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An estimated half-billion blackbirds and Starlings have been roosting in the United States each winter for many years (Meanley and Webb, 1965). Three-fourths of these birds, primarily Red-winged Blackbirds *(Agelaius phoeniceus),* Common Grackles *(Quiscalus quiscula).* Brown-headed Cowbirds *(Molothrus ater),* and Starlings *(Sturnus vulgaris)* winter in the east (lower Mississippi Valley and eastward to the Atlantic Ocean) where food and climate are apparently more attractive than in the more arid west.

In recent years, these birds have come increasingly to public notice because of apparent agricultural, health, aesthetic, and nuisance problems (Graham 1976). Considerable effort has been spent developing lethal agents for local control of problem roosts (Lefebvre and Seubert, 1970). This approach has met with considerable opposition (Russell, 1975; Graham, 1976). Unfortunately, little effort has been directed into ecological studies (e.g., daily habitat utilization, food habits, impact on agriculture) of the various roosting species during the winter months. Such studies are essential to: (1) document the magnitude of the problems, and thus, set priorities for additional research, methods development, and control programs; (2) provide the proper background information for the development of management tools that offer long-term solutions to the problem; and (3) provide the general public with factual information on blackbird and Starling roosts. Attempts have been and are being made to determine the extent of the agricultural, ecological, and health problems associated with these roosts. Once enough information is obtained, the public can be informed and management policies can be formulated and implemented.

One agricultural problem associated with these roosting populations has been the pulling of sprouting wheat by the birds in late fall and winter. Although high losses have been cited in some cases (Russell, 1975), no objective documentation of the problem is available. Our purposes in this study were to: (1) determine the chronology and amount of bird damage to sprouting wheat in the foraging range of a large roosting population and (2) determine which bird species are responsible for the damage and their abundance in relation to other roosting species in this area.

The study was located in Gibson County, Tennessee. A large, winter-roosting population (>5 million birds) of blackbirds and Starlings that forages primarily in Gibson County (Russell, 1975) has been located at various sites on the Milan Army Ammunition Plant on the Gibson-Carroll County border near Milan, Tennessee, since the winter of 1969-70. Wheat production, historically a minor crop in the county, has increased from 8, 000 acres in 1973 to over 20, 000 acres in 1975 (Hobson 1976). Farmer complaints of bird damage have increased concurrently with the increased acreage.

METHODS

Survey Routes

We established five survey routes totaling 80 km along secondary roads west of the Milan roost in the area of the greatest reported agricultural damage (Russell, 1975) (Fig. 1). The routes were located 3 to 24 km from the roost. On three days a week between 31 October and 10 December, two observers drove these routes in one automobile at 10-30 mph and recorded numbers, species composition, and associated habitat types for all observed flocks of two or more blackbirds and/or Starlings. In addition, the following notations were made for all wheatfields encountered on the routes: planting date, type of planting, acreage, previous crop, and depth of planting.

One to four habitat surveys were run monthly on the census routes from late October to early March to determine the relative proportions of 10 habitat types. Each route was driven at 10-30 mph, and the habitat type on each side of the road was recorded at 0.16-km intervals. Thus, about 1, 000 sample points were recorded for each survey.

Bird Damage to Wheat

Along each census route, we counted sprouts and recorded the incidence of destroyed and/or probed (but still living) sprouts in damaged fields on 12 December by taking one $0.3m^2$ plot at 5, 15, and 30 m from the field edge. On 19 December, we obtained a more accurate estimate of percent of sprouts destroyed and/or probed in 10 randomly-selected $0.3m^2$ in each of seven damaged fields. Whenever we saw blackbirds and Starlings in wheatfields, we observed (through a 20-40X telescope) the species, and, if possible, actual items being consumed.

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We studied in detail a field near one of the routes (hereafter referred to as the "Parker Field") that had been brought to our attention as a severely damaged field. We monitored this 10-ha bottomland field for damage throughout the season by randomly establishing 25 permanently-marked 0.3m^2 plots. Thus, we could roughly determine the fate of the sprouts in these plots.

