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Blackbird & Starling Roosts in Warren County, Kentucky

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BLACKBIRD AND STARLING ROOSTS IN WARREN COUNTY, KENTUCKY

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by

Wayne M. Mason

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BLACKBIRD AND STARLING ROOSTS IN

WARREN COUNTY, KENTUCKY

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I would like to dedicate this paper to my wife, Martha B. Mason, for her encouragement and understanding.

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BLACKBIRD AND STARLING ROOSTS IN WARREN COUNTY, KENTUCKY

Wayne M. Mason April 1981 44 pages

Directed by: Herbert E. Shadowen, Kenneth A. Nicely, and Rudolph Prins

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Blackbird and Starling roosts of the 1979-80 winter season were observed in order to obtain as much information as possible concerning roosts in this area. Five species were found to comprise the local roosts: The Common Grackle (Quiscalus quiscula), Red-winged Blackbird (Agelaius phoeniceus), Brown-headed Cowbird (Molothrus ater), Rusty Blackbird (Euphagus carolinus), and the Starling (Sturnus vulgaris).

Seven categories of activities were observed in roost species: predeparture vocalizations; predeparture staging; roost departure; daily activities; roost return; preroost staging; and settlement into the roost. The Common Grackle appeared to be the species around which the activities of the other species were patterned.

Light experiments conducted on Starlings in a barn on the Western Kentucky University farm had no effect on bird movements within the barn. As ambient temperatures decreased, the number of birds in the barn increased, thus revealing the Starling's high adaptability as a species.

INTRODUCTION

A communal bird roost is defined as a place where many birds rest during a long period of inactivity after feeding solitarily or in flocks of different species (Ward and Zahavi, 1973). During the winter, blackbirds (Family Icteridae) and Starlings (Sturnus vulgaris) often form large communal roosts in parts of the United States, particularly in the southeast (Dolbeer, et al., 1978). Although these roosts have been present for years, ornithologists have only recently begun to study the mechanics and behavior associated with large concentrations of birds.

Warren County, located in southcentral Kentucky, has been a favorite roosting ground for blackbirds and Starlings in recent winters, and their presence has created a great deal of local concern and controversy (Shadowen, 1972). Despite all the attention afforded these roosts locally, very little information of scientific value has been gathered concerning the habits of blackbirds and Starlings in this particular area. Therefore this study had three basic objectives: (1) to review the history of roosts in Warren County, Kentucky; (2) to study the dynamics of roost populations; and (3) to study the effect of light manipulation and ambient temperature on the Starling.

Due to the scarcity of data pertaining to local blackbird and Starling roosts, an attempt was made to compile a historical account of all the roosts known to have occurred in Warren County. Included within this background information are such topics of interest as: (1) the locations and numbers of roosts which have been active in Warren County through the winter of 1979-80; (2) the problems which have been found to be associated with blackbird

and Starling roosts locally; and (3) the control practices which have been employed against roosts in this area and their effectiveness.

Warren County offers a researcher excellent opportunities for the study of roosts; therefore, it was decided that the winter bird roosts of the 1979-80 season should be studied in order to obtain as much information as possible concerning blackbird and Starling roosts. Detailed notes on roost departure and return times, flight line directions, numbers, and species composition were recorded and included in this category, as were observations pertaining to roost structure and ecology.

Studies of the roosting behavior of Starlings as it relates to weather conditions and various light treatments were also included. Starlings have been utilizing a particular cattle barn in Warren County as a roosting site for the past three years, and questions have been raised as to whether the number of Starlings in the barn may be correlated with weather conditions, specifically to temperature changes and ground cover (snow or ice). It was hypothesized that the findings of this study would provide information concerning the potential of light as a possible dispersal tool against roosting blackbirds and Starlings.

Furthermore, this study provides information concerning the organization and functioning of roosts in this area and will serve as a reference for those interested in the future study of blackbird and Starling roosts in Warren County.

HISTORICAL ACCOUNT

Blackbird roosts drew little attention in Warren County until 1968, and no documented records of their occurrence were kept prior to 1972. Therefore, much of the early historical data in this survey was obtained via conversations with local people who were believed to have known the location of the early roosts. Whenever possible, personal notes and newspaper articles were also used to provide information on roost locations and numbers. By 1968 the roosts had become a popular media topic and were often covered by the press.

The first reported blackbird and Starling roost to appear in Warren County was located along the Barren River during the winter of 1960-61 (Table I) (L. Y. Lancaster, personal communication). Although the exact location was unknown, birds returned to the same general area for the next three winters. During the winter of 1964-65, the birds roosted in an area 4 miles southeast of Bowling Green and adjacent to Drake's Creek, just off U. S. Highway 231. They continued to use this site each winter for the next five years. As stated previously, roosts drew little attention during these early years; thus, data on roost size, species composition, and time of development are lacking. Even number estimates during this period are uncertain, although Shadowen (1972) states the population had ranged between 3,000,000 and 6,000,000 birds from one winter to the next.

It was not until a roost developed six miles northwest of Bowling Green, near U. S. Highway 231, that data became available concerning roost size, locations, and numbers. An estimated 7,000,000 birds occupied a wooded area on the Bryant Farm from 1968-69 through 1970-71. Birds returned

TABLE I. Historical survey of winter blackbird and Starling roosts in Warren County, Kentucky.

Winter(s) of Roost Activity	Roost Name[1]	Roost Size (in Acres)	Largest Estimated Numbers
1960-64	Barren River	unknown	unknown
1964-69	Scottsville Road	unknown	unknown
1968-69	Bryant Farm	10	7,000,000
1969-71	Bryant Farm	12	7,000,000
1971-72	Bryant Farm	12	5,000,000
1972-74	---------- No Roosts Reported ----------		
1974-75	"small scattered roosts; little numbers"		
1975-76	Plano	8	15,000
	Shive Lane	12	4-5,000,000
1976-77	Bowling Green Center	10	"several thousand"
1977-78	Plano	8	350,000
	Bowling Green Center	10	2,000,000
	Cumberland Trace	5	2,000,000
1978-79	Plano	8	15,000
	Cumberland Trace	5	2,000,000
	Bowling Green Center	10	1,000,000
1979-80	Cumberland Trace	5	2,000,000
	College View Park	12	400,000
	Springhill Subdivision	8	500,000
	Bowling Green Center	10	2,000,000
	Shawnee Subdivision	20	1,102,000

[1]Locations described in detail in the Historical Account

to the Bryant Farm during the winter of 1971-72, but the numbers were reduced from the previous 7,000,000 to 5,000,000 (Shadowen, 1972).

No major concentrations of blackbirds and Starlings were reported in Warren County from the winter of 1972-73 through the winter of 1974-75, but by the winter of 1975-76 the birds had returned, reportedly occupying two different roosting sites. One roost was located ten miles south of Bowling Green near the settlement of Plano, and it contained approximately 15,000 birds (Park City Daily News, #248, October 17, 1975). The other roost was much larger and was located within the southeast section of Bowling Green near the Shive Lane Trailer Park (H. E. Shadowen, personal communication). This roost was estimated at 4,000,000 to 5,000,000 birds and was responsible for generating the local interest in roosts which started at this time and has persisted to the present. Birds did not return to the Shive Lane roost after this initial settlement, but the excitement created by its presence was enough to lead to a heightened interest in roosts locally. Controversy surrounds the dates, exact location, and size of the Plano roost; researchers at the Bird Damage Control Center stationed at Bowling Green question the early information pertaining to this roost, claiming it was not active during the winter of 1975-76. It was active during the winters of 1977-78 (containing approximately 15,000 birds at its peak). It was not active through the winter of 1979-80 although Plano residents reported large numbers of blackbirds and Starlings utilizing the roost during the autumn.

Another roost, in addition to that at Plano, developed behind the Bowling Green Center, just off U. S. Highway 31-W, in the southwestern part of Bowling Green in the winter of 1976-77. Although numbers were estimated at only "several thousand" this first winter, 2,000,000 birds have used the roost each winter since then, except during the 1978-79 winter

when 1,000,000 birds were present (Charles Hume, personal communication).

The first three-roost winter for Warren County was 1977-78, when an estimated 2,000,000 birds occupied a new roost site in the southeastern corner of the city near the Cumberland Trace Road (Dewey Dickerson, personal communication). Birds returned to this site the next two winters but were forced to relocate during the winter of 1979-80 when the habitat was destroyed.

The 1979-80 winter season proved to be a banner year for blackbird and Starling roosts with five different roosts being reported. In addition to the Bowling Green Center and Cumberland Trace Road roosts, I observed three new roosts: (1) the College View Park roost, located in the west central portion of Bowling Green and containing 400,000 birds at its peak; (2) the Springhill Subdivision roost on the western edge of town and totaling approximately 500,000 birds at one time (Charles Hume, personal communication); and (3) the Shawnee Subdivision roost in southern Bowling Green which contained slightly more than 1,000,000 birds at its peak.

