 feet by 940 feet, with an area of

approximately four and a half acres; the long axis runs directly east and west (Figures 6a and 6b).

The vegetation is characteristic of forest which has been subjected to extreme overgrazing (Figure 7). Especially in the eastern part it is difficult to walk through because of a dense growth of oak saplings. Except for a few large black hickories along a narrow, shallow drainage course running across the plot about 100 yards from the east boundary, the only large trees are widely-spaced post oaks, up to 40 feet tall, and a lesser number of shorter blackjacks. Several small openings in the western part support a growth of low grass and a few forbs. To the east of the plot there is an abrupt transition to open oak forest; in all other directions the forest is essentially the same as that within the plot. A firelane 10 to 15 feet wide cuts through the forest along the southern boundary of the plot.

To keep myself oriented during the censusing in such dense vegetation, I strung binder twine along the entire length of the plot midway between north and south borders, as well as across the plot at hundred-yard intervals. Thus, as I zig-zagged from one end to the other I could record fairly accurately the birds, nests, etc., within or adjacent to the plot.

Between June 19 and July 4, 1955, I made six censuses, always in early morning. Census dates are listed on Figure 6a. Symbols in Figures 6a and 6b are used in the same manner as in Figures 4a to 5c. The number of birds seen in this type of habitat was comparatively small; those birds, even fewer in number, known or believed to be breeding in the plot are categorized as follows: (1) species known or thought to be

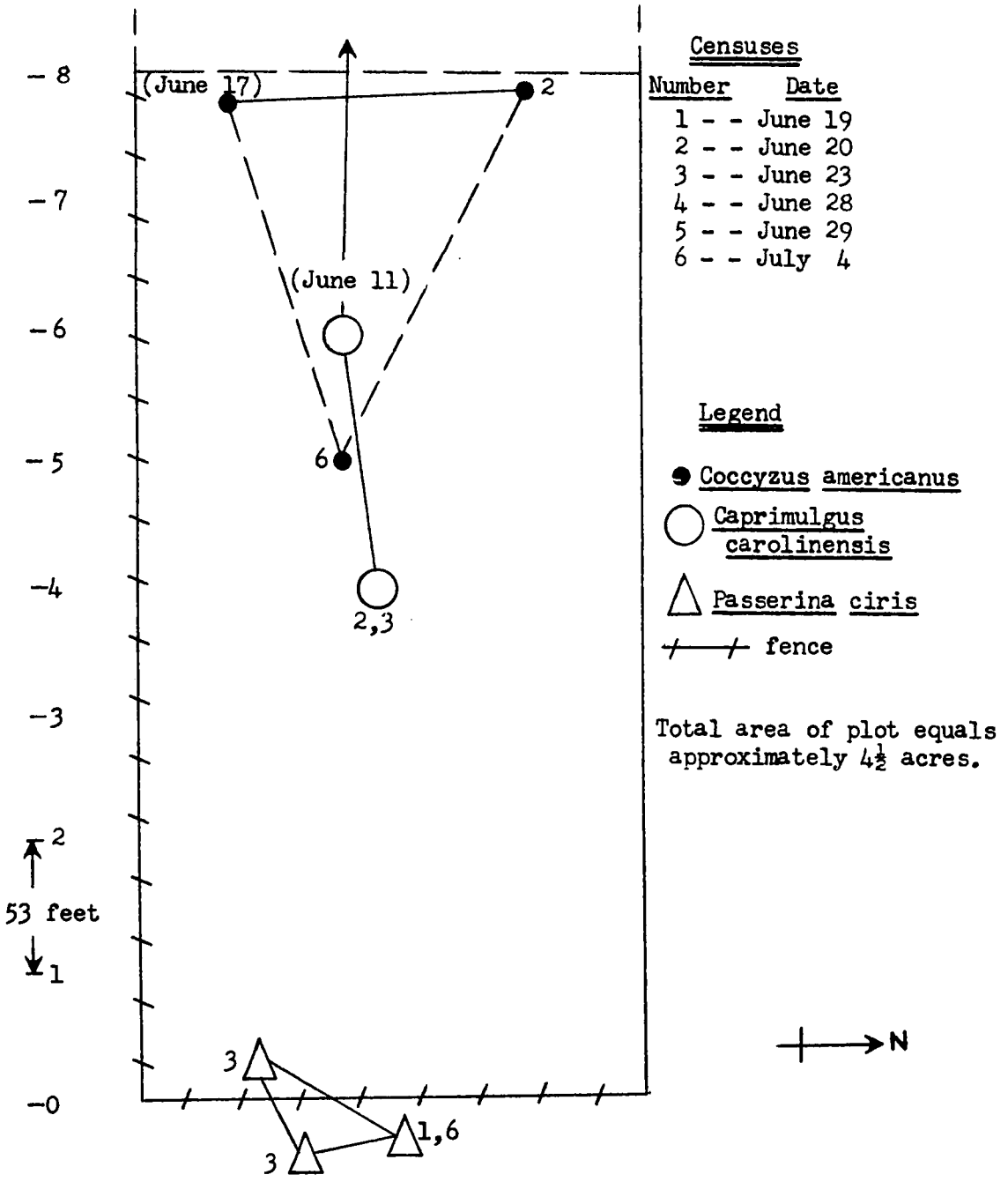

Figure 6a. Breeding Bird Census. Diehm Scrub Oak Forest Plot: eastern section.

