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By Richard A. Dolbeer

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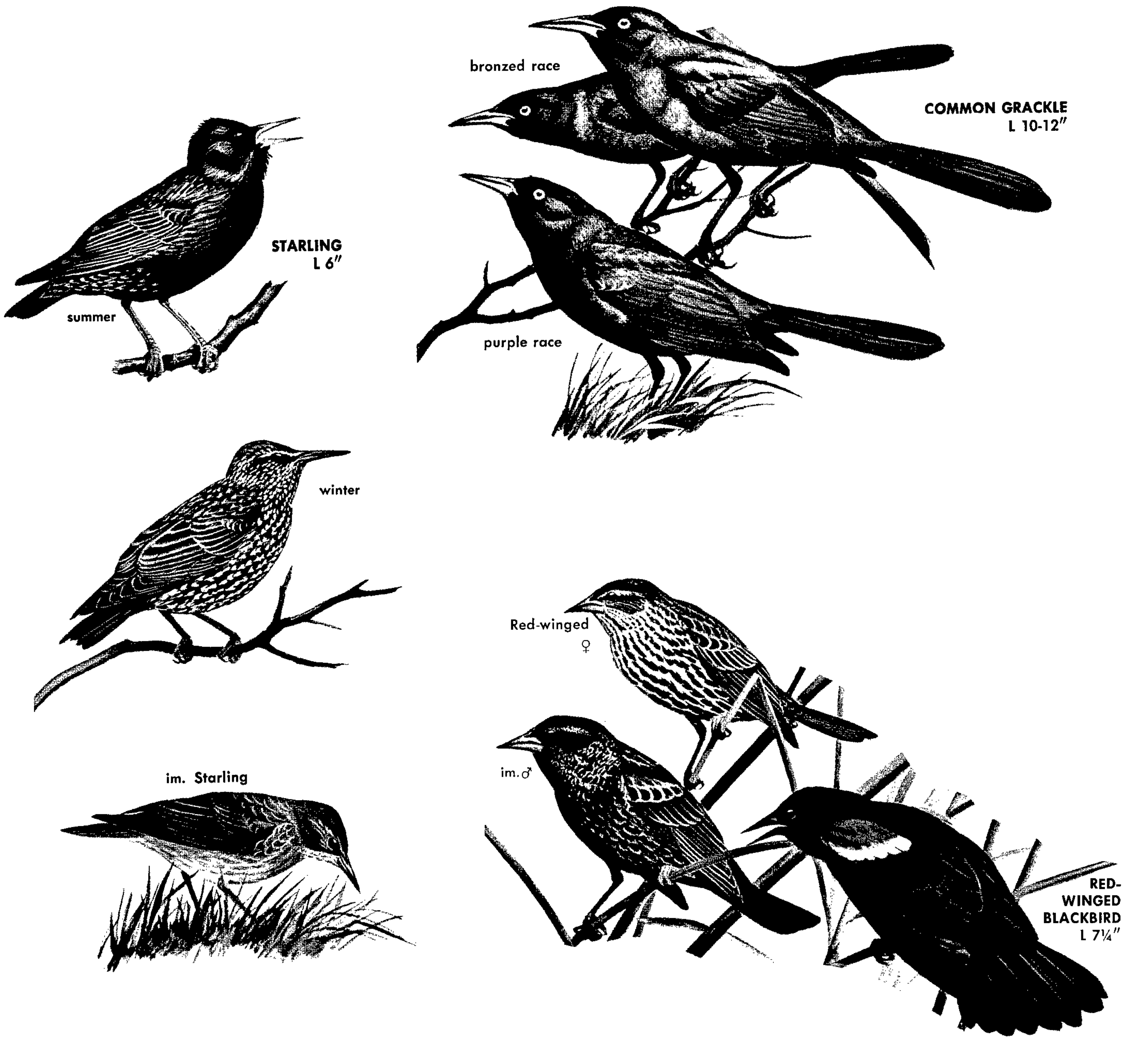

Frontispiece—The red-winged blackbird and common grackle are responsible for most bird damage to maturing corn in Ohio. The European starling also is sometimes found in cornfields, but it usually feeds on insects and not the corn. (Illustrations by Arthur Singer from Robbins et al. 1966)

Blackbirds and Corn in Ohio

By

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Abstract

Damage to corn by blackbirds (Icteridae) has been an economic problem throughout historical times in North America. Ohio, with the highest nesting season population density of red-winged blackbirds (*Agelaius phoeniceus*) in North America and large acreages of corn, has been a key State in this conflict. Surveys of damage from 1968 to 1979 revealed that blackbirds annually destroyed less than 1% of the corn crops in Ohio, a 4- to 6-million dollar loss at 1979 prices. This total dollar loss is somewhat misleading because of the uneven distribution of damage among fields. Over 97% of the cornfields in Ohio receive less than 5% loss and these losses make up about 60% of the total loss in the State. Damage control efforts need to be primarily directed toward the remaining 3% of the fields that often incur losses greater than 5% and constitute about 40% of the total loss in the State. Most of these fields are located within 8 km (5 miles) of the marshes containing concentrations of roosting birds in late summer.

Successful programs to reduce damage must use one or more of a series of management measures, integrated with normal farming practices. The selection of management measures should be based on assessments of amount and type of bird damage likely to occur in a field and constraints imposed by farming practices. Management recommendations include (1) planting of hybrids with ear tips well covered by husks; (2) reduction of weed and insect populations to make the field less attractive to birds; (3) judicious use of mechanical frightening devices or a chemical frightening agent at the time birds initially damage the maturing corn; (4) the provision of natural or planted food and cover sites outside the corn; and (5) harvesting the crop, especially sweet corn, as early as possible.