The number of roosts reported in Warren County has been increasing steadily since 1975 (Table I). This might be attributed to two reasons: (1) blackbirds and Starlings have been roosting in Warren County with greater frequency the last five years; and (2) the roosts have been located in closer proximity to urban areas and thus are being reported more frequently. It appears the latter is more likely. It was not until roosts became located near housing developments within the city limits that discussions of problems associated with the birds became apparent. This led to extensive media coverage, which in turn resulted in more roosts being reported.

As the number of reported roosts increased, residents began stating numerous problems associated with the birds. Landowners blamed the buildup

of fecal matter on branches and limbs for the death of the trees, and some were worried that the heavy build-up of feces on the ground would lead to soil and water pollution problems. In addition, the roosting sites released a foul-smelling odor to which residents objected, and the birds were generally regarded as pests that competed with other, more "desirable" birds for food and cover (Shadowen, 1972).

Farmers also have problems with blackbirds and Starlings. Thousands of birds descend upon fields and feedlots each year feeding heavily on grain and livestock feed. The problem is compounded in feedlots because feed may become contaminated with bird feces and lead to unsanitary conditions. Starlings have been found to carry an intestinal virus in their feces that is responsible for transmissible gastroenteritis (TGE) in young pigs (Graham, 1976). One farmer lost over 60 pigs in the early 1970's, a loss many officials now attribute to TGE.

Local health officials became concerned with roosts during the mid-1970's. Authorities claimed that the location of bird roosts near residential areas posed a health hazard since the fecal matter served as an excellent growth medium for the soil-inhabiting fungus Histoplasma capsulatum. Histoplasmosis is a disease caused by inhaling the fungal spores (Graham, 1976). Although histoplasmosis has been the most publicized health problem associated with blackbird and Starling roosts, it is not the only one. Witty and Elliott (1971) isolated Staphylococcus aureus from the intestinal tract of Starlings that had been collected in Warren County. This is a bacterium which exists in nature associated with the skin, skin glands and mucous membranes of warm-blooded vertebrates; it may become established on the skin or in the nose of newborn humans within ten days of birth. When Staphylococcus aureus comes in contact with certain foodstuffs, notably

meat salads containing mayonnaise, a toxin is produced under certain conditions which causes severe cases of food poisoning (Poindexter, 1971).

Despite all the problems which have been linked to blackbird and Starling roosts, some biologists feel the majority of the fears are unfounded. A case in point is the controversy over possible environmental pollution from fecal matter. Boyken and Elliott (1972) investigated a roosting site near Bowling Green and found no proof that birds contributed significantly to environmental pollution. Although soil from nearby non-roost areas was significantly less contaminated than soil from within the roost area, there was no evidence that the high coliform count of a stream which ran through the roosting site was due to the fecal matter present. Although farmers complain about large economic losses of grain at feedlots and in fields, the U. S. Department of Agriculture and the Fish and Wildlife Service found that, while some farmers indeed suffer heavy losses, blackbirds account for the loss of less than 0.1-0.5 percent of the annual corn crop (Graham, 1976). Even the histoplasmosis problem has been overstated. Graham (1976) stated that the lung disease is endemic to the Kentucky-Tennessee region and much of the Mississippi River Valley with the fungus occurring almost everywhere in the soil. He further stated that tests made by local health officials revealed 70-90 percent of the human population in some areas already had a mild form of the disease. Former Warren County health administrator Charles Hume admitted that the number of cases of histoplasmosis had not increased significantly in the County but added that it is "a difficult disease to diagnose."

Warren County residents felt the birds presented so serious a hazard to health and economy that they began to request some form of effective control. Concerned landowners outfitted themselves with firearms and spent many hours shooting into the masses of birds returning to roost each evening.

This early form of retaliation proved to be futile and was soon abandoned.

Residents directed their efforts toward other channels. In 1971, a committee was formed for the specific purpose of combatting the local blackbird problem. Given the name Starling Control Action Time (SCAT), the committee began searching for ways to control the blackbird and Starling population. Numerous suggestions were offered, ranging in scope from the use of radiation and biological control to the use of surfactants and poisons. Most of these suggestions proved to be of little consequence and were not considered for use. Surfactants and poisons did offer some hope, and the committee contacted the U. S. Government for help.

The U. S. Fish and Wildlife Service had reported the success of a surfactant in trial runs on a roost in Ohio during the early to mid-1970's and expressed hope that the chemical would prove successful on a nationwide scale. The chemical was a detergent-based wetting agent called PA-14, usually referred to as Tergitol. It had to be applied to the birds while they were roosting. To be effective, the weather had to be favorable for its use, a requirement that later proved to be a problem for its users. For best results, Tergitol must be applied in temperature of 0-3 C and under a rainfall of one-half inch or more. Effectiveness was greatly reduced if it were applied when temperatures were above 3 C or if there was no precipitation. Local residents became interested in the product and made plans to obtain it.

The first attempt to use Tergitol in Warren County was in 1976 on the Shive Lane Trailer Park roost. After several delays due to poor weather conditions, an elaborate irrigation system was set up in the roost to provide water necessary for the detergent to take effect. With fire

trucks nearby to provide additional water, the attack began late on the night of February 22. The next day officials reported a disappointing 25.7 percent kill, and the operation was termed a failure. Authorities, blaming the poor results on inadequate water coverage by the irrigation system, prepared for another attack in March at a time when natural rain would provide the necessary water. The attack took place on the night of March 15, and by the next morning the results were obvious; the rainfall had not been adequate, and the kill was estimated at only 22.2 percent. There seemed to be little that Warren County residents could do to reduce the bird population. The cost of the Tergitol applications was almost $9,000 (Charles Hume, personal communication).

In June, 1977, the U. S. Fish and Wildlife Service established a Bird Damage Control Center in Bowling Green to identify the problems associated with roosts in this region and to develop safe and effective control measures. The Center is still conducting research but has not developed an effective control measure. In the meantime, local residents have tried other control measures with limited success. The Warren County Co-operative Extension Service distributed Starlicide to area farmers, but supplies were limited and the number of birds killed was negligible. Starlicide is a poison that is mixed with feed at feedlots and is specifically for Starlings.

Attempts to move the birds to an area outside the city have also been unsuccessful. During the mid to late 1970's, local health authorities obtained various noisemakers designed especially for bird dispersal. These were used for several evenings as birds returned to the roost. These "bird-bombs" were fired as groups of birds approached to land in the roost. When the "bombs" reached a certain height they exploded, causing the birds

to temporarily disperse. Health personnel were hopeful that the birds would move to other areas on the outskirts of town if the explosive devices were used at the first sign of roosting activity. Unfortunately, this did not occur. Birds scattered as they first returned to the roost, but as darkness fell they ignored the shots. The special pistols that were used cost approximately $18.00 each, and the "bombs" were $0.22 or $1.18 each, depending on the type used. It was an expensive practice to maintain, and the results did not merit its continued use.

The 1979-80 winter season saw the use of additional control tactics. In addition to an extensive use of "bird-bombs," there was an attempted Tergitol kill at the Bowling Green Center roost on the night of January 4. Fire trucks were used as a water source. The kill was estimated at only 20 percent. Soon after this, high frequency sound waves were used, first at the site of the Tergitol spraying and later at the College View Park roost. Although birds showed some unrest at the start of each operation, they quickly overcame this and settled back into the roost.

The only form of control that has worked satisfactorily has been the removal of trees from the roosting sites. Property owners bulldozed the trees at the Cumberland Trace Road roost during the last week of November and the Bowling Green Center roost from January 16-24. Bulldozing operations began at the Springhill Subdivision roost on December 26, but were halted after half of the trees had been destroyed; local health officials discovered the presence of Histoplasma capsulatum spores. At the College View Park roost, a program was initiated in which two of every three trees were to be cut down. This program was begun the weekend of January 12, but the conditions were not adhered to. By February 11 bulldozers were present, clearing out huge sections of the roost.

Although land-clearing proved to be an effective way of getting birds to leave one area, it sometimes caused problems in other areas. The Bowling Green Center roost was believed to have formed because of the bulldozing of the Cumberland Trace Road roost, and the Shawnee Subdivision roost formed as a result of the destruction of the Bowling Green Center roost. Only at the Springhill Subdivision roost did birds move to the surrounding countryside.

It should be stated that this historical survey is by no means complete. There are few exact records of roost occurrences available. Despite these handicaps, I have attempted to provide information concerning blackbird and Starling roosts in this area.

METHODS AND MATERIALS

Five major roosts developed in Warren County during the 1979-80 roosting season, but observations were restricted to four of these because one roost was destroyed before the studies began. Studies were carried out at each roost from the time of its discovery until its eventual destruction or break-up, whichever came first. It should be noted that observations did not begin at the same time at each roost due to the time lag involved in locating them. There was a total of 80 observations, of which 54 occurred in the morning and 26 in the evening. Numbers were estimated using a temporal census as described by Overton (1971), whereby the number of birds passing a fixed point were estimated per unit time and recorded. Species composition was estimated by standing under flight lines as birds left or returned to the roost. A bird was randomly chosen from the field of view, identified, and recorded. A total of 100 field identifications was made for each species composition determination. Other observations included roost departure and return times, flight line directions, related weather data, and various behavior pertaining to roosting and feeding habits. The observations relating to feeding activities were made in fields while birds were on their way to or from roosts.

