TEMPORAL USE PATTERNS OF WINTERING STARLINGS AT A SOUTHEASTERN LIVESTOCK FARM: IMPLICATIONS FOR DAMAGE CONTROL

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ABSTRACT

The farm use patterns of individually marked and transmitter-equipped starlings at a livestock farm in southcentral Kentucky were studied each month during the principal damage period (December-February) of 1982-83 and 1984-85 following a pilot study in January and February of 1980. In addition to intensive observation at the farm, sightings of tagged starlings away from the farm were solicited from the public and mapped. For each year of data on individual starlings that used the farm at least once after marking, the expected frequencies of farm occurrence were calculated and compared to observed frequencies. In all 3 years, there was a significant ($P<0.01$) heterogeneity among birds in their frequency of farm use. The observed frequencies of daily farm use appeared bimodal suggesting starling subpopulations of frequent versus infrequent farm users. The preponderance of individuals occurred at the farm infrequently. Analysis of starling foraging patterns indicated that frequent farm visitors were also likely to use livestock feed sites more often than infrequent visitors. In 1984-85 the monthly starling turnover at the farm was calculated at 70.3% from December to January and 67.4% from January to February. Data on marked starling sightings away from the farm indicated that these individuals only moved a median distance of only 2.7 km from the farm suggesting a strong fidelity to their foraging area near the farm. The management implications of these data are discussed relative to integrated strategies of starling damage reduction at livestock farms in the southeastern United States.

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INTRODUCTION

Winter roosting blackbirds (Icterinae), and more particularly starlings (Sturnus vulgaris), are associated with localized damage at livestock feeding operations in the Southeast (Dolbeer et al. 1978, Glahn 1983, White et al. 1985). However, limited and conflicting information is currently available on the behavior of starlings that utilize these operations. Furthermore, basic to the development of control strategies is an understanding of the magnitude and dynamics of starling populations involved in feedlot depredations.

Important in implementing control operations is a knowledge of starling use patterns and turnover at the site of damage to determine when, where, and how long control measures should be implemented to achieve damage reduction. In this regard the literature is conflicting. Feare (1980) indicated a high fidelity of marked starlings to feeding sites at a livestock farm in Great Britain and rather limited local movements of wintering starlings. Similarly, Bray et al. (1975) indicated only small shifts in daily activity centers of wintering starlings in Oregon. In contrast, Gough and Beyer (1980) found a high degree of local movement of marked starlings among farms in Iowa and summarization of their raw data indicated that only 27% of their starlings showed any consistent fidelity to the farm where they were marked.

This paper summarizes data from a multi-year study of feed site use patterns of starlings using a livestock farm in southcentral Kentucky. The objective is to develop a basic

understanding of the dynamics of starling populations in feedlot settings. These data are necessary to assess and implement appropriate control strategies.

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METHODS

Study Area

The primary study site was the Western Kentucky University Farm (WKU Farm) located at the southern edge of the city limits of Bowling Green, Kentucky. This 318 ha farm operated by Western Kentucky University contains livestock feeding areas for dairy cattle, beef cattle, and swine. In addition, winter wheat, corn, and soybeans are grown in rotation over 133 ha with the remainder in pasture, alfalfa, and woodlots. Because of its large size and diversity it is not typical of livestock farms in the Kentucky-Tennessee area, but represents a microcosm of agriculture in this region.

This farm has a history of winter starling depredation problems on livestock feed. Most have been focused at the swine operation where feeder pigs are fed a 16-18% protein complete hog ration in meal or pellet form from flip-top feeders and breeding stock are fed cracked corn and supplement on the ground. Other problems have occurred where dairy and beef cattle are fed corn silage top-dressed with a corn/soymeal supplement from open feed troughs and wagons.

Marked Starling Studies

Starlings were marked and monitored at the WKU Farm during the winters of 1979-80, 1982-83, and 1984-85, to study farm use patterns by individual birds. In January and February 1980, 271 starlings were trapped using Kniffin collapsible baited traps (dove traps) (Reeves et al. 1968), aged and sexed, and individually marked with a back-tag containing a letter-number code described by Furrer (1979). Tagged birds were monitored with 2 Kodak Analyst[1] Super-8 surveillance cameras equipped with Kodak 40 Type A color Super-8 film set to photograph each of 2 (3 x 0.6 m) experimental troughs at 10 sec intervals. Granular meal and pelleted hog rations, typical of those used at the farm, were used to attract starlings to these troughs. Meal and pellet rations were alternated among days, but both troughs contained the same ration on a given day.

