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ABSTRACT: Each winter, more than 300 million blackbirds and starlings congregate in hundreds of roosting sites in the southeastern United States. In addition to nuisance problems involving odor and property damage from fecal material, and potential airport hazards, research studies to date suggest that the major problems with these birds and their roosts involve grain losses in feedlots, latent disease transmission to livestock, and public health concerns with histoplasmosis. Control methods development studies have shown the utility of Starlicide and nonchemical control methods in reducing starling feedlot problems. A sprinkler-irrigation delivery system for the surfactant, PA-14, has been developed that enhances its usefulness for lethal roost management. Research is being continued to (1) define the behavior and impact of roosting birds on the livestock industry, (2) improve methods of dispersing birds from roost sites, and (3) determine the effect of lethal roost control on subsequent roosting and foraging bird populations.

INTRODUCTION

During the winter months (December through March) more than 300 million birds, primarily common grackles (Quiscalus quiscula), red-winged blackbirds (Agelaius phoeniceus), European starlings (Sturnus vulgaris), and brown-headed cowbirds (Molothrus ater), congregate in hundreds of roosts in the southeastern United States (Meanley and Royall 1977). Although blackbirds have roosted in the Southeast for centuries, concern has recently been expressed about many of these roosts and birds because of their potential to create human and livestock health hazards, to damage sprouting and ripening crops and feedlots, to create nuisance problems in and near urban areas, and to pose other hazards such as to aircraft. These man-bird conflicts have probably increased due to growing human population and the continued increase in populations of the starling and other roost-associated blackbirds. Dolbeer and Stehn (1979) in an analysis of Breeding Bird Survey data indicate that breeding populations of grackles, starlings, and possibly red-winged blackbirds (redwings) that overwinter in the Tennessee-Kentucky area have increased during recent years. They also speculated that grackle populations overwintering in the southern United States may have enhanced survival rates because modern agricultural practices increase winter food availability (e.g., large amounts of waste corn from mechanical harvesting).

This situation and the resulting public concern led to the establishment of a U.S. Fish and Wildlife Service (FWS) field station at Bowling Green, Kentucky, in 1977 to conduct research on blackbird-starling winter-roost problems in the Southeast. Our research efforts can be categorized as follows: (1) behavior and ecology of winter-roosting birds; (2) problem definition; and (3) control methods development. This research effort has focused on Kentucky and Tennessee.

BEHAVIOR AND ECOLOGY OF WINTER-ROOSTING BIRDS

A better understanding of the population dynamics and behavior of the various pest species is essential to developing management strategies that offer long-term solutions to problems.

Origin of Bird Populations

Knowledge of the origins of blackbird and starling populations that form winter roosts in the Southeast is based on recoveries of banded birds. Blackbirds and starlings are banded year-round by personnel of the Kentucky Research Station to supplement existing banding data that will ultimately reveal the movements and migratory patterns of these birds. Since 1977 we have banded over 20,000 birds in Kentucky and Tennessee.

An analysis of band recoveries reveals that the majority of redwings, grackles, cowbirds, and starlings wintering in any particular state come from a broad area of the species' breeding range. Most blackbirds breed in northern regions, but Monroe and Cronholm (1977) calculated that nearly half of the wintering starlings in Kentucky represented local breeding birds while the remainder originated from areas to the northeast. Wintering grackles in Tennessee and Kentucky were shown to originate in the states to the northwest, north, and northeast, primarily in the Great Lakes region and Upper Mississippi River Valley (Monroe and Cronholm 1977, Meanley and Dolbeer 1978). Meanley (1971) calculated that 84% of the wintering blackbirds in Arkansas, Louisiana, Mississippi, and Texas came from northern areas. Over 94% of these birds came from the 12 northcentral states extending from Ohio westward to the Dakotas and Kansas. The remainder came from northwestern and the Rocky Mountain states as well as the five bordering Provinces of Canada.