Blackbirds have conflicted with man's activities in North America, especially the growing of corn and other small grain crops, throughout historical times. As early as 1667, Massachusetts Bay colonists had established laws in their attempt to reduce blackbird populations and alleviate damage to corn. One law, according to Henry David Thoreau ([1855] 1951), went so far as to require that "every unmarried man in the township shall kill six blackbirds . . . [and] as a penalty for not doing it, shall not be married until he obeys this order." Of course, since blackbirds "marry" at a much faster rate than humans, this control strategy was doomed to failure from the start and blackbirds are still very common birds in Massachusetts and elsewhere.

Pioneers moving west into the Great Lakes region faced similar blackbird problems. J. G. C. De Léry, a French explorer, noted in 1749 that blackbirds were so plentiful around western Lake Erie that people had to be assigned to guard ripening grain crops (Stirrett 1973). Indians had apparently been using such a guarding technique in this region for centuries (Cardinell and Hayne 1945).

Blackbirds have not been without their supporters either. Some colonists attributed failures of grain and hay crops in the 1740's to insect outbreaks following a large-scale destruction of grackles and crows after a bounty of three-pence a dozen had been established (Hartley 1922). And contemporary man, after enduring a long and dreary winter, often welcomes the migratory red-winged blackbird (*Agelaius phoeniceus*) back to the northern United States and Canada in early March as a colorful harbinger of spring, temporarily forgetting about the crop depredations of the previous fall.

Ohio, combining abundant populations of blackbirds with the fifth highest acreage of corn among the States of the United States, has long been a key State in the conflicts and controversies concerning blackbirds and agriculture. In 1926, when the U.S. Biological Survey made its first compilation of objectionable blackbird roosts, Ohio had more complaints than did any other State (McAtee 1926). During the 1950's, bird control committees were organized in some counties to deal with blackbird damage to corn, and research on the problem was initiated through the Ohio Agricultural Experiment Station (now the Ohio Agricultural Research and Development Center) and Department of Zoology and Entomology at Ohio State University. Information on the relationship of red-winged blackbirds to corn in Ohio was first summarized in 1960 in a special publication of the Ohio Agricultural Experiment Station (Giltz and Stockdale 1960).

In 1965 citizens and representatives from various governmental and private agencies met in Columbus, Ohio, to further discuss the problems caused by blackbirds. Out of this meeting, the Ohio Coordinating Committee for the Control of Depredating Birds was formed to promote and coordinate research, management, and educational activities throughout the State. Largely through the efforts of this organization, new research and management programs on blackbirds were developed by the Ohio Agricultural Research and Development Center and the U.S. Fish and Wildlife Service. These programs resulted in the accumulation of considerable new information on blackbirds in Ohio. Unfortunately, much of this information is generally unavailable to the farmer, extension agent, or pest control manager, because it is widely scattered in the scientific literature, governmental progress reports, and research files. Thus, a new report was sorely needed to draw the relevant information together, primarily to aid agriculturalists in their efforts to reduce blackbird damage to corn, but also to inform other scientists and the general public on progress to date.

The present publication has three objectives (each covered in a separate major section): (1) to provide a summary of the status and biology of blackbird populations in Ohio; (2) to summarize the information available on the pattern and magnitude of economic losses caused by blackbirds to corn in Ohio; and (3) to describe and evaluate the methods now available for combating blackbird damage to corn and to explain how these techniques should be integrated to reduce damage. The first two sections, on the biological and economic aspects of the problem, provide the foundation for the integrated management program presented in the last section.

Status of Blackbirds in Ohio

Three of the nine species of blackbirds found in the United States and Canada breed in Ohio: the red-winged blackbird, the common grackle (*Quiscalus quiscula*), and the brown-headed cowbird (*Molothrus ater*). In addition, the rusty blackbird (*Euphagus carolinus*), a species that nests farther north, is a common migrant in fall and spring. In this report I will discuss only the red-winged blackbird and common grackle, since these are the two species responsible for nearly all bird damage to standing corn in Ohio. The red-winged blackbird is emphasized because it is the major depredating species. Brief mention is also made of the starling (*Sturnus vulgaris*), a species introduced into North America from Europe in the 1890's, because it superficially resembles the native blackbird species with which it sometimes associates.

Red-winged Blackbird

The male red-winged blackbird, with his bright reddish-orange and yellow "shoulder patches," is a familiar springtime sight across rural Ohio, often observed on a fence post, cattail, or other suitable perch near ditches, hayfields, or marshes. The female redwing, often overlooked by the casual observer, is smaller and browner in color, and resembles a large sparrow.

The red-winged blackbird is the most common nesting bird in Ohio. In fact, judging by results of surveys of breeding birds conducted throughout North America, Ohio contains the greatest average density and probably the greatest total population of red-winged blackbirds of any State or Canadian Province (Dolbeer and Stehn 1979). An estimated 8 million redwings[1] are found in Ohio during the nesting season. Population densities are highest in the western and central sections of the State and lowest in the hill country of the east and southeast (Fig. 1).