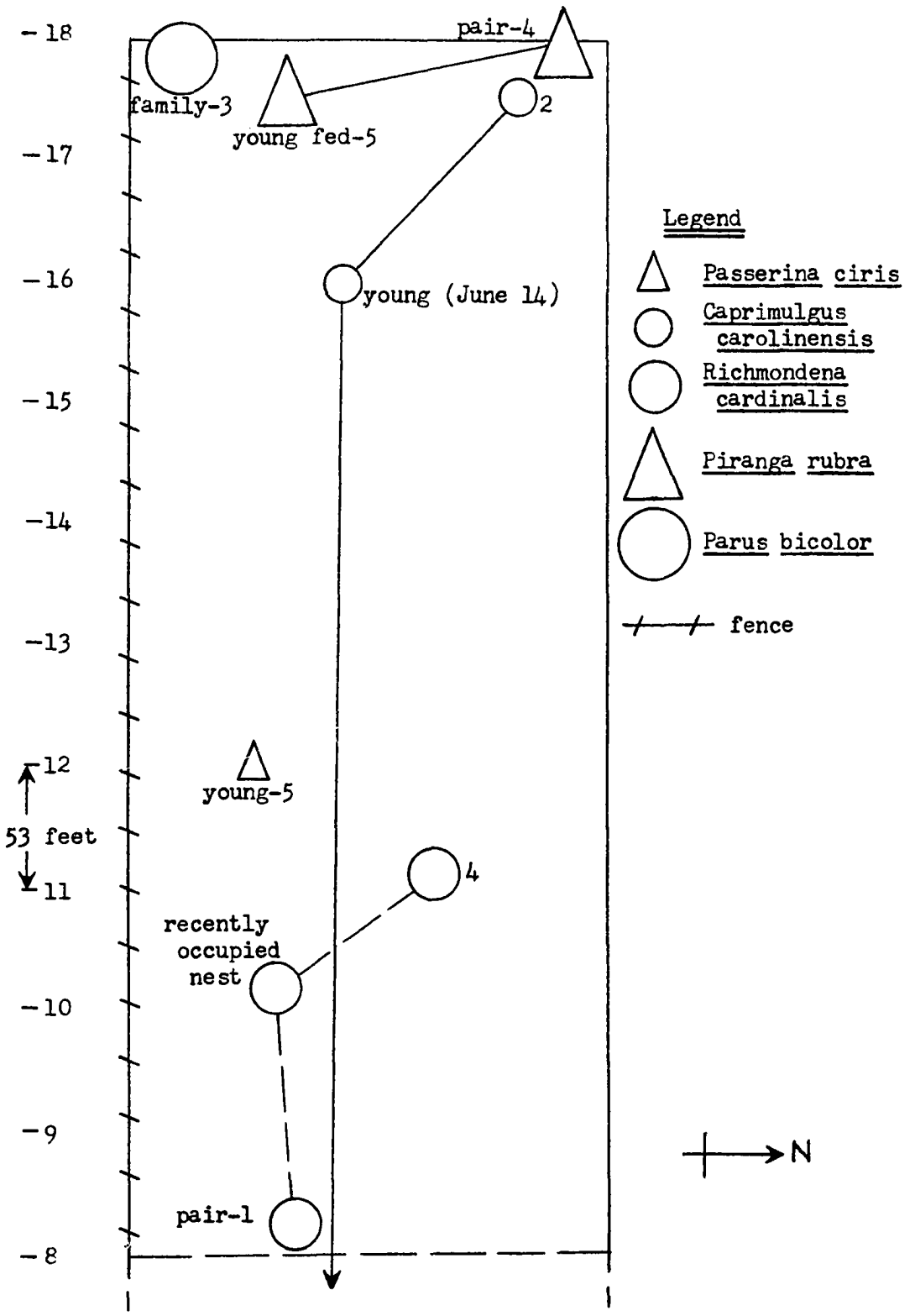

Figure 6b. Breeding Bird Census. Diehm Scrub Oak Forest Plot: western section.

Figure 7. Aspect of Diehm upland scrub oak forest in June, 1955.

breeding within the plot; (2) species possibly breeding within the plot. Species marked with a number sign (#) are discussed in the earlier section of this chapter; those marked with an asterisk (*) are considered further in a later section.

Species Known or Thought To Be Breeding within the Plot

Caprimulgus carolinensis.# I saw one adult Chuck-will's-widow within the plot on June 20, and one (possibly two) on June 23. On June 11, previous to the actual census period, I flushed a bird about 100 yards from the east end of the plot; it uttered its low alarm "chuck" repeatedly and stayed within 50 feet of me. Three days later, about 500 feet farther west, I came upon a pair, one of which feigned injury strongly; a young bird (U. O. M. Z. 2172) squatted motionless on dry oak leaves within a few feet of me. I saw no other young.

Except those at the Fish Estate plots, I have only one other record of this species from Cleveland County: one bird May 7, 1953, in floodplain forest two miles southwest of Norman. The species is a woodland bird.

Richmondena cardinalis.*# On June 20 I found a recently-occupied Cardinal nest five feet above ground against the trunk of a small oak (eight feet tall, one and a half inches DBH) which stood in a small opening within the forest. On the previous day I had seen a pair of adult birds nearby, and on June 28 I heard a male singing near the same place. Infrequently during the census period I recorded other songs of this species on the plot, but not regularly at any given place.

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Species Possibly Breeding within the Plot

Coccyzus americanus.*# The possibility that the Yellow-billed Cuckoo nested at the plot was raised upon my hearing it on June 17 (not a census day), June 20, and July 4. The singing was always within a small area having two or three large oaks.

Parus bicolor.*# I found the Tufted Titmouse within the plot proper only twice. On June 23 I saw a family group at the extreme west end of the plot, and on July 4 I heard a single bird singing at the extreme east end. There were several possible nest cavities on or in the vicinity of the plot. On March 22 (1955) I had found a partially completed nest in a cavity of a dead tree trunk standing in a more open part of the forest no more than 100 feet north of the plot.

Molothrus ater.*# I saw the Cowbird on the plot only once: a male and female together at the extreme east end on June 28.

Piranga rubra.*# The Summer Tanager occurs principally in the more open upland savannah forests. At the Diehm plot I found it only at the west end, always near one of the openings in the forest: a male and female, probably a breeding pair, on June 28; and a female feeding a strongly-flying young bird on June 29. On both days the birds remained no less than 15 feet above ground, in larger post oaks.

Passerina ciris. In one small area at the extreme eastern end of the plot I found a singing male (probably the same individual on each date) June 19, June 23, and July 4. The bird may have had a nest either among the dense growth of oak saplings just within the plot or in a "patch" of similar vegetation in the open forest immediately to the east. On June 29, at a point about 600 feet from the western border, I saw two

stub-tailed fledglings flying rather weakly from limb to limb of small, closely-spaced oaks. Since I had not recorded this species at this place on previous censuses, it seems likely to me that these young birds had not come from a nest there.

The Painted Bunting inhabits the forest edge, the wooded ravines of both savannah and prairie, and areas of scattered trees over the entire central Oklahoma ecotone. I have found it most frequently in places having at least some undergrowth of saplings, shrubbery, and vines. It is not a bird of forest interiors.

Ash Estate Bottomland Forest Plot

The Ash Estate bottomland forest plot is within the well-developed forest of the Hog Creek bottomland, 12 miles northeast of Norman and two miles west of the Stella community. The late Mr. Elmer Ash generously permitted unrestricted use of his property. The plot, approximately 3.1 acres in area, lies in the northeast corner of Section 25, T10N, R1W, Cleveland County. It is roughly rectangular in shape, about 700 by 200 feet except for the extreme south end, which is 150 feet wide; the long axis runs north and south.

Principal trees within the plot are American elm, cottonwood, and green ash, Fraxinus pennsylvanica, up to 75 feet tall. The cottonwoods occur in lesser numbers but are particularly tall and tower above the other species. Common secondary species are box elder, Acer negundo, black hickory, and hackberry. Vines, principally grape, are abundant. Crown cover is at least 75 per cent over most of the plot. Within the plot proper there is little shrubby understory, probably due to the

fairly heavy grazing by cattle which cleans even the leaves on the lower limbs of trees. After heavy rains pools of water stand in low places of the forest floor; the soil remains moist except during extended drought. The north edge of the forest is bounded by a county road, the east edge by a drainage canal, the west edge by channelized Hog Creek (a major tributary to Little River). The forest extends southward for several hundred feet. Except at its southwest corner, the boundaries of the forested plot are 75 to 200 feet from the forest edge.

Using a compass to establish directions, I marked the plot boundaries at intervals of 50 feet with weighted and labeled strips of white cloth. Between June 11 and July 4, 1955, I made one partial and seven complete censuses of the breeding bird population. Census dates are in Figure 8. In the following pages are discussed: (1) species thought to be breeding within the plot; (2) species thought to be breeding immediately adjacent to the plot; (3) species known or thought to be breeding in the forest edge; and (4) species known to have bred in previous years near the plot.

Species marked with a number sign (#) are discussed earlier in this chapter; those marked with an asterisk (*) are discussed later in the chapter.

Species Thought To Be Breeding within the Plot

Vireo olivaceus.# The Red-eyed Vireo was the only species I recorded on all eight censuses at the Ash Estate plot. Throughout the census period it was abundant. The males sang from high up in trees, usually 45 or more feet above ground. Because of the deceptive quality