Starlings were roosting in a cattle barn on the Western Kentucky University farm approximately five miles south of Bowling Green, Kentucky. The rectangular barn measured approximately 16 by 30 m; it was walled on three sides and open on the east side. A partition separated the open,

east side into two sections, both of which housed cattle. The walls and roof were made of corrugated metal built around 16 wooden poles (eight on each side) which supported the roof 7 m above ground at its highest point. There were six 200 watt light bulbs and eight floodlights located in each half of the barn approximately 5.5 m from the ground and 4.5 m apart. These were attached to the 13 wooden rafters located in each half of the barn. Starlings entered the barn from the open, east side and roosted on the rafters.

During the first trip to the barn, before the initiation of the study, the light bulbs on the north end of the barn were on; those on the south end of the barn were off. Of 21 Starlings roosting in the barn, 18 were roosting in the dark, south end of the barn. Studies to determine whether the light was a factor in the Starlings' utilization of the dark portion of the barn were conducted during a four week period beginning January 20 and continuing through February 17. The following sequence of light treatments was developed and applied: (1) south side dark, north side light from January 20-26; (2) south side light, north side dark from January 26-February 1 (lights switched the night of the 26th); (3) south side dark, north side dark from February 3-9 (lights originally switched the night of February 1, but outside interference required the lights to be reset the night of the 3rd); and (4) south side light, north side light from February 11-17 (lights originally switched the night of February 9, but outside interference required a reset the night of the 11th). The barn was visited on five separate nights during each treatment; at each visit, the number of birds on each side of the barn was counted (with the aid of a handheld flashlight) and recorded. The temperature outside the barn was also recorded with each reading taken at the same time of night. Temperatures within each side of the barn were monitored to determine if any differences were evident.

RESULTS AND DISCUSSION

As stated in the Historical Account, five separate blackbird roosts were reported in Warren County during the winter of 1979-80 (Table I). The Cumberland Trace Road, College View Park, and Springhill Subdivision roosts formed in early to mid-November. The Bowling Green Center roost formed in late November to early December as a result of the destruction of the Cumberland Trace Road roost and the extensive use of "bird-bombs" at College View Park and Springhill Subdivision. The Shawnee Subdivision roost did not form until mid-January, following the destruction of the Bowling Green Center roost. Only the Shawnee Subdivision roost suffered no habitat damage, and it disbanded in late March. All other roosts disbanded at the time of their destruction.

The results of the species composition determinations are summarized in Table II. Four species were found to comprise the roosting populations, with Common Grackles (Quiscalus quiscula) being the most abundant and having an overall mean of 59% at College View Park, 56% at Bowling Green Center, 50% at Springhill Subdivision, and 62% at Shawnee Subdivision. Starlings were the second most abundant species, with means of 24% at College View Park, 21% at Bowling Green Center, 22% at Springhill Subdivision, and 17% at Shawnee Subdivision. Red-winged Blackbirds (Agelaius phoeniceus) and Brown-headed Cowbirds (Molothrus ater) comprised the remainder of the roosting populations; the percentages of Red-winged Blackbirds were 8% at College View Park, 11% at Bowling Green Center, 25% at Springhill Subdivision, and 14% at Shawnee Subdivision, while the percentages of Cowbirds were 9% at

TABLE II. Average monthly species composition (%) of birds at each roost.

Roost Name	Month	Species				
		Common Grackle	Star-ling	Br.-hd. Cowbird	R-Wing Blkbd.	Rusty Blkbd.
COLLEGE VIEW PARK	Nov.	63.0	25.0	9.0	3.0	-
	Dec.	53.0	22.0	17.0	8.0	-
	Jan.	59.0	29.0	6.0	6.0	-
	Feb.	62.0	19.0	3.0	16.0	-
	Mar.	-	-	-	-	-
B-G CENTER	Jan.	57.0	16.0	10.0	17.0	-
		55.5	26.8	14.0	3.6	0.1[1]
SPRING-HILL SUB.	Jan.	54.0	18.0	4.0	24.0	-
	Feb.	45.0	25.0	4.0	26.0	-
SHAWNEE SUB.	Feb.	62.0	11.0	5.0	22.0	-
	Mar.	61.0	23.0	11.0	5.0	-

[1]The percentages in this row represent the results of the sampling of birds killed during the PA-14 application, January 4, 1980.

College View Park, 12% at Bowling Green Center, 4% at Springhill Subdivision, and 8% at Shawnee Subdivision.

In January 1980, a sampling of the Tergitol kill at the Bowling Green Center roost revealed the presence of Rusty Blackbirds (Euphagus carolinus). Although this species was not identified at any of the other roosts, it is conceivable that it was present. Rusty Blackbirds are similar in size and shape to Red-winged Blackbirds and could possibly have been misidentified during the species composition determinations since many of the estimations were done under poor light conditions. Furthermore, Shadowen (1972) collected 14 specimens from the Bryant Farm roost while conducting studies on the feeding habits of blackbirds and Starlings in Warren County. It is therefore logical to assume that Rusty Blackbirds comprised some percentage, though small, of the other roosting populations in the County.

The predominately Grackle and Starling roosts in Warren County are similar to other roosts in this section of the United States. Francis (1976) studied a roost of similar species composition at Fort Campbell, Kentucky, as did Dolbeer and his associates (1978) at nearby Milan, Tennessee. Meanley and Dolbeer (1978) stated that the wintering populations of blackbirds and Starlings in Tennessee were predominately Grackles and Starlings.

This is not the case as one moves further south of Kentucky and Tennessee. Although roosts within the same county may vary in their species composition, Red-winged Blackbirds are far more numerous in the southern United States, particularly in the rice belt and along the coast where rice fields are prevalent (Meanley, 1965). Good (1979) studied a roost in Houston, Texas, which was composed primarily of male Brown-headed Cowbirds. She states that although Cowbird roosts are uncommon, the majority of male Cowbird roosts are located in the south while females tend to roost in the

more northern reaches of the species' range. This apparent segregation and distribution of species could explain the low percentages of Red-winged Blackbirds and Cowbirds in Warren County roosts.

The species composition estimates at the Bowling Green Center roost are especially interesting. A comparison of the estimates made by the technique described in this paper with estimates made as a result of the Tergitol kill show similar percentages for Grackles and Cowbirds but obvious differences in the estimates for Starlings and Red-winged Blackbirds. According to the sampling of the Tergitol spraying, Starlings made up nearly 27% of the roost, and Red-winged Blackbirds accounted for only 4%. The average monthly species composition, however, shows Starlings and Red-winged Blackbirds comprising 16% and 17% of the roost, respectively.

Part of this discrepancy might be explained by the fact that during the week of the Tergitol application, Starlings and Red-winged Blackbirds comprised 20% and 10%, respectively, of the population--figures which compare a bit more favorably to the results obtained by sampling the Tergitol kill. Soon after the sampling, however, Starling numbers decreased as Red-winged Blackbird numbers increased. When these estimates were averaged along with the previous ones, it decreased the average monthly percentages for Starlings and increased the percentages for Red-winged Blackbirds.

Reasons for the changes in Starling and Red-winged Blackbird numbers are unclear. The changes were first noticeable after the destruction of a large section of the roost, soon after the sampling of the Tergitol application. If birds in a communal roost segregate by species, as Francis (1976) and Meanley (1965) suggest, it is possible that Starlings had been utilizing that portion of the roost that had been destroyed.

As Starling numbers decreased, Red-winged Blackbirds were identified more often during the determinations. Although birds did appear to segregate as they settled into the roost, it was difficult to ascertain and never proven. Therefore, this theory should only be regarded as a possible explanation for the changes in Starling and Red-winged Blackbird numbers.

The total numbers at each roost was subject to much variation, even within the same month (Figures 1-4). College View Park reached its peak of 400,000 birds in late November then abruptly declined to approximately 27,000 by December 1 (Figure 1). Numbers gradually increased to 70,000 by mid-December when the population stabilized somewhat until mid-January. The selective cutting of cedar trees began at this time, and bird numbers decreased as the cutting progressed.

Although the three remaining roosts were not observed as long as the College View Park roost, their numbers were even more unstable (Figures 2-4). The Shawnee Subdivision roost was the most erratic with two major peaks occurring in less than one month (Figure 4). On February 18, an estimated 8,000 birds were utilizing the roost but four days later, numbers had increased to slightly more than 1,100,000. The population decreased to 5,000 birds on February 25, then rose to 11,000 birds by March 10. By March 23, numbers had decreased to less than 3,000 birds; by the end of the month only a few scattered flocks remained. Similar patterns were noted at the Springhill Subdivision and Bowling Green Center roosts.

This variation in numbers differs markedly from the results published by Dolbeer and his associates (1978). They reported a gradual increase in numbers to a peak population of 11,000,000 in January and early February then a sudden drop in late February. One possible explanation for the

Figure 1. Estimated number of blackbirds and Starlings using the College View Park roost, November 1979 - mid-February 1980.