Although the nesting season population is large, it appears to have declined somewhat in a recent 13-year period (1966-78) during which annual surveys were conducted in Ohio (Fig. 2). Nevertheless, current population levels are probably greater today than in the early 1900's. A study in Illinois, which should be fairly representative of the midwestern United States including Ohio, indicated that the redwing population doubled during 1908-58 (Graber and Graber 1963).

The redwing traditionally was considered a wetlands nesting bird, inhabiting primarily the marshes associated with the lakes and rivers of Ohio. In the last century, however, the redwing has adapted to the habitat changes brought about by man, and now commonly nests in hayfields, along roadsides and ditches, and in other upland sites. Although the highest nesting densities of redwings are still found in marshes, most nest in upland habitat because it is much more extensive than marsh habitat in Ohio (Dyer et al. 1972).

[1]Based on method described in Dolbeer et al. (1976*a*). Each redwing recorded on a North American Breeding Bird Survey in Ohio represents a breeding season density of about 0.3 redwing per km^2 (0.8 redwing per square mile).

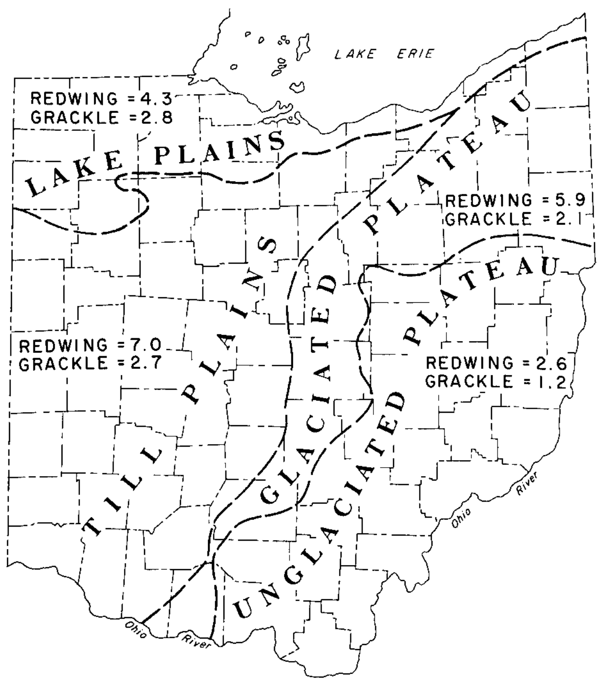

Fig. 1. Index (average number of birds recorded per 3-min roadside census in June) of red-winged blackbird and common grackle breeding population densities for the four major physiographic sections of Ohio. Ohio has the greatest overall breeding season density of redwings of any State of the United States or Canadian Province (from Dolbeer and Stehn 1979).

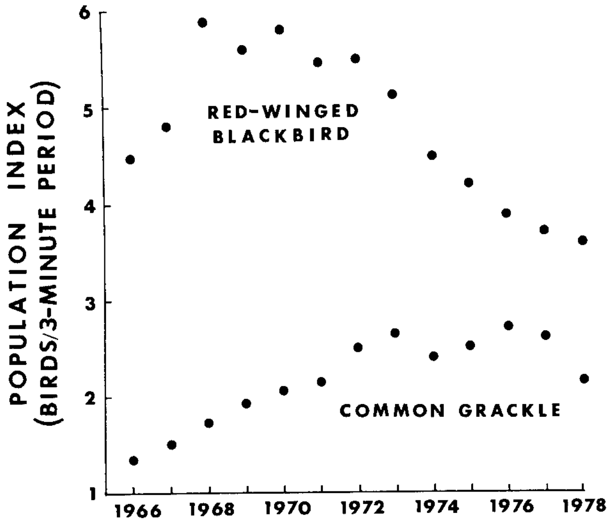

Fig. 2. Nesting-season population trends for red-winged blackbirds and common grackles in Ohio, 1966-78 (from Dolbeer and Stehn 1979).

The average annual cycle of red-winged blackbirds in Ohio (Fig. 3) is as follows: Nesting begins in late April, peaks in May and early June, and is usually completed by mid-July. A female requires about 3 or 4 days to build a nest, 3 or 4 days to lay her clutch of three or four eggs, 11 or 12 days for incubation, and 10 days to raise the nestlings to the fledgling stage. During this 4-week period, about 50% of the nests are destroyed, mainly by mowing of hayfields or by predators such as raccoons (*Procyon lotor*), mink (*Mustela vison*), snakes, and other birds. However, the female redwing is tenacious and often renests one or two times in an effort to raise a brood (Dolbeer 1976).

An average of at least 2.5 young are fledged per female during the nesting season (Dolbeer 1976); thus the nesting season population of 8 million birds probably doubles to about 16 million by late July (Fig. 3). The annual survival rate is about 60% for adult birds (at least 1 year old) and probably less than 40% for fledglings. Thus, there is a high annual turnover in the population and probably less than half the birds present in one summer were alive the summer before (Dolbeer et al. 1976*a*). Analysis of bird banding records indicates that less than 1% of the birds banded as fledglings live to be over 7 years of age.