Film from 53 8-h observation days were analyzed frame-by-frame on an L-W International Mark V Super-8 Analytical projector, and individual tagged starlings observed on film were recorded along with film number indicating time of day and number and species of other birds foraging at the trough with these marked starlings. Using these data, the average probability of occurrence at the farm on a given day was calculated by pooling data over all individual birds. This probability was used in the binomial distribution to calculate the expected frequency of occurrence in 3 categories: <33%, 33-66%, >66% of days monitored. Observed and expected frequencies were used in a chi-square analysis to test if there was evidence for heterogeneity among birds in their frequency of farm use. In addition, the number of visits each tagged bird made to the trough on each day was summarized, an average calculated, and individuals were categorized as frequent (greater than average) or infrequent (less than average) visitors. The distribution of daily occurrence at the farm for these 2 groups was then compared using a 2-way contingency table.

1/Reference to trade names does not imply U.S. Government endorsement.

To examine the spatial distribution of tagged starlings, sightings of tagged birds by the public were solicited through press releases. These sightings were mapped and the distances to the banding site measured. To reduce possible bias in these data, repeated bird sightings by the same observer were only used once.

In the winter of 1982-83 starlings were trapped and marked during 3 periods: 6-8 December, 29 December-12 January, and 26 January-1 February. During the first period, 99 starlings were trapped and released within 24 h from a decoy trap and marked with a pink wing tag modified from Hester (1963) using a Buttoneer® fastener (Cummings 1987). During the second and third marking periods 137 and 161 starlings, captured in dove traps and with cannon nets, were marked with orange and yellow tags, respectively. On 12 January, the last day on the second trapping period, 5 starlings were equipped with a leg-hold transmitter as described by Bruggers et al. (1981) and a 3.8 x 1.5 cm plastic leg streamer and released. Three uniquely marked albinistic starlings were monitored in a similar manner as the tagged birds beginning with the first observation period in December.

Starting 1 to 4 days after each marking period, tagged and transmitter-equipped birds were monitored throughout the day for approximately 2 weeks. Data on tagged and transmitter-equipped starlings were collected with a Datamyte data collector on which specific location, time of day, habitat use, and weather conditions were recorded. The entire farm was initially censused for starlings and scanned for tagged birds along a 8.4 km stretch of road from which all the study area was visible. This census route was driven at 24-48 kph 3 times daily at 3 h intervals starting at a randomly selected 0.5 h between 0700 and 0930. When tracking transmitter-equipped birds all channels were scanned at 0.5 km intervals along the route and also when flocks of starlings were seen. All starlings seen along this census route were tallied to provide an estimate of the total number of starlings using the farm during the course of the study. Since it was difficult to identify tagged individuals from roadsides, most of the data on tagged birds were gathered at feed sites and other areas adjacent to these feed sites where tagged birds had been previously seen. As many different individual starlings as possible were identified from a parked vehicle using binoculars or a 60X zoom spotting scope. During these 1-3 h observations, the activity and habitat of marked individuals were recorded once where they were first observed. Data from these observations were analyzed in a manner similar to the analysis of the data from the winter of 1979-80, except that farm use patterns of transmitter-equipped birds and naturally marked birds were initially analyzed separately, compared with the pattern of tagged bird use and later combined. As in the 1979-80 study, sightings of tagged birds were solicited from the general public through the news media.

In 1984-85, bird marking and monitoring were similar to that in the 1982-83 study. However, because of problems with long-term retention of wing tags and back tags throughout the winter months, leg streamers described by Guarino (1968) were used, but modified by putting a 90^{o} fold at the base of the 10 cm tag to make it stand up and away from the body of the bird. A total of 155, 150, and 162 starlings were marked in December (5-7 Dec), January (2-7 Jan) and February (4-5 Feb) with orange, pink, and yellow tags, respectively. Tagged birds were observed for 12-15 days after each marking period as in the 1982-83 study. Because of the less conspicuous nature of these tags, sightings by the public were not solicited. Farm use patterns from this year were summarized as in the 1979-80 and 1982-83 studies, but because of the use patterns subse-

quently described, no analysis of the association of feed site use per day and percent of farm occurrence was possible. Due to the long-term retention of leg streamers versus other tag methods used, we were able to calculate starling turnover among months at the farm using a change of use method modified from Heisterberg et al. (1984).