Freeze-Thaw Damage to Sprouts

In addition to bird damage, we found sprouts destroyed (i.e., plants completely or nearly completely heaved out of the ground) by freeze-thaw conditions. Between 22 and 31 January, we recorded sprouts destroyed by freeze-thaw in ten 0.3m^2 plots in each wheatfield on the routes.

Wheat Yield

In May 1976, we obtained an index of yield in the wheatfields on the routes, plus an index of yield from the Parker Field. Because of uneven maturity between and within fields, we did not try to determine bushels per ha, but rather recorded the number of wheat heads in 10 randomly-chosen 0.3m^2 plots in each field.

Monitoring of Blackbird Roost

Between 1 November and 5 March, we made 28 estimates of numbers and 18 estimates of species composition of blackbirds and Starlings at the Milan roost; these estimates were made at least weekly, usually by two observers. Population estimates were obtained by block-counting (Meanley, 1965) birds in all major flightlines as they left the roost. To estimate the species composition, an observer was stationed under a flightline in the morning (as birds left) or evening (as birds entered); he sighted repeatedly through binoculars, randomly identifying and recording one bird at a time until at least 100 identifications were made for each estimate.

Bird Collections for Food Habits

With few exceptions, once each week between 14 November and 29 February, we collected approximately 50 birds by shotgun as they settled into the roost at dusk. Each bird was identified, sexed, and weighed; the stomach and esophageal contents were placed in a vial containing *5%* formalin.

To analyze food items, the formalin was drained from each vial; each sample was further dried by placing in an oven (40°C) for several hours. The sample was then placed in a petri dish containing five 1-mm dots symetrically placed 2 cm apart in the form of the center and end points of an "X." The dish was shaken for a short period, and the food item that rested upon or nearest each dot was recorded. This procedure was repeated five times per sample for a total of 25 recordings per sample. The total for each food item (corn, wheat, sorghum, weed seeds, tree seeds, and insects) was multiplied by four to obtain a percentage estimate.

This food-habits analysis, was biased toward items that are difficult to digest (e.g., corn and certain weed seeds); thus, the estimates obtained have this limitation. Moreover, since birds were collected only in the evening, possible diurnal patterns in food selectivity were not sampled. Nonetheless, we believe this analysis provides a general idea of the dominant food items of the roosting species.

RESULTS

Impact of Birds on Wheat Crop

Characteristics of wheatfields along the survey routes. Forty-eight wheatfields, averaging 7.6 ha, were noted on the census routes. Seed was drilled in about 85 percent of these fields and broadcast and disced in the remainder. Seed depth varied from 0 to 6 cm. Soybeans had been the previous crop in about 50% of the fields, corn in about 35%, and cotton or sorghum in most of the remainder.

Bird damage to sprouting wheat. All 15 wheatfields planted after 12 November [hereafter referred to as "late-planted fields" (31% of the 48 fields)] received bird damage (i.e., sprout was wrenched completely from soil or nearly so, or else a probe hole existed with no sprout visible). However, only 2 of the 33 fields (6%) planted prior to 13 November received damage. Damage in the late-planted fields ranged from 2 to 35% and averaged approximately 11% of the total sprout populations. (Note: in the field with 35% damage, birds apparently ate much of the seed sown on the ground before it could be disced; the next highest damage was 22%.) Overall bird damage to wheat sprouts averaged 3.5% for the 48 fields on the routes. We assessed the 25 plots in the late-planted Parker Field on 20 December and found nearly 40% of the sprouts destroyed by birds.

Damage to sprouts occurred from time of emergence (usually early December for the fields that were damaged) until the sprout reached a height of approximately 8 cm. Bird damage to sprouts essentially ceased by mid-January.