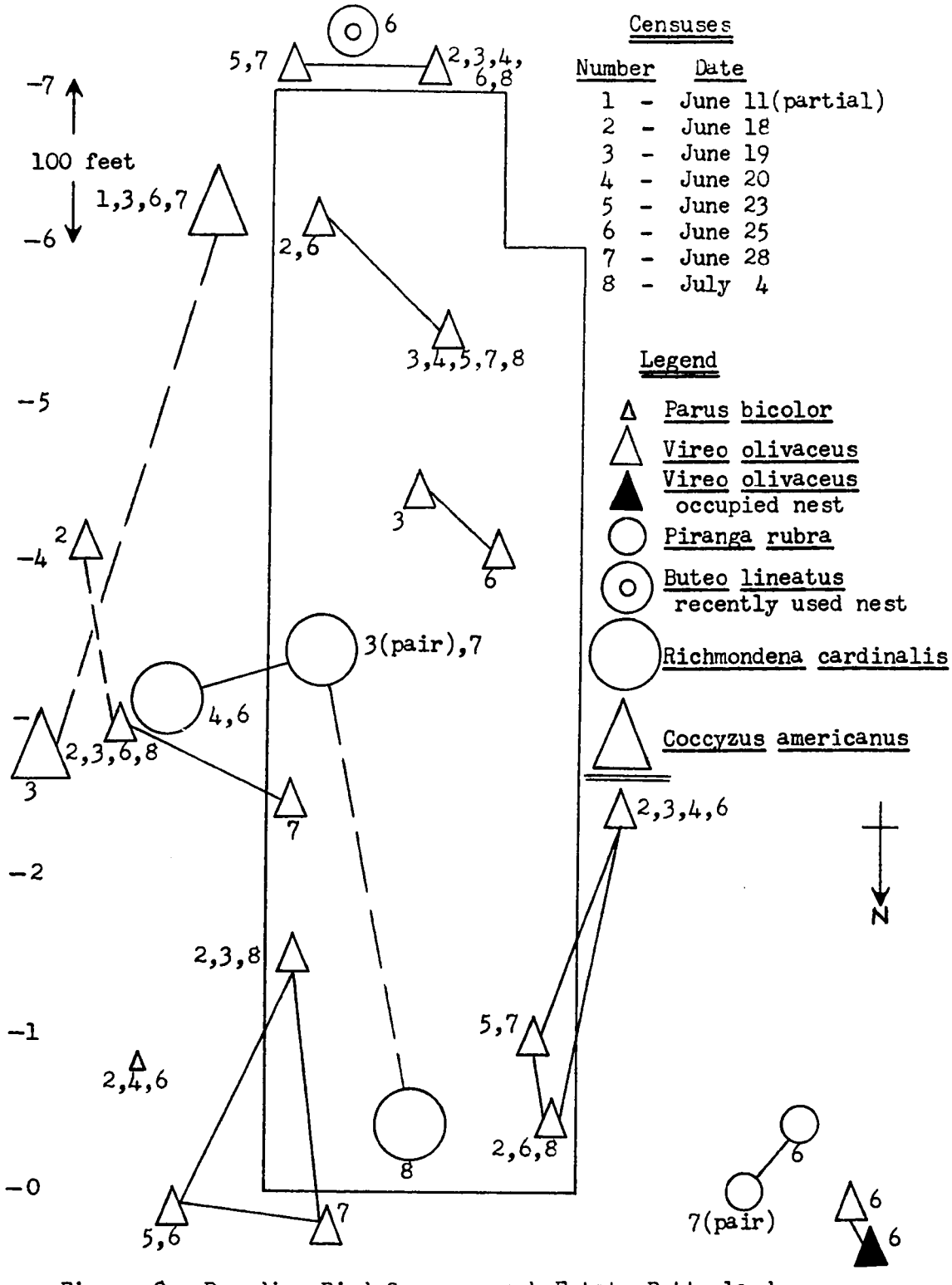

Figure 8. Breeding Bird Census. Ash Estate Bottomland Forest Plot. Area equals approximately 3.1 acres.

of their songs and their inconspicuous coloration, they could be seen only after careful search, sometimes not at all. I was able to establish the positions of six separate singing males whose territories were either entirely or partially within the plot proper. If, as is probable, all of these were breeding birds, the nesting density was somewhat less than two breeding pairs per acre. On June 25 Mr. John Wiens and I found an occupied nest, containing one fresh egg (three vireo and one Cowbird egg June 28), nine feet up in a 20-foot box elder growing at the extreme north edge of the forested tract.

The Red-eyed Vireo arrives in central Oklahoma in mid-April and remains until September. It is found principally in bottomland and floodplain tracts having a high percentage of crown cover; it exhibits a preference for hickories and, to a lesser degree, ashes, but is not restricted to either of these tree species. Occasionally I have seen it west of the savannah, in particularly large and well-wooded prairie ravines. A nest I found on June 21, 1955, was suspended about 30 feet above ground from a fork of small branches of a 55-foot cottonwood standing near the edge of a floodplain cottonwood parkland three miles south of Norman; such habitat is not commonly frequented by this species.

Species Thought To Be Breeding Immediately Adjacent to the Plot

Included in this category are four species whose nest sites probably were in the forest interior (same habitat type) just outside the plot proper.

Buteo lineatus. On June 25 I found a large nest in a 70-foot cottonwood standing about 50 feet south of the plot. The nest had been

built on several limbs against the trunk and appeared to have been occupied recently. My belief that this nest was used in 1955 by a pair of Red-shouldered Hawks rests upon observations during previous years.

On many visits to the Hog Creek bottomlands since 1952, I had seen one or two adult hawks. In late May or early June, 1952, no more than 200 feet from the nest mentioned above, I observed nearly fledged young in a nest built at least 40 feet above ground in a tree (not a cottonwood). This nest was still present in the spring of 1953 and may have been used that year, but it had entirely vanished by late March, 1954. However, on April 10, 1954, David F. Parmelee found an occupied nest not far from the original (1952) site; it was 20 to 25 feet above ground, in a tree standing in an area abundantly upgrown with willows. Hence, it seems probable that one pair of hawks had become well established here and had nested for at least four consecutive years.

The Red-shouldered Hawk, an uncommon resident in central Oklahoma, is restricted to the more mesic lowland wooded areas. Nearly all my records are from the Hog Creek bottomland, but it has been found in similar habitats such as the floodplain of the South Canadian, near Noble. Margaret M. Nice has told me that in the 1920's this bird nested in what is now the Oliver Wildlife Preserve.

Coccyzus americanus.# On four of the eight censuses (June 11, June 19, June 25, and June 28), I saw or heard the Yellow-billed Cuckoo, probably the same individual, in one small area just east of the south end of the plot. One heard about 400 feet northeast of this location may have been the same bird.

Dendrocopos pubescens. Although I saw none actually within

the plot, the Downy Woodpecker probably nested in the forest. There were several cavities which appeared to me suitable for this species. Well-developed mesic forest is one of its preferred habitats.

This woodpecker is found throughout the year in central Oklahoma in almost any place having woody vegetation. During the breeding season I have seen it commonly in wooded areas of bottomland and floodplain, yet I have recorded it also in upland forests and in prairie ravines. On May 6, 1953, I found a nest, containing young, about 25 feet up in a dead trunk standing in dense forest adjacent to the South Canadian River two miles southwest of Norman. I found three occupied nests in 1955 in the Oliver Wildlife Preserve: the first, found April 5, was 29 feet above ground in a dead 35-foot elm (seven inches DBH); the second, found May 9, was 22 feet up in a 24-foot black willow (six to eight inches DBH), and contained young birds; the third, found also May 9, was 25 feet above ground in a dead limb of a 30-foot ash (nine inches DBH), and contained young. On March 31, 1955, I saw a pair of birds at a fresh-looking hole in a dead elm standing along the edge of a large wooded ravine one mile north of Norman.

Parus bicolor.# I recorded the Tufted Titmouse in small loose flocks--probably family groups--on June 18, June 20, and June 25, just east of the north end of the plot. Almost certainly the bird nested there.

On April 28, 1953, in a savannah ravine three miles southeast of Norman, I saw a hawk--probably Sharp-shin, Accipiter striatus--capture a parent titmouse whose attention at the moment was focused on its newly-fledged young bird which I was holding. A likely nest cavity was nearby,

20 feet above ground in a dead cottonwood limb. At the Oliver Wildlife Preserve on April 13, 1954, I watched a bird carrying food to and from the entrance to a cavity 15 feet up in a dead, 20-foot trunk.

During the breeding season this species is distributed widely over wooded areas of the central Oklahoma ecotone; it is most common in the savannah and floodplain, though it also inhabits the larger prairie ravines.

Species Known or Thought To Be Breeding in the Forest Edge

Sayornis phoebe. Each year since 1952 I have found an Eastern Phoebe's nest in the concrete culvert just north of the Ash Estate bottomland forest. The parents perch on trees at the forest edge, as well as on fence and electric wires there.