RESULTS AND DISCUSSION

Starling Populations

Mean daily starling numbers at the farm varied significantly ($P<0.01$) among observation periods and months with mean ±S.E. daily starling numbers of 286±102 birds in 1982-83 and 228±141 birds in 1984-85. Starling numbers at the farm were fairly stable with approximately 75% of the 220 estimates from both years being between 100 and 500 birds.

Roosting locations of foraging birds varied among years. Throughout the winter of 1979-80, a 1-2 million blackbird-starling roost, containing approximately 25% starlings, was located 3.9 km N of the farm. In addition, 100-300 starlings roosted in a calf barn at the WKU Farm dairy. During the winter of 1982-83 this barn had 500-1000 roosting starlings and 2 additional barns each contained 50-100 birds throughout the winter. In addition, a blackbird-starling roost of 200,000 birds, with 13% starlings, formed 1.6 km N of the farm in February 1983. In December 1984 and January 1985, most birds using the farm roosted at Franklin, KY, approximately 26 km SW of the farm, with only 50-150 starlings roosting (in a silo) at the farm. However, in February 1985 a roost 3.2 km N of the farm formed and expanded from 186,000 birds (24% starlings) to 1.2 million birds (1-5% starlings) by the end of February.

Marked Starling Use of Farm

Of 271 starlings individually marked at the WKU farm in January and February 1980, only 75 (27.7%) were recorded using test troughs during the 2-month period. Similarly, in 1982-83, the percent of tagged birds that used the farm at least once during the month after tagging was 20.2 in December, 18.2 in January, and 20.5 in February. With the longer lasting tag used in 1984-85 tagged starling sightings increased from 20% in December, to 26% in January, to 37.3% in February. During similar observations, 50% of the starlings marked with leg streamers were observed at 2 dairy feedlots in Tennessee (Glahn and Steffen 1978). During early and late winter observations in Iowa, Gough and Beyer (1980) had between 73 and 75% of their starlings marked with leg streamers use the farm where they were marked. Similarly, all 5 transmitter-equipped starlings in our 1982-83 study were located at the WKU farm at least once during the January observation period. However, with the exception of 1 individual, transmitter-equipped starlings used the WKU farm only briefly on the days they were known to be in the area. This suggests that the low use by tagged starlings that we recorded may be partly due to birds using the farm so briefly that we missed them even with intensive observations.

Observations of tagged birds off the farm provided additional insight into the spatial distribution and nature of starling activity after tagging. In 1980, only 6 (17.6%) of 34 individually identified starlings seen by observers off the WKU farm were also seen at the farm. In 1982-83, only 1 (5%) of 18 starlings individually identified off the farm was also seen at the farm. This suggests that many of the birds tagged but never observed later at the farm shifted their foraging activity away from the farm. These individually identified birds as well as a number of unidentified marked birds from different locations were observed a mean of 3.1±0.2 km from the farm in 1980 and 4.5±0.5 km in 1982-83. The median distance was calculated at 2.7 km for both years.

The location of 75.5% of these 98 sightings were within 5.6 km N of the banding site, primarily within the city limits of Bowling Green.

Although the short range of leg-hold transmitters precluded tracking starlings much beyond the range of the farm, information on transmitter-equipped starlings indicated that even those starlings that rarely used the farm remained within a 1.6 km radius of the farm perimeter on more than half of the 15 days tracked. Wintering starlings appear to have a strong fidelity to a relatively small foraging area. In Oregon, Bray et al. (1975) determined that the average distance between starling activity centers on successive days was only 4.8 km. Starlings that we tagged at the farm and never observed again made similar small shifts in their daily activity centers, but remained faithful to the same general area near the farm. In Iowa, Gough and Beyer (1980) observed 69 tagged birds an average distance of only 1.8 km from the farm where captured, and the foraging distance of their transmitter-equipped birds were shorter than that recorded by Bray et al (1975). As in our study, many of their birds moved to an urban area and foraged at bird feeders and lawns.

Because of starling movement away from the farm subsequent to tagging, our farm use data included only starlings that used the farm at least once after the day of tagging. Because the exact number of days a bird used the farm could not be precisely determined, these data were placed into 1 of 3 previously mentioned categories of farm occurrence: <33%, 33-66%, and >66% of the days observed. To compensate for the possible bias of tag loss, we restricted our summarization to only those birds marked and observed in the same monthly period.