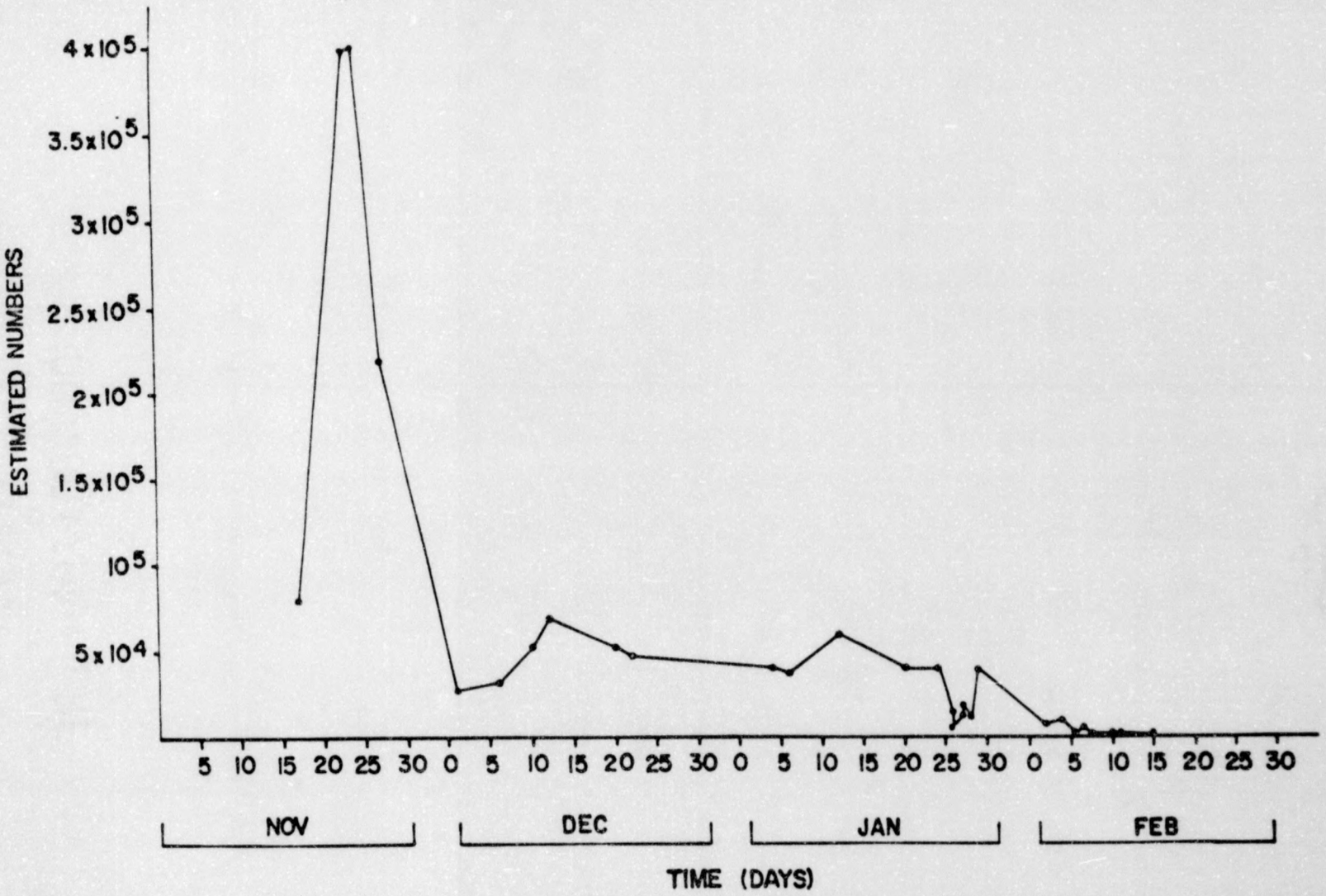

ESTIMATED NUMBERS
4x10^5
3.5x10^5
3x10^5
2.5x10^5
2x10^5
1.5x10^5
10^5
5x10^4
5 10 15 20 25 30 0 5 10 15 20 25 30 0 5 10 15 20 25 30 0 5 10 15 20 25 30
NOV
DEC
JAN
FEB
TIME (DAYS)

Figure 2. Estimated number of blackbirds and Starlings using the Bowling Green Center roost, late December 1979 - late January 1980.

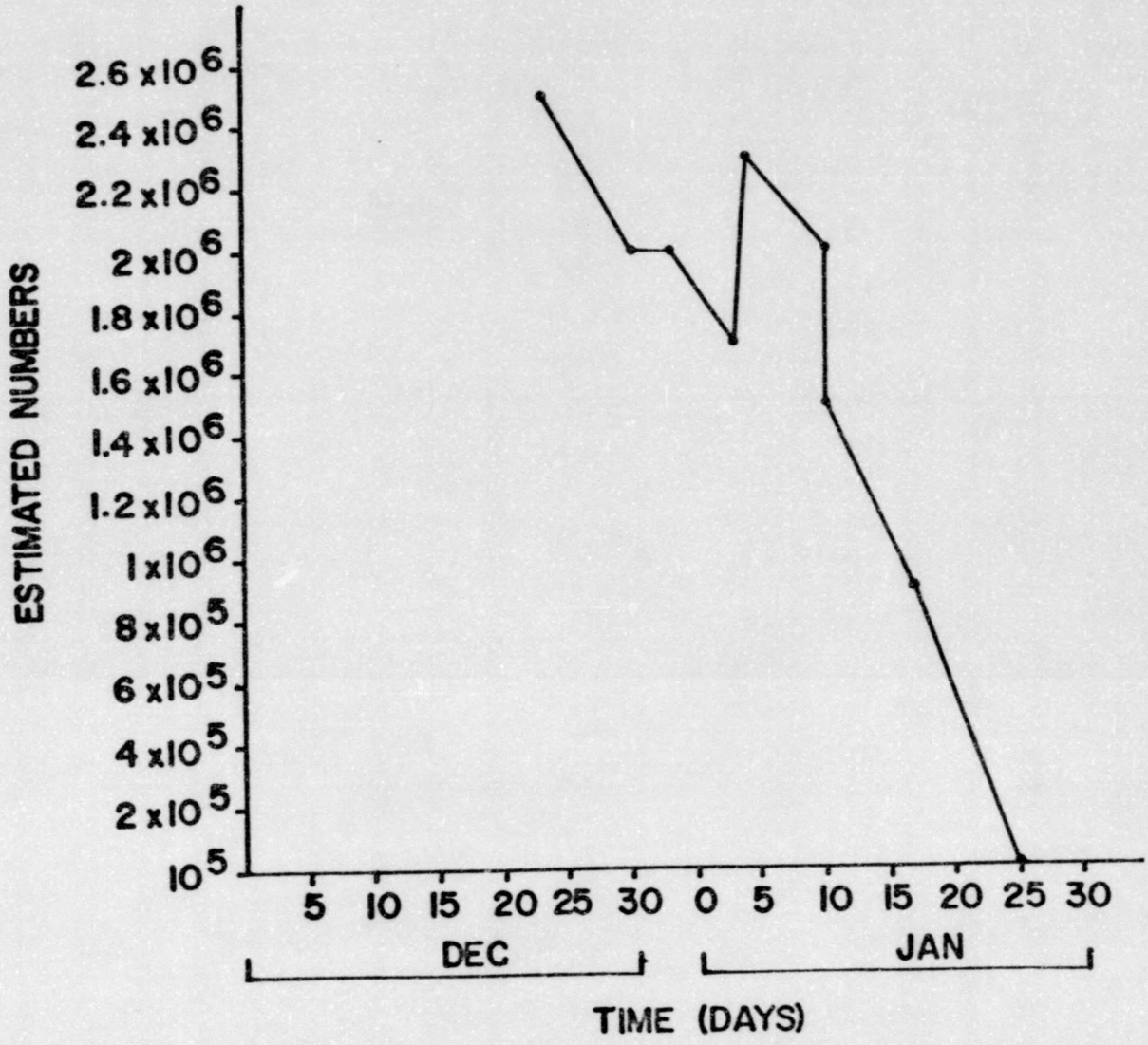

ESTIMATED NUMBERS
2.6 x 10^6
2.4 x 10^6
2.2 x 10^6
2 x 10^6
1.8 x 10^6
1.6 x 10^6
1.4 x 10^6
1.2 x 10^6
1 x 10^6
8 x 10^5
6 x 10^5
4 x 10^5
2 x 10^5
10^5
5 10 15 20 25 30 0 5 10 15 20 25 30
DEC
JAN
TIME (DAYS)

Figure 3. Estimated number of blackbirds and Starlings using the Springhill Subdivision roost, mid-January 1980 - mid-February 1980.