By late July almost all fledglings are able to fly and feed independently of the adults. At this time, most redwings assemble in nighttime roosts (usually in marshes) containing from several hundred to several million birds. During the day, these birds forage out to 32 km (20 miles) from the roost in search of food. Redwings require an abundance of vegetable and insect food at this time of year because they are undergoing a complete molt and regrowth of feathers, and they are also building energy reserves for the fall migration southward (Wiens and Dyer 1975). These additional energy demands of individual birds coincide

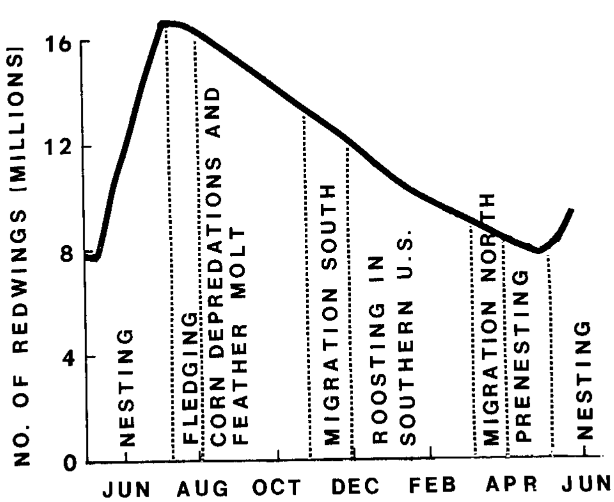

Fig. 3. The average annual cycle of red-winged blackbirds in Ohio. Population estimates derived from Dolbeer et al. (1976*a*).

with peak levels of total birds at the time the corn crop is maturing. Thus, the stage is set for the annual bird depredation problem that exists for some Ohio corn growers.

Red-winged blackbirds attack maturing corn ears during the milk and dough stages of development by slitting husks and pecking out the contents of the exposed kernels. Once the corn has hardened, it is relatively safe from redwings because their bills and digestive systems are not well adapted for handling hard, whole corn. The male redwing apparently does more damage to corn than does the smaller female. In some areas of Ohio corn may compose up to 75% of the diet of males but only 6% of that of females in August and September (Williams 1975; M. Miskimen and R. A. Dolbeer, unpublished report). In South Dakota the gizzards of male redwings contained 29% corn and those of females 9% corn in late summer (Mott et al. 1972).

The birds constituting a late summer roost in Ohio usually are birds that nested earlier in the summer in the surrounding townships and counties. Analysis of band recovery data in Ohio and adjacent States revealed that birds moved, on the average, about 58 km (36 miles) between their nesting locality in early summer and their roosting locality in late summer (Dolbeer 1978). In north-central Ohio there apparently is some interchange of redwings between Canada and the United States across the Lake Erie Islands (Miskimen 1976); however, corn-depredating redwings are usually locally produced birds, rather than far-ranging migrants.

Redwings begin their migration southward from Ohio in late October and November. Although a few hardy redwings overwinter in Ohio, most winter in roosting aggregations throughout the southern United States, where they intermingle with blackbird populations from throughout the eastern and midwestern States and Canadian Provinces (Burtt and Giltz 1977; Dolbeer 1978). For example, redwings banded in north-central Ohio during the summer and early fall have been recovered during the winter in eight States extending from North Carolina to Alabama (Fig. 4).

During the winter, redwings feed on a variety of weed seeds, rain-softened corn left in harvested fields, and tree fruits (Dolbeer et al. 1978). In some areas of the South, an important food source appears to be the seed of cocklebur (*Xanthium strumarium*), an insidious weed in soybeans and cotton. Thus, redwings causing economic loss to an Ohio farmer's cornfield in September may be providing some economic benefit to a Georgia soybean farmer in January. This is but one example illustrating the complexity of determining the net value or cost of blackbird populations to society.

Male redwings return to Ohio in late February to early March and the females arrive a few weeks later.

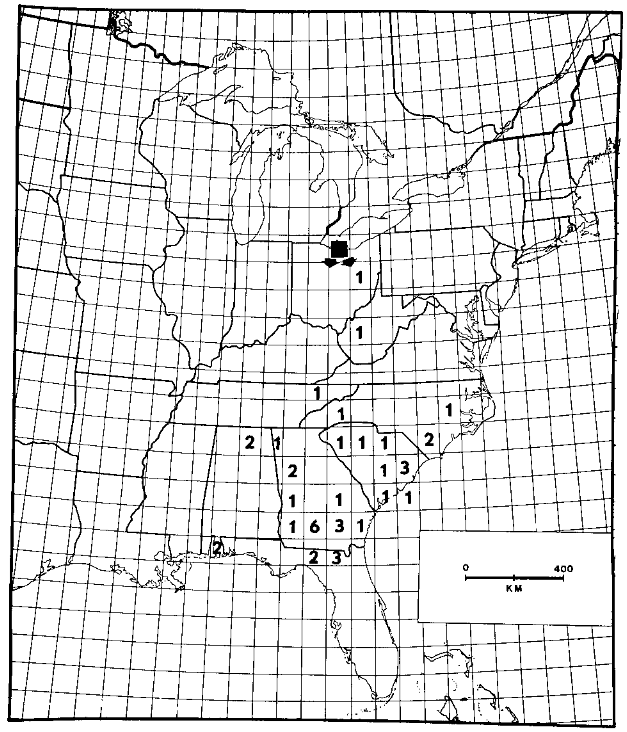

Fig. 4. Number of recoveries by degree blocks of latitude and longitude during the winter roost period for red-winged blackbirds banded during 25 April-15 October in north-central Ohio (from Dolbeer 1978).

Stockdale (1959) showed that waste corn left in fields from the fall harvest is an important food source at this time (Fig. 5). By early April, males are establishing territories in preparation for nesting later that month. Most birds return from their winter range to nest in the same locality where they nested or were hatched the previous summer (Dolbeer 1978).