The species is the earliest flycatcher to return to central Oklahoma in the spring (mid-March). Since in the vicinity of Norman there are few overhanging rock ledges close to water, most phoebes nest under bridges or in high concrete culverts, many of which span intermittent streams. Almost invariably the species chooses sites close to trees, especially places providing a low, shaded perch within 50 feet of the nest. Consequently, it breeds more abundantly in the savannah than in the wooded prairie ravines. I have not found nests in bridges or culverts less than four feet high (stream bed to "ceiling"). The height of the nests varies of course with the height of the bridge, but nests are usually low enough to be reached (lowest measured: 42 inches; highest: about 108 inches).

Geothlypis trichas. On June 11, June 18, and June 19, I heard

or saw a Yellow-throat in the tall black willows (up to 25 feet high) lining the drainage canal along the eastern edge of the forest. Undoubtedly it nested there.

Near Norman this warbler shows a preference for areas which have extensive growths of dense willows. While it occurs chiefly in the bottomlands and floodplain where sufficient soil water for such vegetation is available, I have found it occasionally among willows growing below dams or at the edge of ponds within the prairie. Other plants in which I have found the bird are salt cedars, Tamarix, small cottonwoods, and elm saplings.

Piranga rubra.# At the Ash Estate forest I saw the Summer Tanager only along the forest edge 150 to 200 feet northwest of the plot. On June 25 I heard a singing male, and on June 28 saw a male and female together. I did not visit that part of the forest previous to June 25; the birds may have been there throughout the census period.

Richmondena cardinalis.# I saw an adult male Cardinal within or immediately adjacent to the plot on five of the last six censuses (not on June 23). It seldom sang, but uttered alarm chirps frequently; on June 19 it was accompanied by a female. Since in this part of the forest there was little underbrush, and since it was unlikely that this species would nest high up in trees (see below), I concluded that the nest was along the eastern edge of the forest in the low trees, shrubbery, or vines there. Several times the male flew off in that direction.

The Cardinal is one of the most widespread residents of central Oklahoma, breeding throughout the wooded parts of the ecotone in "edge" or "non-edge" habitats. In urban areas its nest is usually well concealed

in foliage; in rural areas its nest may be either concealed or exposed to full view. It exhibits no preference for particular plant species. Of 13 occupied nests measured, one was 17 feet above ground, and the rest were within 10 feet of the ground (average height: 75 inches).

Passerina cyanea.# On June 15 George M. Sutton and Mrs. John R. Whitaker found an Indigo Bunting nest along the very edge of the forest about 75 feet north of the plot. It was 32 inches above ground, attached to small branches of a four-foot elm sapling--one of a row of saplings, shrubs, etc., beneath mature trees. Although the nest, which held three or four nearly-fledged young, was within a small clearing, tall Johnson grass prevented our seeing it except at close range. A male bunting seen from June 11 on sang from high perches in the immediate vicinity.

Molothrus ater.*# The Red-eyed Vireo nest mentioned above (found on June 25 at the northern edge of the forest) contained three vireo eggs and one Cowbird egg on June 28. I did not see or hear a Cowbird during any of the censuses of the Ash Estate plot.

Species Known To Have Bred in Previous Years near the Plot

Nyctanassa violacea. In the spring of 1952 several pairs of Yellow-crowned Night Herons bred in the forest. One of the nests was in a tree within what was later to be my plot. The nest was between 25 and 30 feet above ground, on a limb beneath which there were no other branches. On April 24, 1954, David F. Parmelee found two or three pairs breeding in the forest. He collected four eggs on that date from one nest 30 feet up in a box elder; on May 7 he collected five eggs from the same nest. I saw no sign of this species in the forest during 1955, but

on June 23 of that year I saw an adult flying at the edge of bottomland forest two miles to the west.

On September 7, 1952, and again one week later, I saw two adult herons and one immature bird at a large prairie pond seven miles north of Norman. On the second date, Mr. Gerbert Rebell found a nest in one of the many large trees below the pond.

Dryocopus pileatus. In the spring of 1952 (late May or early June) Gerbert Rebell found a Pileated Woodpecker nest in a large, dead cottonwood near the east edge of the forest. On April 28, 1954, David F. Parmelee collected four eggs (containing small embryos) from a nest 12 feet up in a large, dry cottonwood stump at the forest's edge (exact location uncertain). On June 25, 1955, we saw a young bird flying across the road just southwest of the forest. There are many possible nest cavities and "workings" of this bird in the Hog Creek bottomland.

Rucker Moderately Overgrazed Pasture Plot

The Rucker moderately overgrazed pasture plot (Figure 9), two miles north of Norman, is a portion of the larger "Rucker tract" (Figure 2) in which I had earlier made a survey of the wintering bird population. The plot is roughly triangular and has an area of approximately 35 acres; on all sides is open field. A wooded prairie ravine approaches to within 200 feet of the southwest corner of the plot. The land slopes gently toward the northwest.

Sixty to seventy per cent of the plot is pasture proper, occupying the higher ground (Figure 10). Mr. Robert H. Rucker, the landowner, says it has never been plowed and had not been mowed for at least two

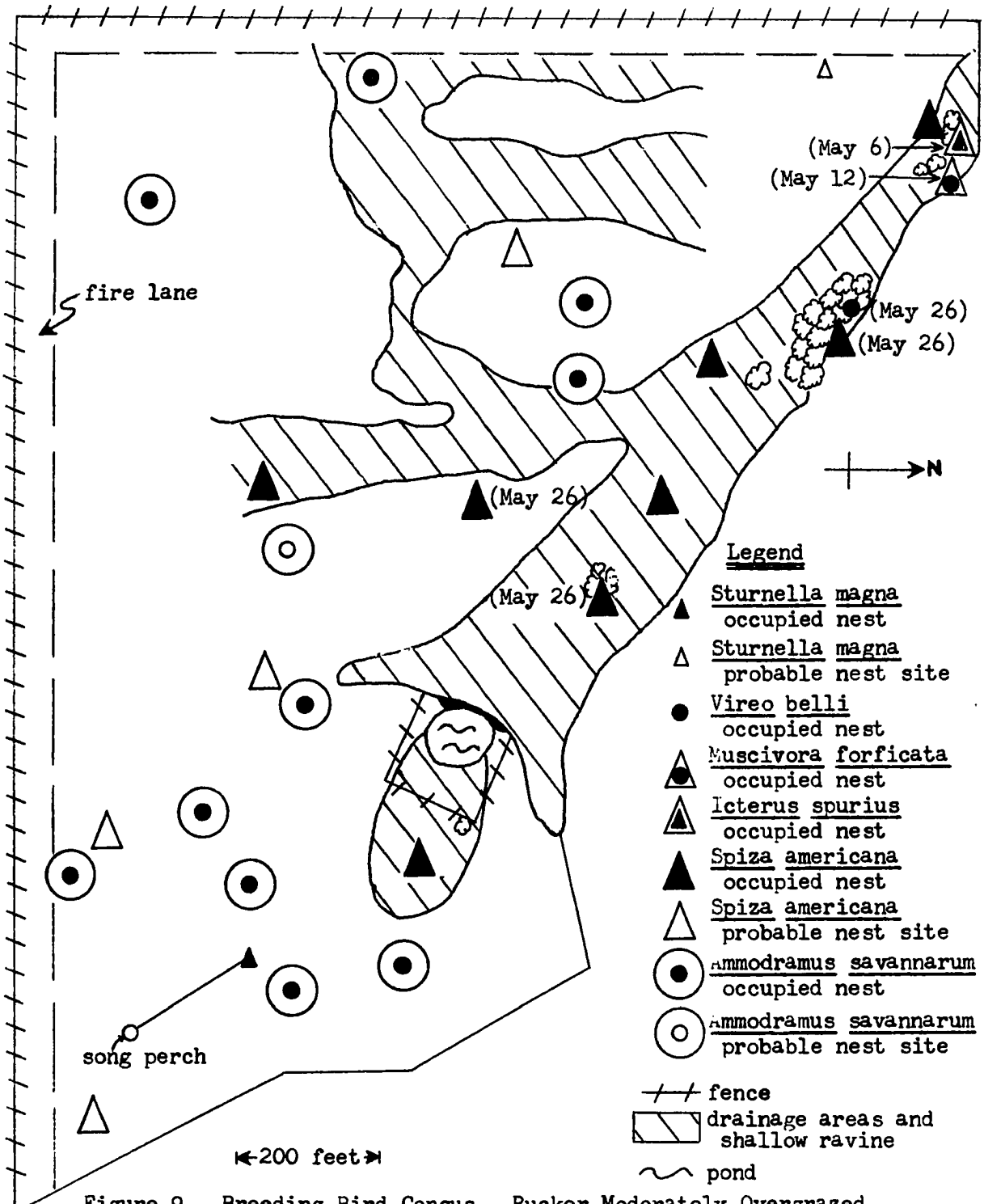

Figure 9. Breeding Bird Census. Rucker Moderately Overgrazed Pasture. May 13-15, 1955, except where noted. Total area equals approximately 35 acres.