Blackbird and Starling Roosting Populations

Each winter more than 100 major roosts in the Southeast contain a million or more blackbirds and starlings (Meanley and Royall 1977). Overall, the species composition of these roosts was reported as 30% redwings, 29% grackles, 23% starlings, and 18% cowbirds. A few rusty blackbirds (Euphagus carolinus) and robins (Turdus migratorius)--the latter not a blackbird--were also found roosting with the above species. The species composition of a particular roost varies, however, with the roost

location and time of winter. At the Milan roost in western Tennessee, Dolbeer et al. (1978) showed that common grackles were most numerous in December (75% of roost population) but in early March decreased to only 47% of the population. Starlings averaged 10% of the population in November but increased to 49% in early March, whereas, redwing numbers declined from 33% (January) to 4% (early March). Total population counts during the roost period at Milan increased from 3.6 million birds in November to a peak of 11 million in February, then dwindled to 500,000 birds in early March before roost abandonment. Obviously the roosting populations are not very stable. Heisterberg et al. (1984) followed radio-instrumented birds from nine different winter roosts in Arkansas, Kentucky, and Tennessee and calculated a 32% nightly turnover rate among the roosting birds. They found the amount of roost interchange was influenced by unstable weather conditions. Nightly turnover increased during periods with snow, ice, and below-average temperatures.

Roost Formation Studies

A study is currently underway to answer some fundamental questions on roost formation. The intent is to identify bird behavioral and roost vegetative characteristics that will give clues as to how and why the birds choose particular winter roost sites. This information is basic for finding ways to encourage birds to use sites where they will cause minimal problems. Preliminary findings reveal that blackbirds and starlings prefer to roost in urban areas and in sites at or near those previously occupied.

Behavior of Starlings in Feedlots

Although winter-roosting starlings have been documented as causing significant feed loss at livestock feeding operations in the Southeast (Dolbeer et al. 1978, Glahn 1983), data are limited on the dynamics of feedlot utilization by starlings and the magnitude of the population involved in depredations over time. A study has been initiated to examine the behavioral patterns of starlings at livestock-feeding operations to address these fundamental questions that impact control strategies.

PROBLEM DEFINITION

Public Health

Histoplasmosis, a human respiratory disease caused by the fungus Histoplasma capsulatum, is often associated with roosting blackbirds and starlings (Furcolow et al. 1961, Powell et al. 1973, Latham et al. 1980, Chick et al. 1981). Because accumulated bird droppings in a roost are considered a major contributor to fungal growth, this disease is used as a primary justification for attempts to eradicate large numbers of roosting birds. To learn more about the association of bird roosts and human exposure to histoplasmosis, a Fish and Wildlife Service contract study was initiated with the Kentucky Department for Human Resources to determine the incidence of the disease in humans in relation to distance from bird roosts. Another contract study was initiated with the University of Louisville to study the relationship between the growth patterns and physiological behavior of H. capsulatum and the environment associated with the prevalence of histoplasmosis. A third Service contract was established with the Public Health Service's Centers for Disease Control to determine the length of time (years) for a roost to become positive for histoplasmosis, and to prepare a state-of-the-art report on histoplasmosis encompassing descriptions of the disease organism, the role of blackbird-starling roosts in its epidemiology and occurrence, and recommended methods for disease control.

Considering human health, Chick et al. (1981) reported that 22 (32%) of 70 roost sites in Kentucky were found to harbor H. capsulatum. In an evaluation of 7,123 persons living in proximity to H. capsulatum-positive and negative sites, those living near positive sites (either with disturbed or nondisturbed soils) had a significantly higher skin test reaction rate (and presumably were at a somewhat higher health risk) than those living near negative sites.

Ecological studies on the growth of H. capsulatum revealed that temperature and humidity have a major influence on determining the geographic distributions of the fungus. Cronholm and Monroe (1983, unpubl. final rep., FWS Contract #14-15-009-77-039, Ecology of Histoplasma capsulatum in Bird Roosts, University of Louisville, Louisville, Kentucky) detected H. capsulatum spores in nonbird roost forested areas but felt that the environmental conditions in mature bird roosts (including mostly the high nitrogen levels from the bird fecal material) promoted a much greater proliferation of the fungus than did nonroost soil. They found that high (40°C) as well as lower (15°C) temperatures, high hydrogen ion concentration in the soil (<pH 6.6), and low relative humidity inhibited spore formation. Regarding management of histoplasmosis-positive roosts, they recommended restricting entry on the site and keeping the soil and vegetation undisturbed.