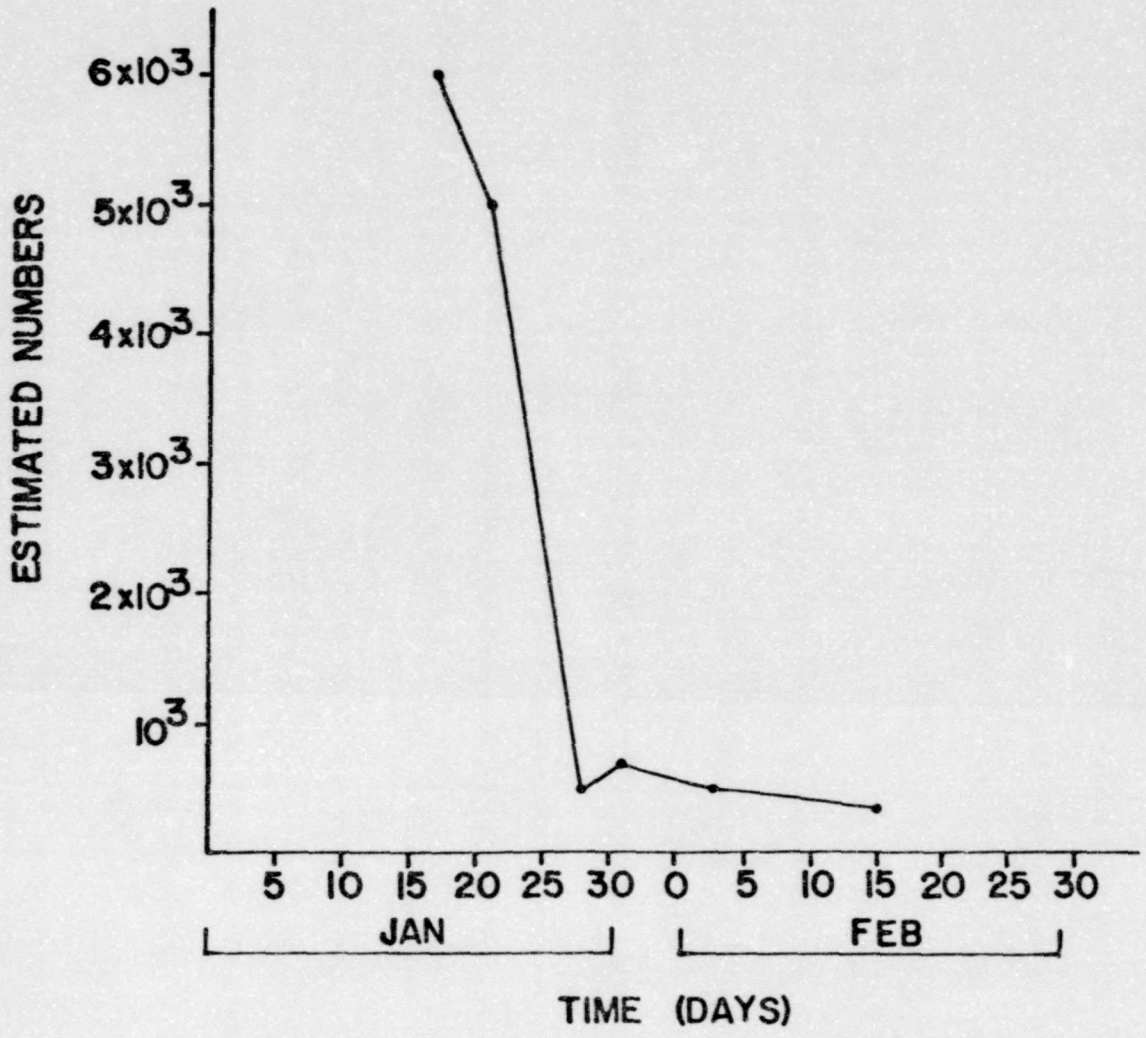
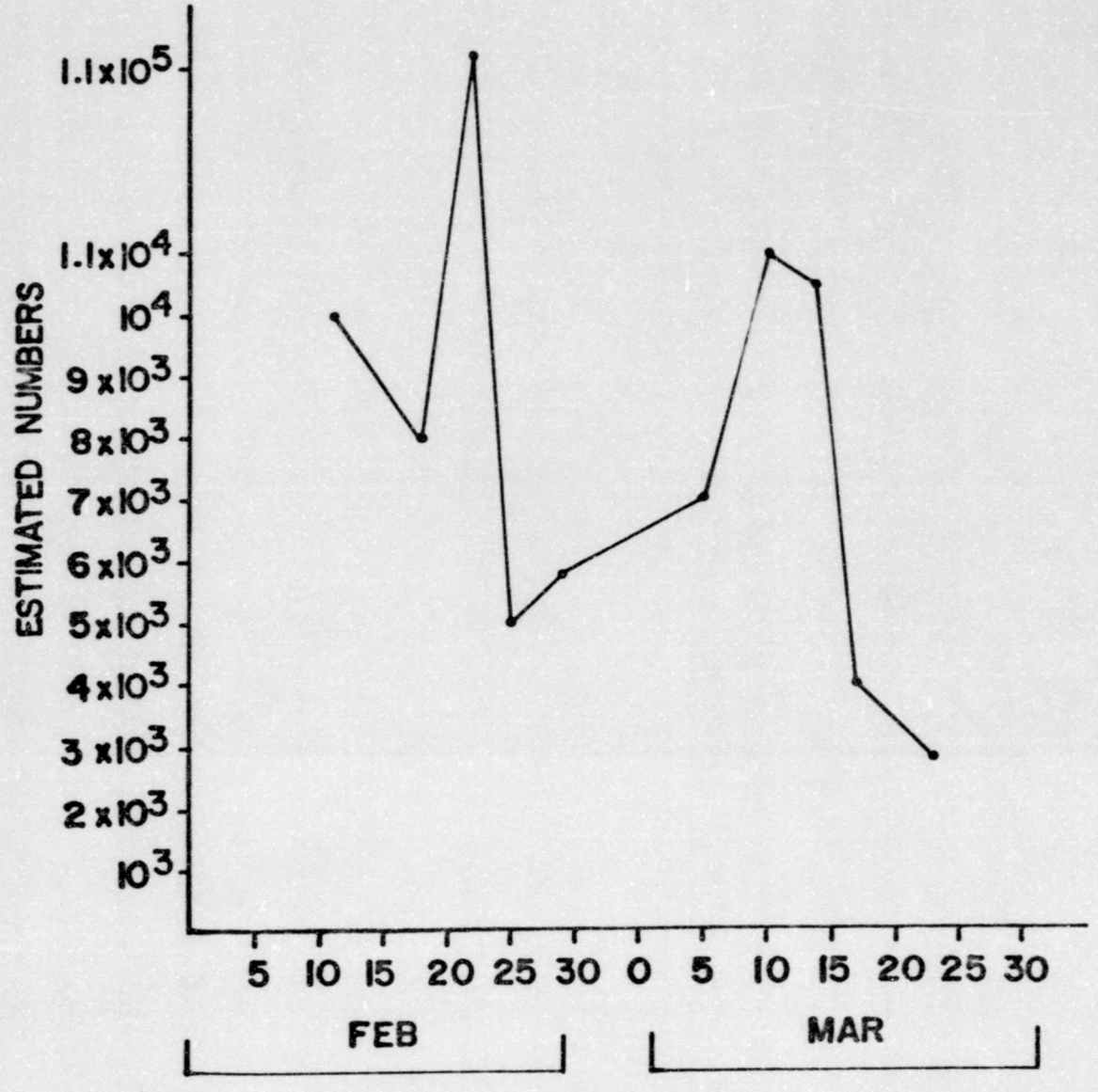

ESTIMATED NUMBERS
6x10^3
5x10^3
4x10^3
3x10^3
2x10^3
10^3
5 10 15 20 25 30 0 5 10 15 20 25 30
JAN
FEB
TIME (DAYS)

Figure 4. Estimated number of blackbirds and Starlings using the Shawnee Subdivision roost, mid-February - late March 1980.


ESTIMATED NUMBERS
1.1x10^5
1.1x10^4
10^4
9x10^3
8x10^3
7x10^3
6x10^3
5x10^3
4x10^3
3x10^3
2x10^3
10^3
5 10 15 20 25 30 0 5 10 15 20 25 30
FEB
MAR

variation observed at the Warren County roosts might be related to human activities. The extensive use of various noisemakers apparently had an unexpected and previously unnoticed effect on numbers. It is doubtful that these practices alone accounted for the variations, but in conjunction with other factors, they may have resulted in reduced numbers. For example, many ornithologists feel that if bird-bombs and other noisemakers are applied early in the roosting season before the roost has become established, it is much easier to force birds away from the site. This appears to have been the case at the College View Park roost. Local authorities began an intensive control program at the time the roost was becoming established, using noisemakers as the nucleus of their attack. Coupling this with the assumption that the maximum population may have contained some late migrants, it is possible that these factors were responsible for the sharp reduction in numbers.

Weather factors appeared to be responsible for the first peak in numbers at the Shawnee Subdivision roost. Bowling Green experienced a week of unusually warm weather from February 17-23 with daytime temperatures averaging 10.8 C during this period (Kentucky Climatological Data, February 1980). During this period, numbers increased followed by a reduction suggestive of a mass movement away from the roost. A similar peak occurred in early to mid-March, just before the birds began their migration northward. The correlation between peak numbers and weather conditions seems to indicate that periods of warm weather, late in the roosting season, may initiate some type of migratory response.