The percent of individual starlings falling into the 3 categories of farm use was analyzed by chi-square contingency table analysis and was significantly different (P=0.001) among years (Fig. 1). Further contingency table analysis indicated that the difference was between the 1984-85 data and the other 2 years of study (P<0.01) with no difference between the 1980 data and the 1982-83 data (P=0.228). This difference in the ratio of frequent to infrequent farm use by starlings in 1984-85 compared to other years is not understood, but may be related to the fact that the primary source of birds in 1984-85 was from a roost 26 km SW of the farm. In other years more birds roosted in barns at the farm and at major roosts within 3.9 km N of the farm.

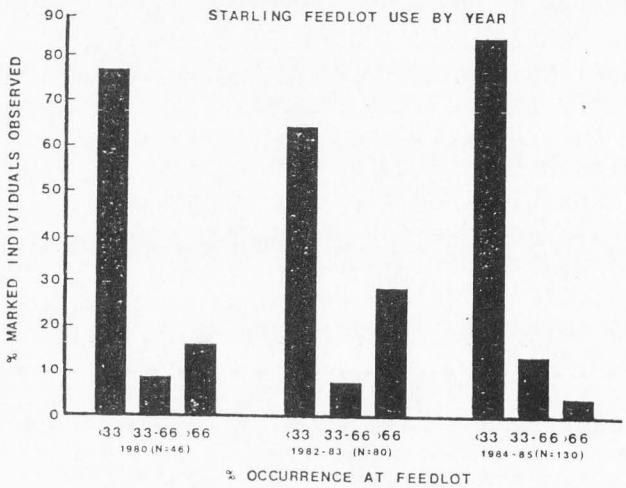

Figure 1. Percent of marked starlings observed at WKU Farm at least once during the winters of 1979-80, 1982-83, and 1984-85 categorized by their percent daily occurrence observed at feed sites.

For each year of data the expected frequencies of occurrence were calculated based on the assumption of homogeneous daily bird use and compared to observed frequencies in a chi-square goodness-of-fit test. These data pooled for all years are presented in Fig. 2. In all years there was a significant (P<0.01) heterogeneity among birds in their frequency of farm use. A small percentage of starlings were observed far more often (>66% of the observations) than expected, although the

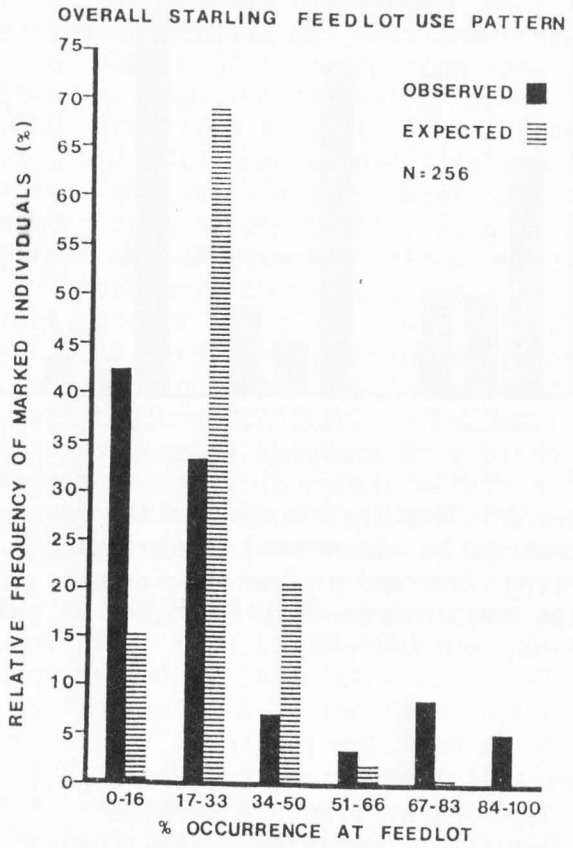

Figure 2. Observed versus expected percent frequency of daily occurrence for marked starlings observed at the WKU Farm during the winters of 1979-80, 1982-83, and 1984-85.

largest percentage of individuals occurred less than 16% of the time (Fig. 2). Thus, in contrast to the expected frequencies, observed frequencies appeared to be bimodal suggesting subpopulations of frequent and infrequent visitors. Data from 15 consecutive days of tracking transmitter-equipped birds showed a similar use pattern with 3 of 5 birds using the farm <33% of the time and 2 birds occurring >66% of the time. Similarly, only 1 of 3 albinistic starlings consistently used the farm. In Iowa, Gough and Beyer (1980) reported a similar pattern of occurrence at the farm where their starlings were transmitter-equipped. Of 20 transmitter-equipped birds tracked at least 2 days, 11 (55%) occurred at that farm <33% of the time, 3 (15%) occurred 33-66% of the time, and 6 (30%) occurred >66% of the time. Feare (1980) indicated that several individually tagged starlings had a high fidelity to a livestock farm in Great Britain, but no information was presented on the percent of the tagged population these birds represented.