The yet unpublished results of the Public Health Service study supports the current belief that only roosts occupied by birds for three or more years (rarely two) become infected with H. capsulatum. This document will provide the most recent information on this disease relative to bird roosts. Currently, the only way to decontaminate positive roost son 1s is to saturate the soil with formaldehyde (U.S. Department of Health, Education, and Welfare, undated). Finding less hazardous decontamination methods (either chemical, physical, or biological) should receive research attention.

Agricultural Losses

Initial research studies were conducted to determine the magnitude of agricultural problems caused by blackbirds and starlings in the Southeast. Agricultural losses to birds were assessed in objective

statewide and local surveys of sprouting and ripening corn (Stickley et al. 1978, Heisterberg 1983), sprouting wheat (Stickley et al. 1977, Dolbeer et al. 1978/1979), and in livestock feeding areas (Glahn 1983). Studies were also conducted to measure the adverse effect on feed acceptance and feed efficiency of calves and swine fed feed contaminated with starling fecal matter (Glahn and Stone 1984). The role of starlings as vectors of transmissible gastroenteritis (TGE) to swine was investigated through a Service-sponsored study by Iowa State University (Gough et al. 1979).

Although the extent of bird damage varies from year to year, results of crop surveys revealed that overall losses caused by winter-roosting birds in the Southeast were minor (< 1% of the crop damaged) compared with the total crop produced and other losses (insects or weather). The distribution of damage, however, indicated that heavy damage was usually sustained by relatively few farmers and those fields nearest to a roost usually received the most damage. Starlings were almost exclusively responsible for damage to sprouting wheat, whereas blackbird species were involved in damage to corn. According to Dolbeer et al. (1978/1979), damage to sprouting wheat can probably be reduced by planting before November 1 prior to the birds' arrival. Almost all damage to corn takes place before (ripening) or after (sprouting) the winter-roost season and is thus not normally associated with winter-roosting birds. Survey methodology was developed to assess the losses in feedlots (Glahn et al. 1983). An analysis of bird depredations at a number of feedlots in six Tennessee counties revealed that starlings were responsible for most of the damage (Glahn 1983). Severe bird problems in livestock-feeding areas were found to be associated with severe weather conditions and usually occurred near winter roosts and at larger feeding operations where a constant supply of feed was available (Glahn, unpublished data). Studies on the effects of high levels of starling excrement in livestock feed failed to demonstrate any adverse effect on weight gain or feed rejection by calves and swine fed the contaminated ration and a control feed (Glahn and Stone 1984). Findings of the TGE study, however, revealed that starlings do have the potential to serve as vectors of TGE to swine under conditions where birds forage in hoglots (Gough et al. 1979).

In addition to nuisance problems involving odor and property damage from fecal material, and potential airport hazards, studies suggest that the major problems associated with blackbird-starling roosts involve feedlot losses, latent disease transmission to livestock, and public health concerns with histoplasmosis. The impact of disease transmission by or resulting from birds needs further investigation.

CONTROL METHODS DEVELOPMENT

Research is necessary to develop, register, and maintain effective control techniques that can be used to reduce economic, health, safety, and nuisance problems caused by winter-roosting birds. Control-oriented studies initiated by the Kentucky Research Station have been directed at the source of the problems in livestock-feeding areas, damage to sprouting corn, and nuisance and health hazards associated with winter roosts.

Livestock-Feeding Areas

The slow-acting toxicant bait for starlings, Starlicide Complete® (Ralston Purina Co., St. Louis, Missouri), was evaluated in tests to determine its utility in Southeastern feedlots (Stickley 1979). (Use of trade-named products does not imply endorsement of commercial products by the United States Government.) Although results of these tests were somewhat confounded by changing weather conditions, its use was recommended as part of an integrated pest management program for alleviating bird problems at feedlots. Since results obtained from Starlicide baiting can vary depending on the individual user, Glahn (1982) prepared guidelines for its most effective use. He recommended baiting strategies including the use of prebait and bait containers to improve the efficiency of Starlicide. In the Southeast, Knittle et al. (1980), used Starlicide to bait preroost starling congregating areas near roost sites, and this appeared to be more efficient than baiting widely scattered feedlots. Although this study suggests that large numbers of roosting starlings can be killed by baiting them at preroosting areas, its potential for reducing damage problems, such as at feedlots, and the environmental and nontarget hazards involved with these treatments have not been thoroughly investigated.