In order to support a large population of blackbirds and Starlings throughout the course of a bitter winter season, the roosting site must provide adequate protection from the elements. In more southerly states,

where winters are mild, birds may select any of a number of habitat types. Tidal marshes, bottomland forests, flooded rice fields, deciduous thickets and coniferous forests are all listed as favored roosting sites in the southern states (Meanley, 1965). Good (1979) reported on a roost of blackbirds and Starlings in Texas that was located in a stand of live oak trees, and Orians (1961) studied blackbirds which roosted in cattail marshes in California.

This variety of roosting sites is not found in south-central Kentucky. All roosts reported in Warren County with one exception have been located in extensive stands of Eastern Red Cedar (Juniperus virginiana), a species characteristic of old-field habitats. The only exception was the Cumberland Trace Road roost located in a stunted white pine (Pinus strobus) plantation. Other plants found in association with the Red Cedar were those typical of old-field habitats: Broomsedge (Andropogon sp.), Honeysuckle (Lonicera spp.), Blackberry (Rubus spp.), sumac (Rhus spp.), Sassafras (Sassafras albidum), and an occasional oak (Quercus spp.), Tulip Poplar (Liriodendron tulipifera), maple (Acer spp.), Elm (Ulmus spp.), and Black Locust (Robinia pseudo-acacia). The ages of the roost sites were not determined; most of the cedars at all roosts were 3-6 m tall.

It is not surprising that birds would select cedars as their roosting trees; Kentucky winters are harsher than those in the south, and habitats of this type offer the greatest protection against the elements. Francis (1976), revealed that wind speed within a pine plantation was reduced to practically zero; the reduction of the wind by the trees slowed down the rate of temperature decrease so that the roost area was as much as 2 C warmer than the surrounding area. Although no attempt was made locally to measure the micro-meteorology in any of the roosts studied, the reduced wind speed was evident by merely walking through the roost area.

Roost sites during the 1979-80 winter season ranged in size from 5 acres at the Cumberland Trace Road roost to 20 acres at the Shawnee Subdivision roost; average roost size was 11 acres (Table I). This compares favorably to the average size (approximately 10 acres) of all other reported roosts prior to the 1979-80 winter season. Although the Shawnee Subdivision roost site extended over 20 acres, it should be noted that much of this acreage was in open grassland, and the majority of birds roosted in an 8-10 acre section of the area where the cedars were concentrated.

The accumulated roost data in Table I suggests abandonment of a roost site after it has been used for two-five years. The Barren River, Scottsville Road, Bryant Farm, and Plano roosts were all utilized for two-five consecutive winters before birds moved to another site. This raises an obvious question. Why would birds abandon a site which has served the population adequately after only a few winters of use?

The answer may lie within the habitat itself. A primary complaint of landowners against blackbird and Starling roosts is the destruction of trees by the fecal matter build-up on the branches. After four months of heavy use by several thousand blackbirds, the accumulated fecal material is sufficient enough to "burn" the foliage, particularly near the base of the trees. As this site is utilized year after year, it is possible that the damage may be severe enough to decrease the density of the foliage so that the trees no longer provide adequate protection from harsh weather. As a result, birds may be forced to locate another site.

The impact that a large concentration of roosting birds can have on a habitat is poorly understood. Short-term effects such as defoliation of roost trees are more readily observed and more often reported. On the other hand, long-term effects are less obvious and rarely mentioned. Due to the nature of the habitat chosen by blackbirds in this area, the long-term

impact may lead to some dramatic changes. Keever (1950) found that old-field habitats in the eastern United States develop on the nitrogen-depleted soils of abandoned farmlands. The Red Cedar, a species characteristic of old-field habitats in this area, cannot tolerate high levels of nitrogen in the soil. One gram of bird droppings, however, contains approximately one percent nitrogen and five percent phosphorus (Good, 1979). Given a roost of 1,000,000 birds and assuming that an individual bird deposits at least one gram of fecal material per night, (as Good reports for male Cowbirds), this would amount to 2,640 pounds of nitrogen and 13,200 pounds of phosphorus per winter season. This heavy degree of fertilization may be sufficient to lead to a rapid disappearance of cedars and the establishment of a totally different type of habitat in heavily used sections of the roost. Evidence of the heavy degree of fertilization can already be seen at the sites of bulldozed roosts; walks through the roosts during the summer of 1980 revealed a lush growth of a variety of herbaceous plants, some of which have attained considerable height. After four successive winters of heavy "natural fertilization," the impact on the environment may be even more pronounced.

The most fascinating aspect of this study had to do with the behavior exhibited by blackbirds and Starlings in the vicinity of the roosts. Observations revealed that daily activities were well-defined and orderly and varied little from one roost to the next. Seven categories of activities were recognized, each of which will be described in their proper sequence below.

Predeparture vocalizations. Thirty to forty-five minutes before each morning departure, a series of whistles, cackles, clucks, and squawks could be heard emanating from various sections of the roost. The vocalizations

would gradually increase in audibility and intensity as the departure time approached and as more birds participated in the activity. Twenty to thirty minutes before departure, the chattering would reach its peak audibility and remain at that level until the departure began.

Predeparture staging. During the period of vocalizations, fifteen to twenty minutes before departure, birds began to move from their roosting places within the cedars to the outer edges of the cedars, especially into the taller hardwoods scattered within the roost site. Common Grackles always initiated the movements. Vocalizations continued throughout this activity.

Roost departure. After predeparture staging, birds would begin their morning exodus. At all roosts, this was characterized by the formation of one major flightline. Before the formation of this flightline, however, there were always a few birds that left the roost in scattered flocks. These flocks were loose and varied considerably in size, ranging from as few as 10 to as many as 200 birds per flock, usually only 20 to 30 birds. Starlings and Cowbirds were the principal species involved; Grackles were rarely a part of these early flocks. These flocks appeared to be unsure of their destination, very often starting out in one direction, circling overhead several times and then finally veering off in another--a pattern also recognized by Good (1979).

The majority of birds left in one major flightline. Unlike the earlier, less organized flocks, the major flightline was very compact and functioned as a unit. The departure was restricted to only one direction with any course alterations occurring smoothly and with little confusion. The rate with which birds left the roost varied considerably and, as a result, the flightlines displayed a wave effect. Grackles appeared to initiate

the departure, but this was often hard to confirm. There did not appear to be any vertical segregation of species as described by Meanley (1965).

Data pertaining to the correlation between departure time and sunrise for birds at the College View Park roost are presented in Table III. As can be seen, the time of morning departure was not directly related to sunrise. Birds departed earlier on clear days as opposed to cloudy days, thereby suggesting a relationship between roost departure and light intensity. On clear mornings, departure time ranged from 14 to 22 minutes before sunrise (average time = 17 minutes before sunrise); on partly cloudy mornings, departure occurred from 11 to 16 minutes prior to sunrise (average time = approximately 13 minutes prior to sunrise); and on overcast mornings, departure time was 5 to 9 minutes before sunrise (average time = 7 minutes before sunrise). These data tend to lend support to the findings of other researchers who worked with the timing of roost return in blackbirds and Starlings (Bliese 1955, Jumber 1956, Davis and Lussenhop, 1970).

The direction of flightlines during morning exodus is also indicated in Table III. The vast majority of departures at the College View Park roost were to the southeast; on a few occasions, flightlines were to the northeast. At the Shawnee Subdivision, Bowling Green Center and Springhill Subdivision roosts, all morning departures were to the southeast. It is not known whether flightlines followed watercourses as reported by Jumber (1956) and Bray et al. (1975).

Daily Activities. It is believed that most of the time away from the roost was spent in searching for feeding sites and feeding. Bray and his co-workers (1975) found that Starlings also spent time "loafing" during the day. The areas where most of the birds foraged is unknown, but farmland in southeast Warren County and in Barren and Allen Counties may have been favored,

TABLE III. Roost departure times and directions as correlated with sunrise and sky conditions at the College View Park roost.

Date	Sky Code[1]	Dt[2]	Sr[3]	Sr-Dt[4]	Direction
11-17-79	Cl	6:02	6:24	22 min.	S,SE
11-23-79	Oc&r	6:24	6:30	6 min.	SE
11-24-79	Oc	6:23	6:31	8 min.	SE
11-27-79	Cl	6:18	6:34	16 min.	E,SE
12-1-79	Cl	6:24	6:38	14 min.	SE
12-6-79	Cl	6:28	6:42	14 min.	SE
12-10-79	Oc	6:37	6:46	9 min.	NE
12-12-79	Oc&r	6:40	6:47	7 min.	NE
12-20-79	Cl-Pc	6:40	6:52	12 min.	SE
12-22-79	Pc	6:37	6:53	16 min.	SE
1-4-80	Oc	6:51	6:57	6 min.	SE
1-6-80	Cl-Pc	6:46	6:57	11 min.	S
1-25-80	Pc	6:41	6:52	11 min.	SE
1-26-80	Oc	6:42	6:51	9 min.	NE
2-2-80	Cl	6:27	6:46	19 min.	NE
2-6-80	Oc	6:37	6:43	6 min.	SE
2-15-80	Oc	6:29	6:34	5 min.	E,SE

[1]Cl = Clear; Oc = Overcast; r = rain; Pc = Partly cloudy

[2]Dt = Departure time from roost (CST)

[3]Sr = Time of Sunrise (CST)

[4]Sr-Dt = Time of Sunrise minus Departure time

judging by the direction of the major flightlines. Some birds, most notably Starlings and Cowbirds, elected to feed in residential areas in Bowling Green and would leave for these areas as the major flightline departed. This was especially true during periods of snowfall; Cowbirds and Starlings fed heavily at local residents' bird feeders when enough snow fell to cover the ground. Plowed and grassy fields located near the roosts were not utilized to any great extent during or soon after roost departure; these were heavily foraged during the evening when birds returned.