Figure 10. Aspect of pasture at Rucker moderately overgrazed pasture plot in May, 1955.

years prior to this study. During mid-May, when the major part of the censusing was done, the general aspect of the pasture is that of numerous scattered forbs beneath which is dead grass and a sparse cover of live, green grass up to a foot high. The dead grass forms a layer or loose mat covering much of the eastern portion of the pasture; toward the west, where the soil is shallow, much of the ground is without this cover. The conspicuous forbs are Psoralea sp., Oenothera missouriensis, Cirsium undulatum, Achillea lanulosa, Rudbeckia serotina, Vernonia sp., Gutierrezia dracunculoides, Plantago purshii, and P. virginica. The chief grasses are Andropogon gerardi, Bromus sp., Bouteloua gracilis, and B. curtipendula.

Drainage areas, on lower ground, support principally a dense growth of Sporobolus asper and scattered buckbrush; these areas join an elongate shallow ravine which after hard rains carries the runoff from nearly the entire plot. For most of its length the floor of the ravine is covered principally with Sporobolus asper, Symphoricarpos orbiculatus, Cocculus carolinus, green briar, saplings, and low bushes. The rest of the floor is occupied by trees of the "isolated grove"--already mentioned in Chapter III.

Thus the plot consists of: (1) the pasture proper on high ground, occupying most of the plot; (2) the lower drainage areas--extending into the pasture--and the shallow ravine; (3) the trees and saplings of the isolated grove.

All nests recorded in Figure 9 were found between May 6 and May 26, 1955; the major part of the censusing was done on May 14 and May 15 by Donald H. Baepler, John Wiens, and myself. Since ground nests

are difficult to find, it was necessary for us to drag a rope--one and a fourth inches in diameter and about 75 feet long--through the entire plot except where there was high, woody vegetation. Incubating birds flushed when the rope passed harmlessly over the nests, thus revealing the nest sites. The effectiveness of this method of censusing varies with differing habitats, species of birds, etc., and is at best difficult to determine in any given instance; it is lower for such species as the meadowlark and Dickcissel which tend to flush well ahead of the rope.

Species Breeding within the Plot

Muscivora forficata. On May 6 I found an occupied nest of the Scissor-tailed Flycatcher in the isolated grove. It was about 25 feet above ground in the northwesternmost tree of the grove, a 35-foot American elm; the female was on the nest, the male on an exposed twig near the top of the tree. The nest had been built well out on a main limb and was largely hidden from view. During the winter I had found the remains of a nest under this tree.

The Scissor-tail arrives in central Oklahoma early in April and remains until late October. It is as much a bird of the open country as the meadowlark and is common in the sparsely-wooded portions of the flood-plain and prairie west of the savannah. It almost invariably nests in trees, on crossbars of telephone poles, etc., immediately adjacent to wide, treeless expanses. Rows of deciduous trees planted for windbreaks provide ideal nesting sites. Height above ground of five nests found in 1955: 6½, 8½, 9, 25, and 28 feet.

Vireo belli. Since the isolated grove is at least a quarter

mile from any other group of trees, I was surprised to hear the song of Bell's Vireo there, on and after May 12. On May 26 I found a recently-completed nest in a dense growth of hackberry saplings which was overshadowed by a 25-foot buckthorn. This was the only "suitable" nesting habitat (for this species) in the grove. The nest, containing one Cowbird egg, was 30 inches above ground, suspended from a small fork. Perhaps because of the Cowbird's interference, the nest was abandoned; but the birds built again, low in the buckthorn, and were successful, I believe, in bringing three young to the fledgling stage. So far as I could determine, only one pair of vireos occupied the grove.

The species, found abundantly in central Oklahoma from late April to late September, is widely distributed over the forest-prairie ecotone but is restricted to a definite type of habitat: rather dense growths of trees, saplings, or bushes, usually in more mesic areas. It does not frequent vegetation overgrown with vines. Its nest is usually built near the end of a branch and is well shaded by leaves. So characteristic is the habitat and placement of nests that they are relatively easy to locate. A list of plant species in which I have found nests includes: locust, Robinia pseudoacacia, black willow, American elm, hackberry, black walnut, and buckthorn. Of 24 nests, 15 were less than four feet above ground, eight were four to six feet above ground, one was 12 feet above ground, the average height three and three-fourths feet.

Sturnella magna. The breeding density of the Eastern Meadowlark at the Rucker plot was low. A nest, found May 14, had been built into one of the many low tufts of dead big bluestem in the eastern part of the pasture proper; it contained three eggs. The male sang from a

three-foot stake which I had driven into the ground about 200 feet from the nest six weeks previously. I am convinced that the birds would not have built at that spot far out in the pasture had the stake not been nearby, for no other song perches were within 400 feet of the nest. I could establish only two other probable nest sites, each in the pasture close to a fence from which the males regularly sang.

The meadowlark is a bird of the open country. Two principal requirements in its breeding habitat are: (1) dead (from the previous year) dense grass, either in tussocks or spread uniformly; (2) one or more elevated song perches near the site--fence posts, stout weed stalks, etc. Data concerning three other 1955 nests are: (1) a nest being built April 21 to 23, in dense unidentified grass, near several stout weed stalks, one and a half miles northwest of Norman (North Base); (2) a nest containing three newly-hatched young, found April 23, in foot-high salt grass, Distichlis stricta (identified by George J. Goodman), within 20 feet of a fence, two miles northwest of Norman; (3) a nest (one egg on ground just outside the entrance), found May 5, in dense Bromus, within 150 feet of a plum thicket, two and a half miles north of Norman.

Icterus spurius. On May 12, in a large elm of the isolated grove, I found an Orchard Oriole nest. It contained one freshly-laid egg, was eight feet above ground, well concealed among leaves near the end of a long, arched limb, and was 17 feet below an occupied Scissor-tail nest (previously mentioned).

The Orchard Oriole is distributed widely over the ecotone in edge habitat--forest margins, small groves, orchards, farmyards, etc.--in both urban and rural areas. Its nest is often woven among small live

twigs which wave freely in the wind. It builds in many kinds of deciduous trees, including American elm, willow, cottonwood, pecan, and mulberry.

Molothrus ater.# On May 13 the Orchard Oriole nest (just mentioned) contained two oriole eggs and one Cowbird egg. Three of eight Dickcissel nests within the tract held one Cowbird egg each, in addition to the eggs of the host species.

Spiza americana. We found eight occupied Dickcissel nests within the plot--four May 15, one May 16, and three May 26. Of these, six were in the drainage areas or the shallow ravine, one in a hackberry sapling at the edge of the isolated grove, and one in the pasture proper (though within 15 feet of a drainage depression). Three, visible only from above, were built in low buckbrush; three, partially concealed by adjacent forbs, were on the ground; two were in saplings--one 27 inches above ground in an elm, the other 38 inches above ground in a hackberry. Despite differences in height and vegetative substrate, all the nest sites were similar in that: (1) they concealed the nests well, except from above; (2) they were in or immediately adjacent to open expanses. We found the "roping" technique to be nearly valueless in locating this species' nests: incubating birds flushed well ahead of the rope. Judging from the positions of singing males (May 14 to 16), there were probably four other occupied nests in the plot, all in the pasture proper.