Significant ($P<0.005$) behavioral differences were found in the frequency of feed site use/day and starling occurrence at the farm in 1980 and 1982-83. The 1984-85 data were inadequate to include in a similar contingency table analysis because most birds used the farm so infrequently. From these analyses frequent visitors to the farm also were likely to make more than the mean number of trough or feed site visits per day when compared with infrequent visitors. This suggests that frequent visitors may be the nucleus of the damage problem by consuming more feed than their counterparts, and by their consistent presence at the feed site, they may serve to decoy in other birds.

No significant ($P>0.05$) differences were found among age and sex of individuals and their frequency of occurrence at the farm, even though this distribution of birds using the farm appeared to be skewed. Including December birds reclassified to second year (SY) and after second year (ASY) after January 1, the overall sex and age distribution of 269 birds using the farm was 39% ASY males, 33% SY males, 16% ASY females, and 12% SY females. Thus, the male-female sex ratio was 72:28 and the ASY-SY ratio was 55:45. Feare (1980) reported that males predominated at feed sites in Great Britain and based on our sex ratio of birds caught and subsequently observed at feed sites this may be true for Kentucky also.

Despite the predominance of males at feed sites our data would suggest that something other than sex appears to be the primary factor influencing the frequency of occurrence of certain individuals at feed sites. The factor that may account for this

difference in behavior is that resident starlings may be more likely 66 use feed sites than winter migrants. Banding studies by Monroe and Cronholm (1977) indicate that 47% of the wintering starlings in Kentucky are residents. Nest box studies at the WKU Farm have indicated that certain individuals may be year round residents of the farm (Twedt and Oddo 1984, Timbrook 1985). Another indication of this resident bird hypothesis is the significant (P=0.0002) change in the distribution of frequent versus infrequent visitors over the damage season. From the period of December to February for all years combined the percent of frequent visitors decreases as the percent of infrequent visitors steadily increases (Fig. 3). We believe this phenomenon is related to resident birds becoming increasingly diluted by migrant birds over these winter months. This may explain why observations of tagged starlings by Glahn and Steffen (1978) at 2 Tennessee dairies had a distribution containing few, if any, frequent visitors in February. In contrast, starlings tagged at a dairy feedlot in December near Russellville, KY (Glahn, unpublished data) had a frequency distribution similar to those in December at the WKU Farm.

Tagged starling data from 1984-85 was also analyzed to examine the long-term dynamics of starling populations. In these analyses we used a method described by Heisterberg et al. (1984) to examine changes in use over subsequent months. Use was defined as a bird being observed at the farm at least once during a 10-15 day period each month. Thus, a change in use occurred where an individual was observed in 1 month and not in another in contrast to being observed in both months. For these analyses we used birds tagged in early December and looked at occurrence of individuals each month from that tagged group in December, January, and February.

These data indicate a 70.3% turnover in birds from December to January and a similar 67.4% turnover from

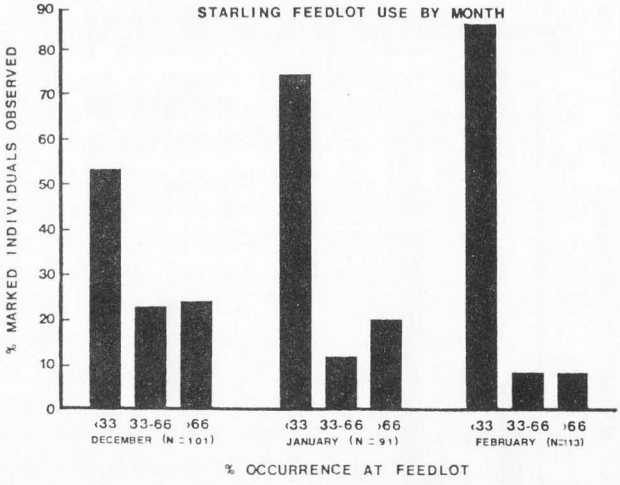

Figure 3. Monthly changes in the percent daily occurrence of marked starling observed at the WKU Farm during the winters of 1979-80, 1982-83, and 1984-85.

January to February (Table 1). Analysis of birds marked in January also showed a similar 59% turnover from January to February. This turnover rate might explain why more than 70% of the birds tagged were never seen again, even though observed numbers remained stable.