Freeze-Thaw Damage to Sprouts. A substantial proportion of the sprouts that survived bird attack in the 15 late-planted fields were destroyed by freeze-thaw damage (i.e., plants completely or nearly completely heaved out of the soil). Of these 15 late-planted fields, the 22-31 January survey revealed that 25% of the sprouts surviving bird damage had been destroyed by freeze-thaw conditions (74% of the sprouts in one field was destroyed in this manner). The average for all 48 fields was 13.5 sprouts destroyed by freezing and thawing. At this time (late January), the average number of undamaged sprouts in the late-planted fields averaged 14.1 per 0.3 m^2 plot. In the Parker Field, 50% of the remaining sprouts had been destroyed by freeze-thaw action; an average of 6.5 sprouts per 0.3 m^2 remained in late January.

Wheat yield in relation to bird damage. In May, we surveyed yields in 9 of the 15 late-planted fields that remained (the other six had been plowed or grazed) and in the Parker Field. The nine fields, which had averaged 14.1 sprouts per 0.3m^2 plot in January, averaged 47 wheat heads per plot in May. The Parker Field, which averaged 6.5 sprouts per plot in January, averaged 22 wheat heads per plot in May. These data indicate partial recovery of sprouts supposedly destroyed by birds or by freeze-thaw conditions, and/or latent sprouting in the spring. In the Parker Field, we could find no correlation between the number of destroyed sprouts in December and the number of wheat heads in the same plots in May (Fig. 2). To some extent, however, the data indicate a positive correlation between high sprout populations and high bird damage.

Bird Species Inflicting Damage

Roost population. Roosting activity at the Milan roost began in early November, reached a peak during the second week of February, and ended in early March (Fig. 3). In late February and early March, other coniferous and deciduous stands about 0.8 km west of the Milan roost were also used. The roosting population estimates showed a steady growth to a peak population of 10 to 11 million blackbirds and Starlings in January and early February followed by abrupt decline to about two million birds by the end of February.

The species composition remained fairly constant from November through February, with overall means of 64% Grackles, 27% Redwings and Cowbirds, 9% Starlings, and trace percent Rusty Blackbirds (Table 1). Redwings and Cowbirds were included together because they were difficult to distinguish during the species-composition estimates. Based on our general observations and the species composition of birds collected for food habits, we believe that Redwings were much more numerous than Cowbirds.

Grackle populations peaked in January, whereas Redwing and Starling populations peaked in February. Grackle and Redwing populations decreased rapidly during late February before Starling populations dispersed.

Food habits. Among the four species of birds collected at the roost, only Starlings were found with more than trace amounts of wheat (19%) in the crop or gizzard (Table 2). Overall, Starlings had the most cosmopolitan diet; other items inlcuded weed seeds (29%), corn (16%), common tree seeds (9%), and insects (3%). In contrast, Grackles concentrated primarily on corn (77% of food items found), while Redwings consumed nearly equal amounts of corn (38%) and weed seeds (36%). Corn (46%) and weed seeds (34%) also were the principal food items for Cowbirds.

Blackbird-Starling habit utilization. The four roosting species differed greatly in their daily habitat utilization during the winter months (Table 3). Starlings, the species that inflicted virtually all the wheat damage, were found primarily in pastures (31% of observations), feedlots (23%), and woods (11%). Overall, only *5%* of the Starling observations occurred in wheatfields. A decrease in the incidence of Starlings seen in wheatfields during January and February (Fig. 4) coincided with the cessation of bird damage to wheat.

Grackles were the most commonly observed species in wheatfields (9% of observations. Table 3); however, we had no evidence that they inflicted damage to the wheat. They, along with the redwings (5% of observations in wheatfields), fed on waste corn, weed seeds, and other food items in the wheatfields. We watched, through the telescope, 55 Grackles and Redwings in wheatfields devour 202 food items consisting primarily of corn and milo (no wheat seeds or sprouts observed) in a total of 3.238 seconds of observations. In contrast, we watched seven Starlings probe at eight wheat sprouts during a total span of 86 seconds.