The Dickcissel is abundant in the open country west of the savannah from late April to mid-September. Like the Scissor-tail, it often perches on high electric wires along roadsides. Four other occupied nests in the Norman vicinity were in sites similar to those on the plot;

a fifth, in a 15-foot black willow, was fully exposed to view and was exceptionally high--nine feet, ten inches above ground.

Ammodramus savannarum. Between May 13 and 15 we found ten occupied Grasshopper Sparrow nests at the Rucker plot. One was just completed (one egg May 16), seven contained five eggs each, one contained three eggs, and one held a nearly-fledged young bird. Of nine nests in the pasture proper, seven were completely domed-over, built deeply into dead grass; the other two were sunk into shorter grass and were exposed from above. The tenth nest, aberrant in site, was among dense Sporobolus asper within a drainage area at the plot's west end; it was flooded out during the hard rains of May 16 to 19. The distribution of nests in the pasture correlated well with the amount of grass cover. Six were grouped in the eastern part of the plot where a layer of grass covered much of the ground; two were in a similar small area to the northwest; only one was in the poorly-covered southwestern part. Minimum distance between nests was about 110 feet. Bearing in mind the total number of singing males, I estimated that by "roping" we found between 50 and 75 per cent of the occupied nests then at the plot; another "dragging" probably would have revealed only one or two more. Since the movements of this sparrow--a small, plainly-marked, weak-songed bird--are difficult to follow, I was able to establish the probable location of only one other occupied nest.

In central Oklahoma the Grasshopper Sparrow is abundant in nearly every open pasture during May, the height of its breeding season; by mid-June the number of songs is markedly diminished. A small bird, it may sing from almost any forb or tuft of grass. On May 21, 1955, I found a nest, with five eggs, in a tussock of little bluestem growing in

lightly-grazed pasture ("The Johnson Pasture"), six miles northeast of Blanchard, McClain County; earlier in the month I had heard several singing males in the same field.

Aimophila cassini. On May 5 I encountered three singing male Cassin's Sparrows perched along the plot's southern fence and among abandoned oil well equipment just to the south. The sparrows were present in the vicinity on May 6, 12, 13, 15, 16, and 17; thus it appeared that the species would breed here, at least 100 miles east of its previously-known breeding range. It was not until June 30 that I found a nest; it held five nearly-fledged young (gone from nest July 1), and was on the ground, well concealed among weeds (primarily ragweed, Ambrosia psilostachya), about 20 feet north of the fence, and in the fireland 35 feet in width paralleling the fence (Johnson, 1956).

The Cassin's Sparrow is very rarely seen in central Oklahoma and cannot be considered a characteristic breeding bird here. In Oklahoma it breeds regularly in the arid prairies of the western half of the state, being very local in distribution.

Species Occurring at but Not Nesting within the Plot

Bubo virginianus. On February 24 I discovered a pair of Great Horned Owls nesting in the wooded ravine ("main ravine" of the winter tract) to the southwest of the plot. The easily-seen nest was 31 feet up in a multiple fork of a 45-foot elm standing within 200 yards of the (later-established) plot; both eggs hatched between the mornings of March 3 and 6. Undoubtedly the owls preyed to some extent upon animals living within the plot. During subsequent visits I found remains of the

following species in the nest: cotton rat, Sigmodon hispidus, pocket mouse, Perognathus hispidus, cottontail, Sylvilagus sp., meadowlark and Robin.

This owl breeds throughout the ecotone in groups of tall trees adjacent to open fields. On April 7, 1953, in a wooded ravine about one and a half miles northeast of Norman, George M. Sutton found two young owls (several weeks old) in a nest about 30 feet up in a tree; a cottontail was cached in a clump of bluestem about 200 feet from the nest. David F. Parmelee collected two eggs on April 4, 1954, from a nest 25 to 30 feet above ground in a crotch of a cottonwood in the floodplain near Goldsby, McClain County. On April 21, 1955, Donald H. Baepler and I watched a young bird perched on a limb about 30 feet above ground at the Oliver Wildlife Preserve, and on May 3 of the same year G. M. Sutton observed one sitting quietly in a tall tree at Indian Springs, about three miles south of Norman.

Tyrannus tyrannus. On May 13 I saw an Eastern Kingbird perched on a wire of the fence bounding the plot on the south. On May 19, a day of intermittent rain, I watched a loose flock of about six flying between the isolated grove and the fence on the plot's western border; three were chased out of the grove by Scissor-tails which had a nest there.

In central Oklahoma the Eastern Kingbird is much less common than the Western. The Eastern is often found near prairie farm ponds and in low fields of the floodplain. It requires an elevated perch which, unlike that of the other large flycatchers, may be quite low--fence wires, etc. Records of three 1955 nests are: (1) May 27, four eggs, nest about 19 feet up in a low horizontal branch of a solitary 25-foot elm

(ten inches DBH), one mile east of Norman (Robert Frank); (2) June 2, four eggs, nest about 25 feet above water, in a 35-foot black willow (14 inches DBH) growing in farm pond one mile east of Norman (Robert Frank); (3) June 12, one egg, nest four feet above water, in multiple crotch of seven-foot persimmon standing in water one foot deep, about six feet from edge of farm pond, three and a half miles east of Norman.

Tyrannus verticalis. On May 12, a day of light intermittent rain, I watched two Western Kingbirds flying together over the plot toward Little River to the north. On May 20, during light, steady rain, two were perched together on the west fence, far from trees. Seldom does one see this bird in the open prairie; the rain may have forced these birds to search for insects far out from their usual perches on tall trees. I found no evidence that the species nested at the plot; the only suitable habitat had already been claimed by a pair of belligerent Scissor-tails. However, on June 15 I found a nest, with five eggs, ten and a half feet up in a 30-foot mulberry--one of many large trees--in the farmyard a half mile to the south.

The species arrives in the Norman vicinity in mid-April to late April and nests abundantly beginning two to three weeks later. It invariably builds in a tree immediately adjacent to wide expanses, and, so far as I have seen, close to human dwellings; such places as campuses, parks, and farmyards having large trees are ideal. I have not seen it in the savannah during the breeding season. The nest is usually partially concealed among leaves and is placed in a multiple fork on a branch around which is several feet of space. Commonly the nest is 20 to 25 feet above ground. Two nests, both found on university grounds in 1955, are of

special interest in that each was near an occupied nest of the Warbling Vireo, Vireo gilvus: one, in the yard of the President's home, was about 20 feet from a vireo nest; the other, at the south oval, was about 35 feet from a vireo nest.

Eremophila alpestris. On April 28 I found a Horned Lark nest (four eggs) about 150 feet southeast of the plot, nearly on top of the wind-blown hill. It was in very short grass in a shallow drainage channel; by May 8 all the eggs had hatched. On May 12 I found the nest flooded out by the hard rains of May 10 and 11; there was no sign of the young and the nest itself was coated with mud.

The lark nests in very exposed places in the prairie. I have not seen it, nor would I expect to see it, in the savannah. Five other occupied nests were all far from trees and in places of little or no vegetation: (1) April 9, 1953, a nest with two nearly-fledged young, in short grass, one and a half miles northeast of Norman (George M. Sutton); (2) March 31, 1954, a nest with four eggs, in a plowed field at the North Base (Richard R. Graber); (3) April 3, 1955, a nest with three eggs (a fourth laid between 7:00 and 10:00 A. M.), on bare soil in a field containing stubble of kaffir corn, at the North Base (George M. Sutton); (4) April 3, 1955, a nest with two eggs (abandoned by April 11), in grass about two inches tall, along airport runway at North Base (George M. Sutton and myself); (5) March 17, 1956, a nest with two eggs (both hatched by March 27), in short grass on gentle slope of drainage channel, at North Base (E. Miller).

Hirundo rustica. On May 5 and May 12, both rather clear days, I saw several single Barn Swallows flying over the pasture. During the

light but steady rain of May 20 I watched a loose concentration of a dozen or more birds sweeping back and forth across the pasture, keeping within ten to fifteen feet above the grass; what insects were flying were probably also low. There were several possible nest sites within a mile's radius of the plot.