Table 1. Monthly turnover of tagged starlings at the WKU Farm, winter of 1984-85.

	Dec-Jan	Jan-Feb
NO CHANGES IN FARM USE (Birds occurring in both periods)	19	15
CHANGES IN FARM USE		
New Birds Occurring	27	5
Old Birds Not Occurring	18	26
CHANGE/TOTAL	45/64	31/46
TURNOVER (%)	70.3	67.4

High turnover rates and/or reinvasion of feedlots by starlings is inferred from several other studies. Gough and Beyer (1980) reported that removal of starlings did not have a significant effect on the size of foraging populations at a number of

farms on subsequent days even when the original estimate was less than the total number of starlings removed. This included the removal of more than 1000 birds from a single farm. Feare et al. (1981) used alphachloralose to remove 449 starlings or about half the number seen before baiting with little effect on subsequent starling numbers.

In summary, these data suggest that, except for a small percentage of resident birds which forage at livestock feeding sites regularly, most starlings used the farm infrequently. This is despite the fact that birds tagged appeared to remain within a short distance from the farm after tagging. These infrequently occurring starlings are likely responsible for the reinvasions of feedlots after population reduction or during inclement weather. The stable nature of starling numbers at the farm each day belies the high turnover rate in individuals each month. The stability in starling numbers more likely reflects the carrying capacity of the food base of the farm as suggested by Glahn and Otis (1986).

MANAGEMENT IMPLICATIONS AND RECOMMENDATIONS

Based on the findings of this study, there is a small resident segment of the starling population that is part of the damage problem. Because of their frequent occurrence and use of livestock feed, members of this segment should be eliminated through baiting with Starlicide®. Control of these resident populations early in the damage season could help reduce the consistent nature of starling damage throughout the damage season by reducing the decoying effect of these birds. However, because of the infrequent use of livestock feeding sites by most of the birds and the high turnover rate in birds each month, nothing short of an extended baiting program throughout the damage season at an individual farm is likely to be effective in substantially reducing damage. Coordinated baiting efforts by a number of livestock operators in a localized area and/or roost control could in some cases be more productive in reducing a large bird shed more efficiently, but data are not currently available to substantiate this theory. Considering the time, effort, and expertise necessary to conduct such lethal control programs, alternative approaches to damage control at the farm would appear to be needed for some of the damage problems that occur in the southeastern United States.

Alternatives to lethal control could include limiting, where practical, the amount and period of time that feed palatable to birds is exposed (Twedt and Glahn 1982). A second alternative could be the use of a livestock feed bird repellent such as dimethyl anthranilate (DMA) (Glahn 1984, Mason et al. 1984). However, the cost-effectiveness of this material at efficacious levels is still unresolved and it is presently unavailable for use.

A third alternative is the use of various frightening devices. Similar to the use of repellents, frightening devices are likely to be effective only if birds have an alternative food source to exploit. Based on the findings of other studies, it appears that throughout most of the damage season here in the southeastern United States several alternative food sources are available. This includes large amounts of corn in stubble fields (White et al. 1985), weed and tree seeds and probably at most times a preferred alternative food in the form of invertebrates. Based on the availability of alternative food sources, deterring starlings should be theoretically practical except under severe weather conditions.

Avitrol® is a registered fright producing chemical for frightening birds from feedlots. However, its efficacy for reducing starling feedlot damage in the Southeast has not been adequately determined. Because of the potential disturbance to livestock from auditory scaring devices

and the small geographic area (<0.4 ha) covered by feed sites, visual scare devices, although having unknown efficacy, may be an alternative method worthy of consideration. Limited evaluations of such devices have been conducted in feedlots, but Smart (1982) indicated some success in deterring starlings from a swine feed site with helium balloons in Britain. The deterrent effect of "eyes" to starlings has been documented (Inglis et al. 1983) and is commercially available in a balloon device (D.F. Mott, pers. comm.). Hawk kites, that are available commercially, have shown some efficacy in protecting crops (Hothem and DeHaven 1982, Conover 1982, Conover 1984), and might also show some promise at small livestock feeding sites because varying number of raptors occurring there may help to reinforce these effigies. Lastly, Bruggers et al. (1986) have reported promising results in protecting various field crops with commercially available reflective tape, and these tapes may also be effective in protecting small livestock feeding areas.

Given the need, availability, and unknown potential of simple and inexpensive visual scarers and other methods for repelling starlings at feed sites, these alternative methods should be examined either individually or in combination with Starlicide baiting for long-term damage reduction.

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