DISCUSSION AND CONCLUSION

We commiserate with the local people who have to bear the decidely unaesthetic aspects of close proximity to a major blackbird roost. Understandably, these roosts can be a nuisance and/or health factor that may at times call for control measures.

On the whole, from our data gathered in 1975-76, we cannot conclude that bird damage to winter wheat is severe in the vicinity of Milan, Tennessee. We found only two instances (2 of 33 fields) of bird damage and no cases of freeze-thaw damage to wheat planted prior to 13 November. In contrast, all 15 (31%) of the fields planted after 12 November had bird

damage (average 11%). Overall, for all fields examined, regardless of date planted, bird damage averaged only 3.5%. Occasionally, we found a late-planted field that had severe bird damage (e.g., Parker Field had 40% of sprouts bird-destroyed).

Freeze-thaw damage to these late-planted fields averaged 13.5% sprouts destroyed and often exceeded the bird damage. In the Parker Field, 50% of the sprouts not destroyed by birds were destroyed by freeze-thaw conditions.

We found much higher wheat populations in the spring. Recovery from damage or a high rate of late-winter and/or early-spring sprouting in these late-planted fields may have caused this. In January, sprout populations on the 15 late-planted fields averaged 14.1 sprouts per $0.3m^2$ plot; plots in nine of these same fields averaged 47 wheat heads per $0.3m^2$ plot in May (the other six fields were no longer in existence). The 47 heads per $0.3m^2$ compares well with production on a field planted at the Milan Field Station on 17 November that had no bird damage and a wheat-head count of 54 per $0.3m^2$ plot. Even the Parker Field, with a count of 6.5 sprouts per $0.3m^2$ in January, had a head count of 22 per $0.3m^2$ in May.

In essence, we are saying that bird damage to wheat planted prior to 13 November is a minor problem in the Milan area. Even in fields planted after 13 November that get some bird damage plus freeze-thaw damage, rejuvenation of apparently-destroyed plants and/or new sprouting in the spring seems to negate much of the problem.

An obvious management recommendation to reduce bird and frost damage is to plant wheatfields by early November. For reasons other than bird damage, the Tennessee Agricultural Extension Service already recommends that wheat be planted by 1 November (Cobble, 1974).

Regarding the damaging species, evidence points exclusively to the Starling. Wheat or wheat sprouts were found almost entirely in Starling stomachs. Moreover, observations of birds in wheatfields, showed probing for wheat sprouts by Starlings but no occurrences of Grackles and Redwings feeding on wheat.

If bird control is needed because of damage to wheat, control methods should be directed at the Starling, a minor (9%) species in the roosting population. The blackbird species are virtually blameless for this type of damage activity.

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TABLE 1 Average species composition (%) of birds roosting at Milan, Tennessee roost, November 1975 through early March 1976. Values in parentheses are peak monthly population estimates (X 10^6).

Species	November	December	January	February	Early March	Entire period
Grackle	70 (2.5)	75 (5.2)	63 (6.7)	57 (6.3)	47 (0.2)	64
Redwing and Cowbird together	20 (0.7)	15 (1.0)	33 (3.5)	34 (3.7)	4 (<0.1)	27
Starling	10 (0.4)	10 (0.7)	4 (0.4)	9 (1.0)	49 (0.2)	9

TABLE 2. Average (%) of various food items in the crop and gizzard of four roosting species collected at the Milan, Tennessee roost, 14 November 1975 - 29 February 1976.

Food Item	Common Grackle	Red-winged Blackbird	Starling	Brown-headed Cowbird
Corn	77	38	16	46
Wheat	0	<1	19	0
Sorghum	<1	2	0	4
Weed seeds	6	36	29	34
Tree seeds	8	1	9	0
Insects	1	<1	3	0
Unidentified	7	22	24	16

TABLE 3. Utilization of habitat by Grackles, Redwings, Cowbirds, and Starlings based on observations along survey routes near Milan roost, 31 October-10 December 1975.