The Barn Swallow nests abundantly in central Oklahoma, principally west of the savannah. It uses chiefly concrete culverts and, unlike the Eastern Phoebe, may build in culverts no more than three feet high (inside height). It spends much time in the air and when it does alight usually perches within a few feet of the ground. It requires mud of the right consistency with which to build its nest: invariably a source of such mud is close to the nest site. Especially in lower culverts, the rim of the nest is within two inches of the "ceiling." The highest nest I have seen in central Oklahoma was about ten feet above the culvert floor--May 3, 1955, in a high culvert under the intersection of Highway 77 and Lindsay Road at the south edge of Norman.

Corvus brachyrhynchos. On April 7 I discovered a newly-completed Crow nest several hundred yards south of the plot. It was 18 feet up in a 25-foot buckthorn; no other tree stood within at least 150 yards. The bird (probably the female) was very reluctant to leave the nest, as though she were about to lay an egg. Before April 18, on which date I found the nest (three eggs) abandoned, the birds ranged into the plot.

The Crow breeds in virtually all parts of the forest-prairie ecotone. Its only requirements seem to be a supply of nesting materials and a live tree in a place not regularly visited by man. Its nest is usually more than 15 feet above ground and in a site not easily accessible

to predators. In the Norman vicinity the peak of the breeding season is April, though some individuals nest earlier (my earliest record: March 19, 1955, four eggs).

Sialia sialis. On March 3, March 10, and March 17, I saw a male Eastern Bluebird singing in the wooded ravine about 200 feet south of the plot. Very probably it nested in one of the trees there or in a cavity of one of the many fence posts nearby. Some individuals establish nests by mid-March (my earliest record: March 20, 1954).

The bluebird is common over the whole ecotone. It nests in pre-existing cavities of fence posts, dead limbs, etc., usually not less than four feet from the ground. Of nine measured, the lowest entrance hole was 45 inches above ground, the highest 180 inches, the average 96 inches. I have not found a nest in the Norman vicinity farther than about 100 feet from trees, though I suspect that such nests do exist. The species builds at places close to open fields, from which it obtains much of its insect food. A nest--four feet above ground, in a fence post at the side of a much-used county road, one and a half miles south of Norman--was of particular interest: on March 30, 1955, it held two bluebird eggs (female incubating), and 12 days later, on April 11, Carolina Chickadees were building in the same cavity (female incubating five eggs on April 19). This site had been temporarily claimed by bluebirds the previous year.

Species Which Breed in Habitat Similar to That at the Plot

Included in this category are several species which I recorded in the general vicinity of the plot.

Colaptes auratus. The Yellow-shafted Flicker is not common in Cleveland County during the breeding season. It occurs in tall trees of floodplain, bottomland, and, more frequently, in towns and prairie ravines. Data on three occupied nests are: (1) May 11, 1953, 25 to 30 feet above ground, in dead limb about six inches in diameter, at "Macy Street ravine"; (2) April 30, 1955, about 25 feet above ground, entrance hole about eight inches from end of vertical dead limb about eight inches in diameter, adult incubating, at "Macy Street ravine"; (3) May 26, 1956, about 20 feet up in a dead limb of a maple, young in nest cavity, in Norman.

Dendrocopos villosus. The Hairy Woodpecker is about one-fifth as common as the Downy in central Oklahoma. Usually dependent on dead stumps for nest sites, the Hairy is seen throughout the ecotone. Records of occupied nests are: (1) March 27, 1954, in strip of well-developed forest along northern edge of South Canadian River, two miles southwest of Norman (George M. Sutton); (2) April 28, 1955, young birds (gone from nest May 6) in nest about 25 feet above ground in 35-foot dead black willow--one of many willows below dam at Crystal Lake, one mile north of Norman; (3) April 9, 1956, four eggs collected from nest about five feet above ground in small cottonwood stump, in cottonwood parkland of floodplain, about three miles south of Norman (David F. Parmelee).

Thryomanes bewicki. On May 5 and again on May 12 I heard a Bewick's Wren singing at the brush-lined wooded ravine about 200 feet south of the plot. Probably it was breeding there.

This wren, while not common, is distributed throughout the ecotone in places having brush or undergrowth, though not in forest

interiors. It nests in cavities of all sorts in urban and rural areas, and it requires an elevated song perch. Information concerning three occupied nests, all in Norman, is as follows: (1) April 7, 1953, in cavity of tree standing in backyard at 711 Jenkins (Mrs. A. R. Ramey); (2) April 2, 1955, being built in cavity of rock wall, entrance 44 inches above ground, 524 Macy Street (Mrs. Charles E. Harp); (3) April 11, 1955, nearly completed (six eggs by April 30), in open garage among pile of boxes and newspapers, entrance three feet from floor, 440 Chautauqua Street (Charles C. Carpenter). On June 27, 1955, about seven miles northeast of Norman (well within the savannah) I came upon a male wren singing near a fence pole in the cavity of which was a characteristic nest, four feet above ground.

Lanius ludovicianus. While the Loggerhead Shrike is not abundant at any season in central Oklahoma, its nests are comparatively easy to find. Shrikes perch in conspicuous places--usually on fence or telephone wires--and often an individual so perched has a nest nearby in an isolated tree or one of several scattered trees; the parent birds scolds fiercely and may even attack the intruder when he approaches the nest site.

I have not seen this bird in the savannah. Data on five nests, found in 1955 within two miles of Norman (widely separated locations) are: (1) April 12 (six eggs April 27), eight feet up in 20-foot juniper (Robert Frank); (2) April 24, six eggs, nine feet up in 15-foot American elm (Robert Frank); (3) May 3, six eggs, four and a half feet up in a 12-foot mulberry; (4) May 12, young birds, about ten feet up in a 30-foot black willow; (5) June 3, six eggs, nine and three-fourths feet up in a 13-foot elm (John Wiens).

Icterus galbula. The Baltimore Oriole arrives in late April and breeds commonly in town, beginning by the first week in May. The pensile nests are well concealed among leaves near the end of long, freely-swaying branches of deciduous trees. The male sings insistently from perches hidden within the foliage. In Norman one may see many winter nests in branches extending out over the streets, on the campus, and in older residential areas. I have encountered few orioles of this species in rural areas--nearly always in the tall trees of ravines, bottomland, and floodplain.

Chondestes grammacus. The Lark Sparrow is found principally in areas of scattered woody vegetation west of the savannah. It is one of the earliest spring arrivals--some individuals appearing in the Norman vicinity in mid-March (my earliest record: March 22). In rural areas, it is common near dwellings. The nest is well hidden among foliage. In some regions the species sometimes nests on the ground, but in the Norman vicinity the lowest nest of which I have record was three feet above ground (possible exception: an old nest, characteristic of this species, found by Donald H. Baepler and myself on March 27, 1955, in a tussock of prairie grass at the Rucker Ranch). On the university campus Lark Sparrows commonly build at the ends of pine limbs. Other plants in which I have found occupied or recently-used nests are: honeysuckle, Lonicera (both vines and bushes), elm, mulberry, plum, and pecan.

Discussion of Breeding Birds

Composition of the Breeding Population

The breeding bird population in central Oklahoma is composed of

summer visitants and residents. Summer visitants are those species which winter farther south and return here to breed. Resident species occur here throughout the year. As mentioned in the discussion of wintering birds, individuals of some resident species probably spend the winter to the south and, during the breeding season, replace other individuals of the same species which move northward out of central Oklahoma to breed.

The Broad-winged Hawk and Cassin's Sparrow are mentioned above chiefly as a matter of record; since the status of these two species in central Oklahoma is uncertain, neither is included in the following general discussion. Of the other 41 breeding species considered in this paper, 24 (about 59 per cent) are summer visitants, and 17 (about 41 per cent) residents (Table 2).