Fig. 5. Red-winged blackbirds and common grackles often feed on waste corn, weed seeds, and insect pupae in harvested cornfields, both in the fall during migration and in the spring when they return from the southern United States. (Photo by J. T. Linehan.)

Common Grackle

The common grackle, easily identified by its black body, iridescent head feathers, and keel-shaped tail, is also a familiar bird to most Ohioans. The grackle is probably the fourth most abundant breeding bird in Ohio, following the redwing, house sparrow (*Passer domesticus*), and starling (Robbins and Van Velzen 1969; Dolbeer and Stehn 1979). Using the same approach I used for redwings, I estimated the population of grackles in Ohio during the nesting season to be about 2.1 million birds in 1978. The geographic pattern of population densities during the nesting season is similar to that of redwings (Fig. 1). Inasmuch as the annual cycle of the grackle is also similar to that of the redwing, only important differences are mentioned here.

There is no historical evidence to suggest that grackles have substantially increased in numbers over the past century as redwings have. However, annual surveys conducted in Ohio during 1966-78 suggest that, in contrast to redwings, populations have increased during this recent period, perhaps by 50% or more (Fig. 2). This strong increase in the past decade may be related to increased nesting habitat in suburban areas.

Nesting begins in mid-April for the grackle and ends in June (Erskine 1971). The nesting habitat is often decidedly different from that for redwings. Evergreen trees and shrubs are preferred although deciduous trees and bushes are often used and some marsh nesting occurs. Grackles often nest in small colonies in proximity to man; farmyards, residential neighborhoods, and cemeteries are favorite nesting locations. Grackles are commonly seen in spring and early summer, foraging for insects and weed seeds on lawns. At this time of year, grackles occasionally cause damage in newly planted cornfields by pulling up the sprouting corn.

During late summer and fall, some grackles roost with redwings in marshes; however, they usually prefer upland roost sites in deciduous or evergreen woodlots. Along with starlings, with which they sometimes associate, grackles can create nuisance situations when roosting in city parks, cemeteries, or residential areas.

Grackles sometimes damage corn in the milk and dough stages but more often cause damage later in the fall, when the corn has begun to harden. The grackle has a larger and stronger bill than the redwing and can feed more easily on hardened whole corn kernels. A study conducted in northern Ohio indicated that corn was not as important a food for grackles in late summer to early fall as it was for red-winged blackbirds (Williams 1975).

Grackles from Ohio overwinter in the southern United States in the same general localities as do red-winged blackbirds (B. Meanley, unpublished report). Corn left in harvested fields appears to be an important food source in winter (Dolbeer et al. 1978) as well as in spring when grackles first return to Ohio. Acorns (*Quercus* spp.) are also an important winter food.

Blackbird Depredation on Corn

Statewide Estimates of Loss

From 1968 to 1976 (except 1973), U.S. Fish and Wildlife Service personnel annually assessed blackbird damage to field corn in about 900 fields in 19 Ohio counties. Starting in 1977, the assessment was modified to include sampling in more counties so that statewide estimates of damage could be obtained. In addition, independent estimates of statewide loss were made in 1970 and 1971 by the U.S. Department of Agriculture. These assessments measured both primary damage (the actual corn removed by the birds) and secondary damage (molding or sprouting resulting from moisture entering the opened ear).

The results of these assessments, summarized in Table 1, indicate that the average annual loss to Ohio corn growers consistently has been less than 1% of the total crop. Primary damage has averaged 0.40% and secondary damage 0.18% The statewide estimates made in 1977-79 indicated a loss of 2.5 to 3.0 million bushels (3.8 to 6.8 million dollars) annually.

No systematic surveys have been made of blackbird damage to the approximately 6,000 ha (15,000 acres) of sweet corn in Ohio. The only information available comes from a survey of 31 sweet-corn fields under cannery contract in Erie and Huron counties in 1974, which revealed an average of 6.6% of the ears opened by birds and 0.6% of the corn removed (Dolbeer et al. 1976*b*). This sample was probably not representative of sweet corn statewide because the survey was in an area of historically above-average bird damage.

Distribution of Losses

Losses caused by insects, weeds, diseases, and fungi probably average over 20% of the total potential harvest of field corn in the midwestern United States (Jugenheimer 1976:261; Pimentel 1976; McEwen 1978), and harvesting procedures often leave 5% or more of the corn in the fields (Jugenheimer 1976:212). Compared with these losses, the average loss of corn to blackbirds in Ohio has not been great. However, the average loss is not so much of economic importance as is the distribution of loss among farmers. Blackbird damage to corn has not been evenly distributed over fields in Ohio; a small proportion of farmers are absorbing high losses, whereas the vast majority of farm-

Table 1. *Estimated percentage loss of field corn to blackbirds in Ohio, 1968-79.* Estimates in the years 1968 to 1976 are for 19 counties only and do not represent statewide losses. Estimates for 1977 to 1979 are for the entire State. Data are from unpublished reports, U.S. Fish and Wildlife Service, Animal Damage Control, Columbus, Ohio.