Habitat type	Percent of total habitat (Nov.-Feb.)	Grackles (%)	Redwings (%)	Cowbirds (%)	Starlings (%)
Pasture	23	4	2	6	31
Soybeans	21	4	36	3	11
Woods	13	36	15	12	11
Buildings, misc.	12	1	3	1	10
Fallow	11	2	2	0	<1
Cotton	8	<1	2	0	2
Wheat	5	9	5	<1	5
Corn	4	36	28	11	5
Plowed	3	2	5	2	1
Feedlot	<1	6	3	65	23

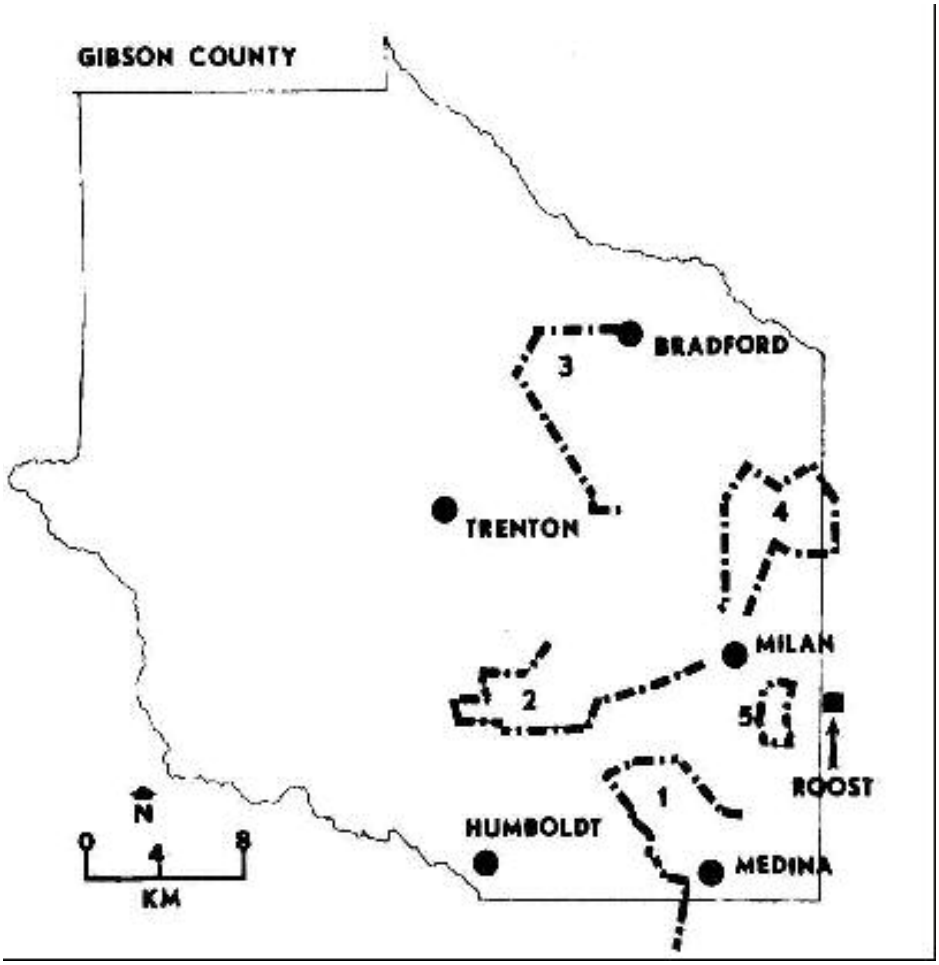

FIGURE 1. Routes run by automobile in Gibson County, Tennessee, in surveying bird damage to winter wheat, October 1975-March 1976.