Roost return. It is not known at what time blackbirds first began their movements back toward the roosts, but Bray et al. (1975) reported that the return trip for Starlings occurred 23 to 104 minutes before sunset, depending on the cloud cover. The return trips differed markedly from the morning departures in that birds returned in more than one flightline. These flightlines were much smaller than the major flightline of roost departure. The birds returned from several directions indicating that a divergence away from the major flightline occurred at some point during the morning exodus. There appeared to be some segregation of species with predominately Grackles and/or Red-winged Blackbirds returning in one flightline and Starlings and Cowbirds returning in segregated or mixed flocks. Starlings and Cowbirds did not form flightlines when returning in segregated flocks. They did participate in flightlines when associated with Grackles or Red-winged Blackbirds. Separate flightlines and flocks also arrived at roosting areas at different times, making it difficult to measure the time of arrival of different flocks at each roost site. To further complicate matters, the close proximity of the different roosting sites to one another produced very confusing observations with flightlines from each site flying back and forth during the period of roost return.

There was also a great deal of foraging as birds returned to their roosts; fields passed over as birds departed each morning were used heavily as birds returned in the evening. There appeared to be some segregation as birds fed; large flocks of Grackles and Red-winged Blackbirds (few Starlings) were always noticed feeding together in large, plowed corn fields. Small, scattered flocks of Starlings preferred to feed in grass pastures, but a large plowed field located near the Shawnee Subdivision roost was used extensively by returning Starlings and Cowbirds.

Preroost staging. Before the returning birds reached the roosting area, large flocks would land in the groves of tall deciduous trees located near the roost. Birds were extremely vocal when undertaking this activity and the intensity of the vocalizations rivaled that of the predeparture vocalizations. As birds from incoming flightlines landed in the staging trees, others would leave so that there was always a considerable amount of shifting during this activity. Segregation was not evident during these series of events.

Settlement into the roost. As flocks left the staging areas, they approached the roosting site rather cautiously at first, choosing to fly over it to other staging areas several times before committing themselves to settling into the roost trees. As darkness approached, more and more birds would circle closer and closer to the roost, until the sky above the site was a swirling mass of hundreds of birds. During this time, an occasional flock of American Robins (Turdus migratorius) would become associated with them and participate in the aerial displays to an extent but would usually separate from the others after a short period. As the mass of birds circled closer to the trees, Grackles would begin dropping from the flock into the tops of the cedars in selected sections of the roosting site. These selected sections were always in areas where cedars were densely clumped. Grackles

moved into the center of these areas singly at first but soon began to drop in with greater frequency. The other roost species followed the pattern established by the Grackles and mixed flocks began settling into the selected areas. As the preferred areas filled, birds began filtering into the other cedars situated about the site. Brown-headed Cowbirds appeared to settle in those cedars bordering open areas in the roost and around the roost periphery. Settlement into the roost continued for some time after sunset; birds frequently moved about within the roost before settling onto their perches for the night, soon after dark.

Throughout the sequence of events, from morning exodus until roost settlement, Common Grackles appeared to be the species around which the others patterned. Stewart (1973, 1975) reported similar observations, referring to Grackles as the "nucleus" or "leaders" while the others were described as "followers." The results presented here tend to support his findings.

Some of the more conspicuous behaviors associated with blackbird and Starling roosts deal with the intense vocalizations and aerial displays that are evident in the vicinity of the roosts. Ward and Zahavi (1973) suggested that the primary function of communal roosts is as information centers where locations of adequate food supplies can be passed on to other members of the roosting congregation. Should this be the case, intense vocalizations prior to roost departure might be one way of communicating to others the location of prime feeding areas. Despite the fact that data to substantiate this possible explanation are lacking, it is obvious that these behaviors are of some vital significance to the roosting population.

The relationships that existed between roost species and non-roost species provided interesting observations. As previously stated, large flocks of Robins would become associated with returning blackbirds and Starlings but

did not roost with them. There did not appear to be any non-roost species utilizing the areas studied as a roosting site. The sampling of the Tergitol kill tends to support this; only one non-roost species, a male Cardinal (Cardinalis cardinalis) was found during sampling procedures. The large number of seeds in the fecal matter deposited on the ground provided an ample source of nutrition for many birds, and when blackbirds and Starlings were away from the area, several non-roost species foraged in the roosting sites. Fringillids made up the bulk of these: Cardinals, White-throated Sparrows (Zonotrichia albicollis), and Dark-eyed Juncos (Junco hyemalis) were at all sites. Rufous-sided Towhees (Pipilo erythophthalmus) and Field Sparrows (Spizella pusilla) were also seen at one time or another at all sites, and Mockingbirds (Mimus polyglottos) were occasionally observed, especially at the Shawnee Subdivision roost. At the College View Park roost, a small covey of Bobwhite Quail (Colinus virginianus) fed regularly in the area during the day. It is not known where these species roosted in the evening, but it is doubtful that they spent the night within the roost.

Diurnal and nocturnal birds of prey were regularly observed in the vicinity of some of the roosts. American Kestrels (Falco sparverius) were seen perched in the tops of trees at the Shawnee Subdivision and Springhill Subdivision roosts on several occasions. A Red-tailed Hawk (Buteo jamaicensis) was often seen at the Bowling Green Center roost and on several occasions was observed attempting to take prey from returning flightlines. A Cooper's Hawk (Accipiter cooperii) visited a favorite staging area near the Shawnee Subdivision roost several times and caught birds on each visit. The hawk would perch in the center of a frequently used tree and await the arrival of returning blackbirds. Despite the hawk's presence, birds continued to stage in the tree

in which the hawk was perched, and the predator would merely pick its prey right off the branches. Also, a Great Horned Owl (Bubo virginianus) and a Screech Owl (Otus asio) were occasionally heard and/or seen near the Bowling Green Center roost, but only the Great Horned Owl was observed taking prey.

The presence of these birds of prey in residential areas suggests they were drawn to the sites by the large concentration of possible prey organisms (blackbirds and Starlings). Despite this apparent increase in predator pressure, Zahavi (1971) feels that the aggregation of individuals into large assemblages is actually advantageous. He suggested that it would be much easier for a predator to launch an attack upon a single individual than it would be for a predator to attempt to single out an individual from a large flock. Coupling this with the various gyrations and aerial maneuvers that flocks undergo in the immediate vicinity of the roosts, the task of obtaining a meal becomes even more difficult for potential predators. Stewart (1973), however, feels that predator aversion is not a primary function of communal roosts and believes that Zahavi's interpretation is inaccurate. He claims that the conspicuous nature of pre-roost gatherings (staging) actually directs attention toward the roosting congregation and results in greater predator pressure. Although the aforementioned observations of the Red-tailed Hawk's futile attempt at predation on returning flightlines might offer support to Zahavi's proposal, the feeding behavior exhibited by the Cooper's Hawk obviously supports Stewart's interpretation. Furthermore, owls first become active near dusk, a time in which blackbirds and Starlings are still in the process of settling into their roosts, and thus are still conspicuous due to the aerial displays that they undergo prior to settling down for the night. With the exact location of a roost having been disclosed, it would be a simple task for an owl to wait until after birds had settled onto their perches and

gone to sleep before flying into the area and taking prey off the branches. The interrelationships that exist between roost and non-roost species, particularly as it applies to predator-prey relationships, is one area of roost biology that has been overlooked by researchers. In order to fully understand the behaviors associated with communal roosts, more attention will have to be directed toward this topic.

The final concern of this project deals with the studies conducted on Starlings that were roosting in a cattle barn on the Western Kentucky University farm. As previously stated, Starlings had been utilizing the barn as a roosting site for several winters and questions were raised as to whether the number of birds in the barn could be correlated to various weather factors, most notably to temperature and ground cover (snow and ice). At the time of the initial inspection, it was noted that a series of lights were on in the north-facing side of the barn and that lights in the south-facing side were off. The majority of birds were roosting in the dark, south-facing side of the barn. This arrangement prompted the following questions: "Are birds roosting in the dark side to avoid the lighted north-facing side? If so, could these birds be induced to move from one side of the barn to the other by alternating the lighting sequence"?

Light apparently was not a factor in the selection of roost sites within the barn; there were always more birds in the south-facing side of the barn, regardless of the lighting arrangement employed. This was evident mid-way through the study, and it was at this time that temperatures were taken from within both sides of the barn to determine if the south-facing side was warmer than the north-facing side.