Year	Type of loss				
	Primary (%)	Secondary (%)	Total (%)	Total bushels lost (thousands)	Total dollars lost millions
19 Ohio counties only					
1968	0.41	0.16	0.57	365	0.44
1969	0.63	0.23	0.86	383	0.44
1970	0.28	—	—	—	—
1971	0.20	—	—	—	—
1972	0.36	0.50	0.86	456	0.24
1974	0.41	<0.01	0.41	221	0.74
1975	0.27	0.17	0.44	294	0.81
1976	0.27	0.07	0.34	300	0.54
Statewide[a]					
1977	0.59	0.08	0.67	2,500	3.80
1978	0.60	0.20	0.80	3,000	5.90
1979	0.67	0.04	0.71	2,700	6.78

[a] In addition to these estimates, Stone et al. (1972) and Stone and Mott (1973*a*), using a different procedure, estimate statewide losses in 1970 and 1971 at 0.28% and 0.29% of the crop, respectively. These estimated losses represented 650,000 to 930,000 bushels or about 0.9 to 1.2 million dollars annually.

ers escape economically serious damage. Of 7,237 fields examined in 19 counties during 1968-76, the percentages that suffered different percentages of loss were as follows:

Percent of crop lost to blackbirds	<1	1-5	6-10	>10
Percent of fields	85.4	12.1	1.5	1.0

Loss in only 2.5% of the fields exceeded 5%—the threshold level above which an investment in damage prevention usually is economically justified. These high-damage fields, representing 2.5% of the fields in the 19 counties sampled, incurred about 40% of the total loss in these counties. Statewide, the percentage of fields receiving over 5% loss is probably less than 2.5% because the 19 counties used in this survey contained most areas in the State that received heavy blackbird damage to corn.

All counties in Ohio experience some loss of corn to blackbirds, but greatest losses have been concentrated in a few counties where plentiful marsh habitat for roosting still exists. Damage in Ottawa, Sandusky, and Lucas counties, along the shores of Sandusky Bay and Lake Erie, has consistently been the heaviest in the State (Fig. 6). These 3 counties, of the 19 surveyed for damage in 1968-76, contained 62% of the fields where losses exceeded 5% and 77% of those where losses exceeded 10%. Other counties that have had localized high damage include Erie, Ashtabula, and Hamilton.

Almost all fields where loss exceeded 5% were within 8 km (5 miles) of a major marsh roost of blackbirds (Fig. 7). For example, Fig. 8 depicts the pattern of loss in cornfields recorded during 1968-76 in northeastern Sandusky County and in northwestern Ottawa County, where large roosts of blackbirds containing up to a million birds have been located in late summer and fall (B. Meanley, unpublished report). Average damage levels were over 9% in fields at distances of 3 to 5 km (2 to 3 miles) from the roosts but were less than 5% at 8 km (5 miles) and less than 2% at 16 km (10 miles).

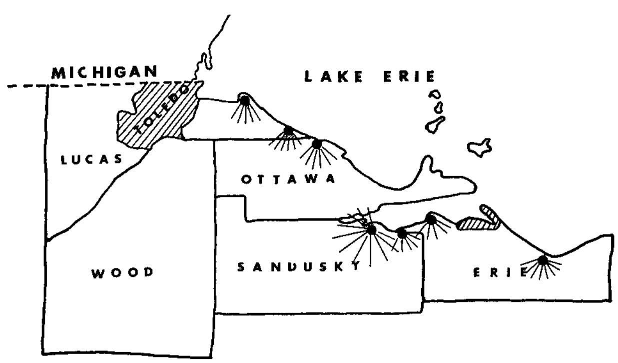

Fig. 6. The region along the shoreline of western Lake Erie, including Sandusky Bay, has historically received the highest blackbird damage to maturing corn in Ohio. This map depicts the general location of late-summer roost sites (solid circles) that have been active in the 1970's and shows the areas (radiating lines from roost sites) containing fields where losses from blackbirds have exceeded 5%.

Other studies have revealed similar patterns of loss in cornfields in relation to roost location (Dyer 1967; Martin 1977).

One source of economic loss these surveys do not reveal is the loss farmers could incur by shifting from corn to other crops, such as soybeans, because of high bird-damage levels near roosts. Such shifts may have occurred; for example in Erie, Sandusky, Ottawa, and Lucas counties, the number of cornfields per mile of road in traditionally high-damage areas near the marsh roosts is about half the number per mile in the southern parts of the counties away from the marshes (K. M. Coté and R. A. Dolbeer, unpublished report).

Beneficial Aspects of Blackbirds

Although considerable information has been gathered on the damage caused by blackbirds, few studies have been undertaken to examine beneficial feeding habits. During the nesting season, the estimated 8 million redwings and their nestlings in Ohio probably consume over 5.4 million kg (12 million pounds) of insects—an average of almost 53 kg/km^2 (300 pounds per square mile; Fig. 9).[2] Many of these insects, such as weevils (*Hypera* spp.), come from alfalfa fields, pastures, oat fields, and other crop fields (Stone 1973). In maturing cornfields, blackbirds often feed on insects such as earworms (Mott and Stone 1973), and rootworm beetles (*Diabrotica* spp.). In early spring, redwings consume European corn borers (*Pyrausta nubilalis*) while foraging in fields of corn stubble (Fankhauser 1962). However, not enough information exists to determine if this feeding actually provides any economic benefit.

Blackbirds may fulfill important roles in the environment in other ways. For example, redwings may be an important food source for valuable furbearers such as raccoon and mink. Also, nesting and roosting populations of redwings in a marsh may serve as a buffer for waterfowl and other wildlife by bearing some of the predation by various marsh predators (Eberhardt and Sargeant 1977). Only through additional research will it be possible to define more clearly the role, both detrimental and beneficial, of blackbirds in the environment.