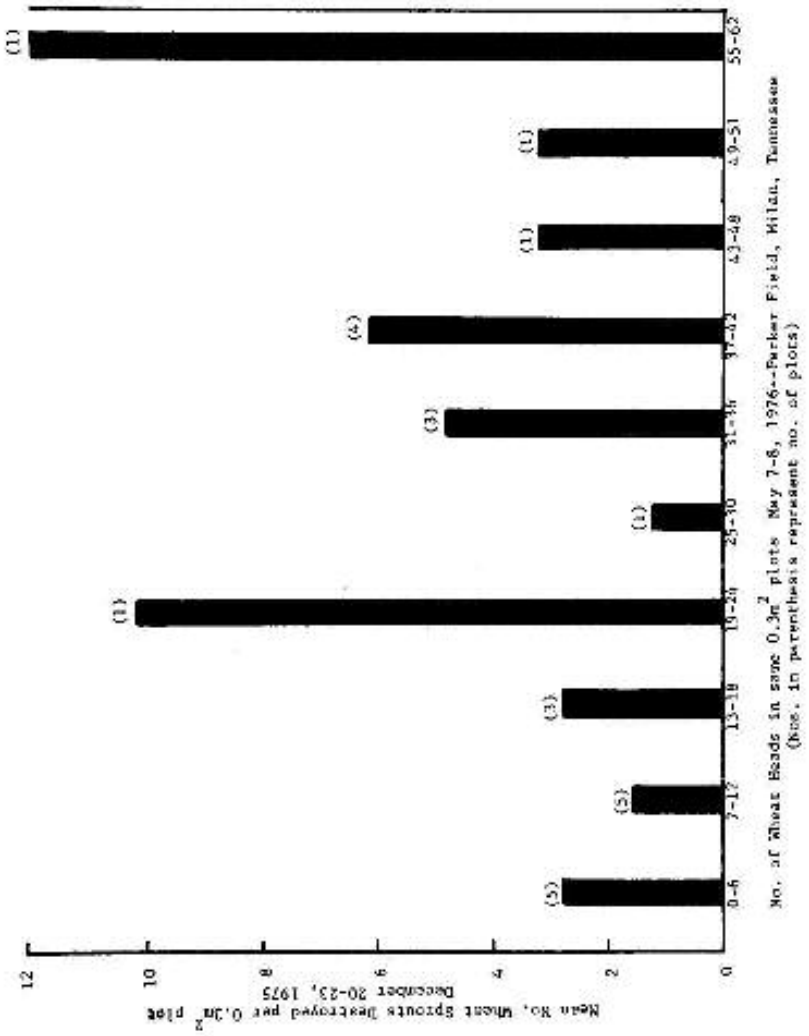

FIGURE 2. Relationship of number of wheat sprouts destroyed by birds in December 1975 and number of wheat heads found in May 1976 in same 25 plots in Parker Field, Gibson County, Tennessee.