In addition to controlling feedlot damage with toxicants, economic losses can be reduced by implementing management practices that limit the availability of grain products to starlings (Twedt and Glahn 1982). These practices include the use of barriers to separate the feed from the birds or use of feed forms that are unpalatable or unattractive to them.

Sprouting Corn Damage

Chemical seed-corn repellents are the most frequently used for reducing bird damage to sprouting corn. Because of the problems of determining the most efficient commercially available repellent to use, Heisterberg and Otis (1983) devised a testing design whereby candidate repellents could be tested simultaneously against each other and a control (untreated). Confounding factors such as uneven germination, insect and disease damage to sprouts, weather-related sprout mortality and treatment phytotoxicity were eliminated by using this test design. An evaluation of federally registered seed protectants revealed the superiority of the chemical, methiocarb, commercially available as Mesurol® 50% Hopper-Box Treater (Mobay Chemical Corp., Kansas City, Missouri) and Borderland Black® (Borderland Products, Inc., Buffalo, New York).

Urban-Suburban Roosts

Health hazards and nuisance problems associated with winter roosts have received increased research effort. Urban-suburban roosts comprised nearly 50% (80% in Tennessee) of all roosts reported in the Southeast during a 1980 national roost survey (Stickley, unpublished data). Although roost dispersal can solve some of these problems (Mott 1980), dispersal may not be the answer where a community is plagued by a roost nucleus year after year. In this situation, dispersal may only shift the roost from site to site or, worse, fragment the roost and thereby increase the problem. Here lethal control may be a more desirable alternative. Lefebvre et al. (1979), described the developmental status of one potential contact toxicant (CAT, DRC-2698) for use as a roost spray. Field testing of this compound was suspended because of estimated exorbitant development costs for a material that, because of its toxic nature, would have very limited use in urban-suburban situations. Currently, the only chemical registered for spraying blackbird-starling roosts to reduce their populations is the avian stressing agent, PA-14 (Lefebvre and Seubert 1970). Effective use of this compound has been hampered, however, because of very stringent weather conditions that are required during roost treatments (1.3 cm of rainfall followed by temperatures around 5°C or lower). To circumvent these conditions, a PA-14 delivery system that obviates the need for rainfall and aerial application was designed, constructed, and successfully tested (Stickley et al. in preparation). It consists of an overhead sprinkler-irrigation system that can treat up to four acres of roosting habitat. PA-14 is metered into the irrigation water via a proportioning valve. The system is ideally suited for urban sites since little primary or secondary toxic hazard is associated with PA-14 provided it is kept out of aquatic systems (PA-14 is toxic to some aquatic organisms).

To further expand the use of PA-14, studies are underway that address its aquatic hazard potential. The extent of potential PA-14 residues resulting from runoff due to its application to roost sites are being determined, and chemical and physical barriers for preventing PA-14 entry into aquatic systems are being tested.

FUTURE STUDIES

The Fish and Wildlife Service will continue to search for and refine safe and effective ecological, behavioral, mechanical, and chemical methods for alleviating problems caused by winter roosting populations of blackbirds and starlings. Specific studies designed to define the behavior and impact of roosting birds on the livestock industry either through consumption of feed or through transmission of disease will be continued. Since starlings appear to be the primary species involved in feedlot losses, a method of selectively removing starlings from winter roosts by possibly baiting adjacent congregating (staging) areas with Starlicide baits will be explored. The search for improved methods of dispersing problem roosts via mechanical and chemical means and by habitat alteration will receive high priority. Methodology for enhancing PA-14 use with the sprinkler-irrigation system will continue to be examined. Through use of the irrigation system we plan to define the impact of roost kills on the foraging populations of blackbirds and starlings, and also determine the effect of these roost kills on the formation of subsequent roosts during the current roosting season and in subsequent years.

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