[2]Based on adult requirement of 34.3 kcal/day (Brenner 1968) during the 90-day nesting season, of which about 20 kcal (4.6 g, dry weight) come from insects (Hintz and Dyer 1970; Stone 1973). Each nestling requires 395 kcal (90 g) of insects from hatching until fledging (Kendeigh et al. 1977). Thus, each female uses about 225 g of insects to raise 2.5 fledglings plus an additional 50 g for nestlings that die (Dyer et al. 1977). In addition, I assumed that after fledging each young bird adopts the adult diet (4.6 g insects per day) and feeds for an average of 30 days until the nesting season ends.

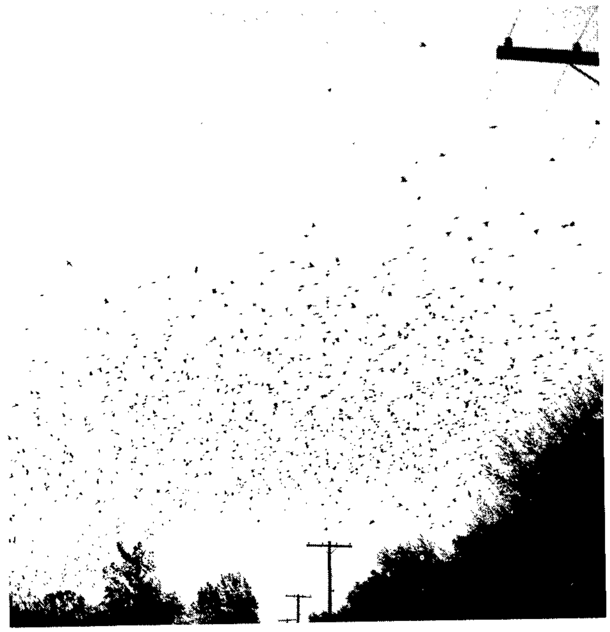

Fig. 7. Flightlines of blackbirds returning to their nighttime roosts are commonly seen at sunset in late summer. This photograph was taken near the marshes of Sandusky Bay, Sandusky County, Ohio. Most economically serious bird damage to corn occurs within 8 km (5 miles) of such marsh roosts.

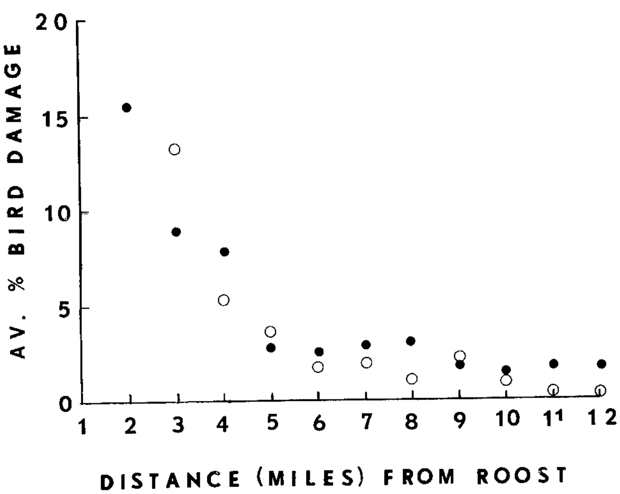

Fig. 8. Blackbird damage to maturing field corn in Ohio is mainly a problem near large marsh roosts. Open and solid circles represent fields associated with the Sandusky Bay roost, Sandusky County, and the Metzger Marsh roost, Ottawa County, respectively. See Table 1 for source of data.

Integrated Management Program to Reduce Blackbird Damage to Corn

There are two approaches to reducing blackbird damage to corn. The first is through population reduc-

Fig. 9. This female red-winged blackbird, perched on a cattail, is ready to feed her nestlings a bill-full of insects. Redwings in Ohio consume an estimated 5.4 million kg (12 million pounds) of insects during the nesting season. (Photo by Brooke Meanley.)

tion programs whereby steps are taken to substantially reduce the problem populations in an entire area to levels where the birds are no longer of economic concern. The second approach is to provide farmers with practical management measures and technical assistance that will enable them to reduce the damage in their individual fields to economically acceptable levels without resorting to mass population reduction. The first type of control is under the jurisdiction of governmental agencies because of the legal status of blackbirds and the magnitude of the control operations; the second type of control is in the hands of the individual farmer.

Using the sections on the biology of blackbirds and the economics of damage as a foundation, I now discuss both approaches with emphasis on the second. But first I offer a short explanation on the legal status of blackbirds in Ohio.

Legal Status of Blackbirds in Ohio

The public recognition of the benefits of native bird species, including blackbirds, and an international concern for the welfare of North American birdlife, resulted in the establishment of the Federal Migratory Bird Treaty Act in 1918, a formal treaty with Canada that was later extended to include Mexico. Under this Act of Congress, blackbirds are given legal protection in the United States but they may be killed "when found committing or about to commit depredations upon ornamental or shade trees, agricultural crops, livestock, or wildlife." Ohio law has the further restriction that no blackbirds may be killed on Sundays. Thus, blackbirds, though obviously pests in certain situations, must be treated somewhat differently from other more typical pests of man, such as insects or certain rodents.

Although all native birds are covered under the Migratory Bird Treaty Act, starlings, house sparrows, and domestic pigeons (*Columba livia*)—all species introduced from Europe—are not. These birds can be killed at any time in Ohio except on Sundays.