TABLE 2

COMPOSITION, DISTRIBUTION, AND NESTING SITE OF BREEDING BIRDS

Name of bird	Resident	Summer visitant	Found widely over ecotone	Found principally in savannah	Found principally in prairie	Nests principally in edge	Nests in edge or uniform vegetation	Possibly nests in uniform vegetation only
Yellow-crowned Night Heron		x		x			x	
Mourning Dove		x	x				x	
Yellow-billed Cuckoo		x	x				x	
Great Horned Owl	x		x				x	
Chuck-will's-widow		x		x				x
Yellow-shafted Flicker	x		x			x		
Pileated Woodpecker	x			x		x		
Red-bellied Woodpecker	x		x				x	

TABLE 2--Continued

Name of bird	Resident	Summer visitant	Found widely over ecotone	Found principally in savannah	Found principally in prairie	Nests principally in edge	Nests in edge or uniform vegetation	Possibly nests in uniform vegetation only
Hairy Woodpecker	x		x				x	
Downy Woodpecker	x		x				x	
Eastern Kingbird		x			x	x		
Western Kingbird		x			x	x		
Scissor-tailed Flycatcher		x			x	x		
Crested Flycatcher		x	x				x	
Eastern Phoebe		x		x		x		
Horned Lark	x				x			x
Barn Swallow		x			x		x	
Crow	x		x				x	
Carolina Chickadee	x		x			x		
Tufted Titmouse	x			x			x	
Bewick's Wren	x		x			x		
Carolina Wren	x		x				x	
Eastern Bluebird	x		x			x		
Blue-gray Gnatcatcher		x		x			x	
Loggerhead Shrike	x				x	x		
Bell's Vireo		x	x				x	
Red-eyed Vireo		x		x			x	
Yellow-throat		x		x		x		
Eastern Meadowlark	x				x		x	
Baltimore Oriole		x	x			x		
Orchard Oriole		x	x			x		
Cowbird		x	x				x	
Summer Tanager		x		x			x	
Cardinal	x		x				x	
Blue Grosbeak		x	x			x		
Indigo Bunting		x		x		x		
Painted Bunting		x	x			x		
Dickcissel		x			x	x		
Grasshopper Sparrow		x			x			x
Lark Sparrow		x			x	x		
Field Sparrow	x		x				x	

General Distribution of Breeding Birds over the Forest-Prairie Ecotone

Each species of wintering and breeding bird discussed here seems to have its own peculiar seasonal habitat or habitat niche. Because nesting birds are restricted in the range of their movements, their habitat preferences are more readily observable than those of wintering species. The following summary statements, which are based upon observations over the whole forest-prairie ecotone, include information gained through censusing the four plots (Table 2).

Many breeding birds in central Oklahoma are widely distributed over the ecotone, i. e., they are not noticeably more abundant in either the savannah or prairie. Of the 41 species, 21 (about 51 per cent) are so distributed; in the order discussed in this chapter, they are: Mourning Dove, Cardinal, Carolina Chickadee, Yellow-billed Cuckoo, Red-bellied Woodpecker, Cowbird, Field Sparrow, Crested Flycatcher, Blue Grosbeak, Carolina Wren, Painted Bunting, Downy Woodpecker, Bell's Vireo, Orchard Oriole, Great Horned Owl, Yellow-shafted Flicker, Hairy Woodpecker, Crow, Bewick's Wren, Eastern Bluebird, and Baltimore Oriole. The habitat requirements of these species are well met in both savannah and prairie.

Ten species (about 24 per cent of the total) are found principally in the savannah. Of these the following five nest in both uplands and lowlands (bottomland and wooded savannah ravines): Tufted Titmouse, Blue-gray Gnatcatcher, Summer Tanager, Indigo Bunting, and Eastern Phoebe. The habitat requirements of the other five species vary. The Red-eyed Vireo nests chiefly in very shady, well-wooded areas. The Yellow-throat

is found principally in willows and other similar vegetation in lowlands. According to my records, the Yellow-crowned Night Heron and Pileated Woodpecker nest only in well-wooded bottomlands. The Chuck-will's-widow I have found breeding only in upland forests.

The remaining ten species of breeding birds are found principally in, or are restricted to, the prairie: Scissor-tailed Flycatcher, Eastern Meadowlark, Dickcissel, Grasshopper Sparrow, Eastern Kingbird, Western Kingbird, Horned Lark, Barn Swallow, Loggerhead Shrike, and Lark Sparrow. The meadowlark, Grasshopper Sparrow, and Horned Lark nest only on the ground; the Dickcissel nests either on or above the ground. The Barn Swallow uses culverts as nesting sites. The Scissor-tail, both the kingbirds, the Loggerhead Shrike, and the Lark Sparrow nest in solitary trees or shrubs or in widely-spaced woody vegetation; all of the tree-nesters which commonly nest in the wooded prairie ravines of central Oklahoma also breed in the savannah.

Thus, of the 41 species discussed, about the same number breed in the savannah as in the prairie. This statement sheds no light on the numbers of individuals breeding in savannah and prairie.

The South Canadian River floodplain is without distinctive bird habitats, i. e., habitats different from those of the prairie or savannah. The statement applies to both winter and summer. I know of no central Oklahoma bird whose wintering or nesting is restricted to the floodplain.

Use of Edge Habitats

Many of the 41 species nest only in edge habitats (Table 2). Some nest in extensive areas of uniform vegetation, but certain

individuals of these very species may use edge habitats for nesting, feeding, or roosting. None of the 41 species is restricted to "non-edge" habitat--possible exceptions being the Chuck-will's-widow (upland forests), Grasshopper Sparrow (pastures with much dead grass), and Horned Lark (fields with little or no vegetation). Thus the high ratio of species nesting in edge habitat to those nesting in "non-edge" habitat correlates well with the large amount of edge habitat in the forest-prairie ecotone of central Oklahoma.

CHAPTER V

SUMMARY

1. Broad ecotones are of special interest in the study of bird distribution because of the variety of strongly contrasting habitats in them. The forest-prairie ecotone of central Oklahoma is a region of grassland, post oak and blackjack upland forests, and well-wooded floodplains and ravines.

2. The prime determiner of bird distribution is, generally speaking, vegetation. In this investigation the bird populations of certain restricted areas believed to be vegetationally characteristic of the ecotone were studied, and the bird species found on these areas were therefore considered representative also. Winter birds of two tracts (one in woodland, the other in grassland) and breeding birds of four plots (three in woodland, one in grassland) were studied intensively in 1954-55.

3. Data were obtained concerning each species' habitat preference, frequency and manner of occurrence, and relative abundance in the ecotone. Many data were based on general observations in central Oklahoma from 1952 to 1955 inclusive, but those obtained on the special study areas in 1954-55 served as an important check.

4. Of the 41 representative species of winter birds studied,

28 were found to be resident, 13 visitant. Some of the resident species, e. g., the Cardinal, were strictly non-migratory; others, e. g., the Blue Jay, while present the year round as a species, were to some extent migratory.

5. Twenty species of winter birds were seen regularly in both prairie and savannah, eight principally in the savannah, thirteen principally in the prairie. Three were virtually restricted to the savannah, seven to the prairie. Several were found only in edge habitats; none was restricted to "non-edge" habitats. Twenty-five species occurred more or less regularly in flocks, six usually in mixed flocks.

6. Of the 41 species of breeding birds, 17 were resident, 24 visitant. Eleven resident species seen in winter did not inhabit in summer the four plots censused.

7. Twenty-one species of breeding birds were not noticeably more abundant in either savannah or prairie. Of these, the more arboreal that nested in the prairie nested principally in the wooded ravines. Of ten species found primarily in the savannah, three were restricted to bottomlands and one to upland forest. Ten species were found only in the prairie (rarely in the savannah); of these, the more arboreal used solitary or widely-spaced woody vegetation principally. Several resident species which inhabited edge habitats in winter moved into "non-edge" habitats to nest.

8. The South Canadian River floodplain in central Oklahoma offered no unique wintering or breeding habitat. None of the 65 species studied was restricted to the floodplain.

9. Each bird species studied showed preference for vegetation of particular "life-form" rather than for particular plant species.

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