Temperatures on the south-facing side of the barn were the same as temperatures on the north-facing side of the barn; thus, temperature had little to do with the unequal distribution of birds within the barn (Table IV).

TABLE IV. A comparison of temperatures (°C) outside the barn to temperatures inside the barn.

	Inside Barn	
Outside Barn	South Side	North Side
-4.4	17.0	17.0
-5.0	-3.0	-3.0
0.0	1.5	1.5
-6.1	-5.0	-5.0
5.0	8.0	8.0
7.8	9.5	9.5
-2.2	-5.0	-5.0
-6.1	-3.0	-3.0

Barn temperatures averaged 16.3 C higher than outside temperatures with barn temperatures ranging from 16.7 to 14.4 C higher than the outside temperatures. (The first temperature readings in Table IV are obviously in error; the readings were apparently taken before the thermometers had an opportunity to register the barn temperature. As a result, these temperatures were not included in the averages.) Only on one occasion was the outside temperature warmer than the barn temperature.

The inability to force Starlings from one side of the barn to the other by alternating the lighting sequence indicates that light may not be an effective means of roost dispersal. However, light should not be abandoned as a possible dispersal tool. Continuous exposure to the various light treatments may have produced different results. Also, experimentation involving greater light intensities may produce favorable results. Light should be thoroughly explored and its potential fully realized before it is abandoned as a possible dispersal tool.

One can only speculate as to the reason for the Starling's preference for the south-facing side of the barn. The fact that light and temperature appear to have no bearing on their arrangement suggests that other factors may be involved. One possibility may be related to nearby food supplies. A large feeding trough, approximately 16.0 by 1.5 m was located near the south-facing side of the barn. The trough was situated perpendicular to the open side of the south-facing side of the barn and offered a readily accessible food supply to any Starlings roosting in that half of the barn. Starlings may have been roosting in that half of the barn simply because a steady food supply was located near that side of the barn.

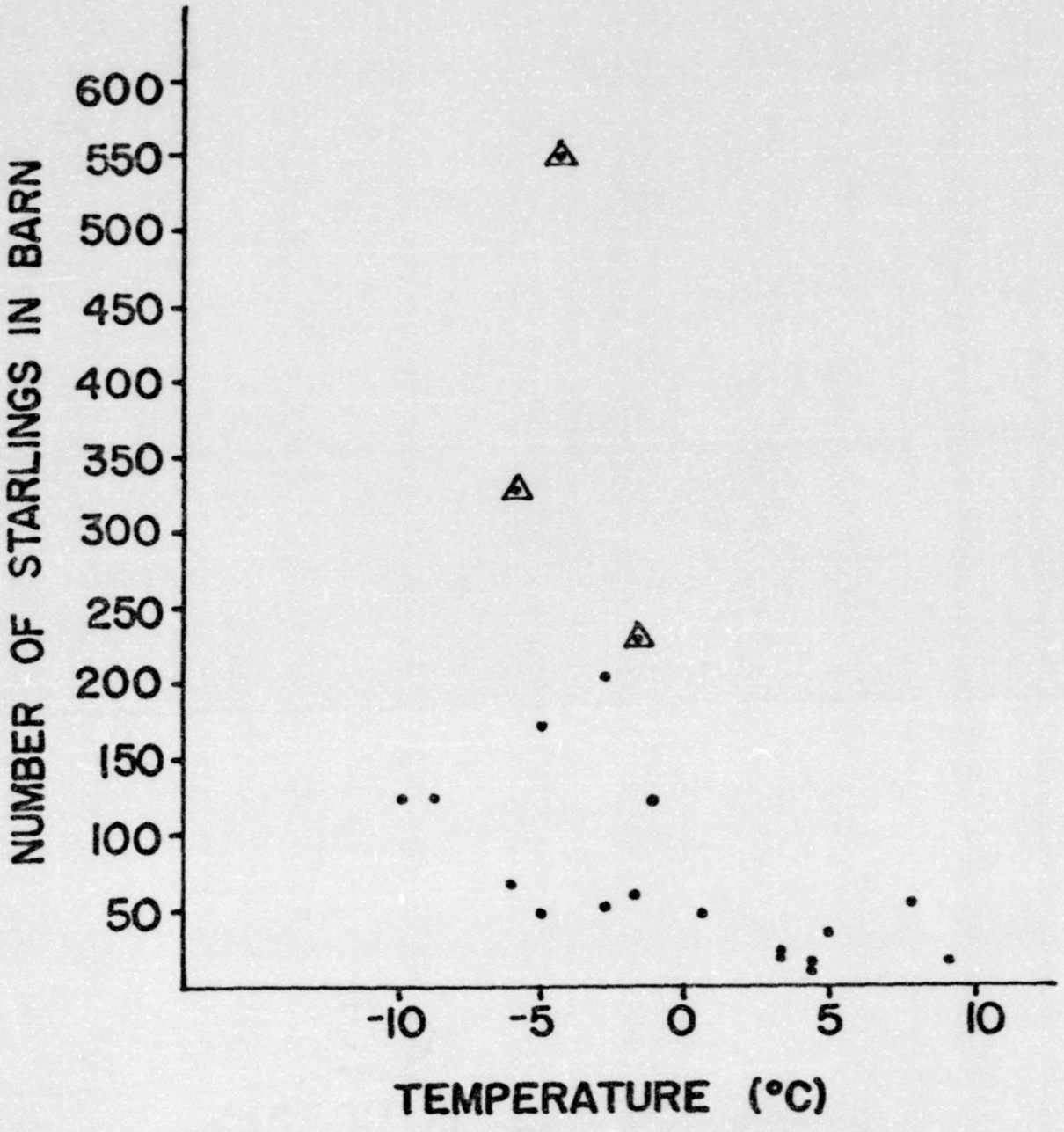
Another possible explanation may be related to wind direction. During the study period, the prevailing winds were from the north or northwest.

The space between the roof and the sides of the barn would allow entry of these northerly winds into the barn. Birds were less susceptible to these winds by roosting on the south-facing side of the barn.

The largest number of Starlings recorded in the barn was 550; the least was 10. Generally, the cooler the temperature, the greater the number of Starlings in the barn (Figure 5). There was an average of 174 birds in the barm when temperatures were less than or equal to 0 C, compared to an average of 28 birds when temperatures were greater than 0 C. Much of this difference may be attributed to the effect of snowfall; there were three snowfalls during the study period, and numbers increased dramatically following each snow. The greatest number of birds recorded occurred the night of or the night immediately following a snowfall. Numbers did not remain at these high levels but decreased almost as abruptly as they increased.

Judging from the above results, it does appear that Starlings will seek refuge from adverse weather conditions under periods of environmental stress (cooler temperatures and snowfall). The fact that they use man-made shelters for refuge indicates their resourcefulness in coping with stressful situations.

Figure 5. The total number of Starlings roosting in a cattle barn on the Western Kentucky University Farm as correlated with temperature (°C). Points enclosed by triangles represent days of snowfall.


NUMBER OF STARLINGS IN BARN
600
550
500
450
400
350
300
250
200
150
100
50
-10
-5
0
5
10
TEMPERATURE (°C)

SUMMARY

Blackbird and Starling roosts of the 1979-80 winter season were observed in order to obtain as much information as possible concerning roosts in this area. Four species were found to comprise the local roosts; Common Grackles were the most abundant, followed by (in decreasing abundance) Starlings, Red-winged Blackbirds, and Brown-headed Cowbirds. Rusty Blackbirds were found at one roost during a sampling of a PA-14 application and were believed to have been present at all other roosts as well. The total numbers at each roost were subject to much variation, due possibly to human activities and related weather factors.

All roosts were located in stands of Eastern Red Cedar which occupied typical old-field habitats. Roost site size averaged 11 acres, and all sites were in their first winter of use with the exception of the Bowling Green Center roost; it was in its fourth successive winter of use. All roosts with the exception of the Shawnee Subdivision roost were destroyed before the end of the roosting season.

Seven categories of activities were observed in roost species: predeparture vocalizations; predeparture staging; roost departure; daily activities; roost return; preroost staging; and settlement into the roost. All activities were well-defined and varied little during the study period. Common Grackles appeared to be the species around which the activities of the other roost species were patterned.

In addition to the above observations, studies were conducted on Starlings that were roosting in a cattle barn. The birds were subjected

to various light treatments in order to determine the effect of light on moving birds into different halves of the barn. Outside temperature and snowfall were also monitored to determine whether adverse weather conditions would force birds into the barn.

The lighting arrangement used in this study had no effect on bird movements from one side of the barn to the other; Starlings were always located in the south-facing side of the barn. Temperatures in each half of the barn were the same; thus, temperature was of little consequence in Starling distribution. The unequal distribution of birds in the barn may be attributed to a readily accessible food supply near the southern end of the barn or to the protection offered by the southern end of the barn from northerly winds.

Generally, as temperatures outside the barn decreased, the number of Starlings in the barn increased. Snowfall had the most pronounced effect on increasing the number of birds in the barn. The data gathered clearly shows that Starlings will seek shelter from the elements under periods of environmental stress.

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