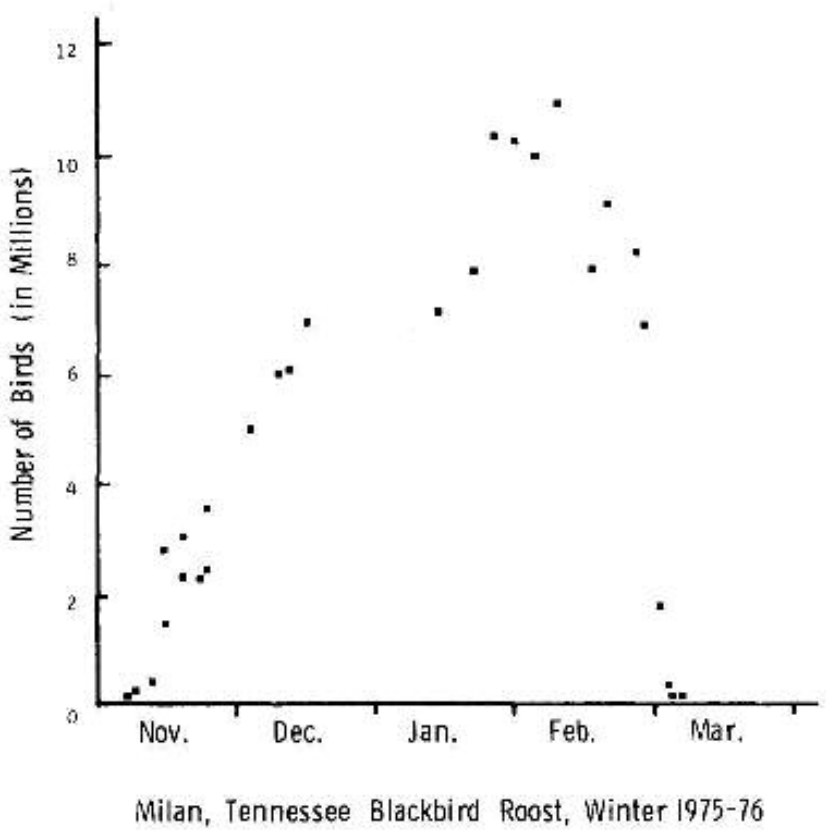

FIGURE 3. Estimate of number of roosting blackbirds and Starlings at Milan, Tennessee roost, November 1975-March 1976.

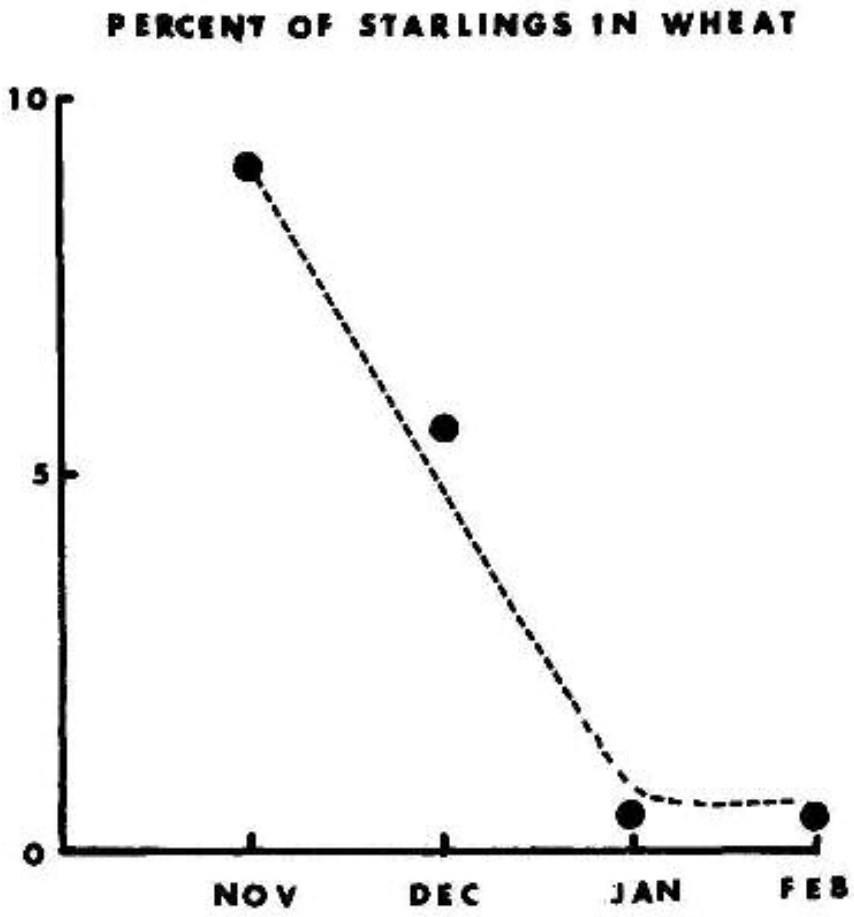

FIGURE 4. Percentage of Starlings observed in wheatfields, November 1975-February 1976, Gibson County, Tennessee.