Population Management

As already noted, blackbird damage to corn occurs throughout Ohio, but the economically serious damage (i.e., to more than 5% of the crop) occurs mainly in fields within 8 km (5 miles) of a few large late-summer blackbird roosts located in marshlands. There are no known safe and economical means of reducing the roosting populations in these marshes without adversely affecting other wildlife or the marsh vegetation.

Some poisoning programs have been attempted in Ohio and elsewhere (Meanley 1971:59-60) to reduce roosting concentrations of blackbirds in late summer. These programs, in which baits are placed in plowed or open fields, have been largely unsuccessful. Although thousands of birds have occasionally been killed, the effect was small on the large flocks associated with roosts that sometimes contained over a million birds. Also, nontarget species of wildlife are often killed. The use of large decoy traps that often catch hundreds of birds per day also is ineffective for reducing these large flocks. Although these techniques are not recommended for reducing blackbird damage to corn in Ohio, both have proved successful and safe in reducing damage around feedlots caused by local populations of starlings (Besser et al. 1967; Palmer 1972).

One technique of population reduction has been developed in which a detergent solution, PA-14, is sprayed onto birds at night while they are in the roost. The detergent removes the protective oils from feathers, causing the birds, during wet, cold weather, to die of exposure (Lefebvre and Seubert 1970). Several million blackbirds (mainly grackles) have been killed with PA-14 in each of the past several winters in Tennessee and Kentucky. This technique could not be used for late-summer marsh roosts in Ohio because the air temperature is too high and because PA-14 is restricted to use in upland sites where no water pollution problems or nontarget wildlife hazards are likely to develop.

Even if an acceptable method of killing large numbers of blackbirds in these late-summer roosting populations were developed, the technique would probably not be a panacea to Ohio corn growers. Experience with the use of PA-14 in the southern United States has indicated that even successful roost treatments in which large numbers of birds have been killed have generally provided only short-term population reductions. Birds from surrounding areas soon repopulate the roosting area. Also, mass killing negates the beneficial aspects of the birds.

Another approach to population management successfully used in upland roost sites is that of dispersal of the roosting population through habitat alteration or harassment of the birds. These procedures, carried out by biologists in conjunction with the cooperation of local citizens, have been successful in dispersing or relocating roosting populations of up to 1 million birds. Although such dispersal may sometimes only move birds from one problem site to another, it has often effectively solved local problem situations (e.g., Good and Johnson 1978; Mott et al., unpublished report). Habitat modification and harassment have not yet been attempted on marsh-roosting populations; however, these methods may prove feasible in the future.

Integrated Management Program on the Farm

Since large-scale population reductions of blackbirds generally are neither feasible nor desirable in Ohio, most blackbird management programs must occur at the farm level. I here present step-by-step procedures that farmers can use to determine (1) when blackbird damage reduction programs are needed in their cornfields and (2) if control is needed, how the management tools should be coordinated with regular farming practices to optimize the return for each dollar spent on control. As holds true for most pest species, there are no panaceas for controlling blackbird damage to corn. In fact, because of the high degree of mobility and adaptability of blackbirds, their control is sometimes more difficult than that of conventional insect and weed pests. However, the management measures available, if used properly in an integrated fashion, can bring economically beneficial results for most farmers suffering heavy crop losses to birds.

The steps that can be taken by a farmer to reduce blackbird damage to corn (Fig. 10) are discussed separately later, but attention should be directed to the figure to understand the interrelations of the management steps. I emphasize that any blackbird damage reduction program should be integrated with regular farming practices for maximum benefit. Management procedures implemented as an afterthought or in isolation from other management practices are often ineffective.

Damage Assessment

An important first step to be taken, before planting if possible, is for the farmer to have an objective estimate of the amount of damage he can anticipate in a particular field. The anticipated damage level will govern the choice of crop, type of hybrid, planting strategy, and late-summer damage control methods. Although it is impossible to obtain a completely accurate prediction of how much damage will occur in a field, knowledge of the location of the field in relation to traditional roosting sites often provides the basis for a sound estimate of the potential damage. As I noted earlier, almost all fields in Ohio in which losses have exceeded 5% in recent years have been located within 8 km (5 miles) from marsh roosts—primarily those near Lake Erie. Thus, Fig. 8 can be used as a general guideline for estimating potential loss when the location of the nearest roost is known.

Objective estimates of damage levels in previous years for the same or nearby fields are another means of predicting future damage levels, because bird damage is fairly consistent from year to year within a locality. This information also provides a good base line for evaluating the effectiveness of management strategies. It is important that estimates be objective and apply to the entire field. Superficial surveys often overestimate bird damage for one or more of four reasons: (1) the conspicuousness of blackbird flocks tends to heighten the awareness of bird damage compared with other more subtle forms of loss caused by weeds, insects, and other pests; (2) the eye naturally seeks out the conspicuously bird-damaged ears; (3) bird damage is often most severe along field edges where an observer is most likely to check; and (4) raccoon or other mammal damage may be mistakenly considered bird damage (Fig. 11).

To objectively estimate bird damage in a cornfield, the estimator should pick 10 locations widely spaced throughout the field. For example, if a field has 100 rows and is 305 m (1,000 feet) long, the estimator should walk staggered distances of 30 m (100 feet) along every 10th row (e.g., 0-30 m in row 10; 30-60 m [100-200 feet] in row 20; and so on). In each of the 30-m lengths, the estimator should examine 10 ears (1 on alternate stalks along the row) and visually estimate

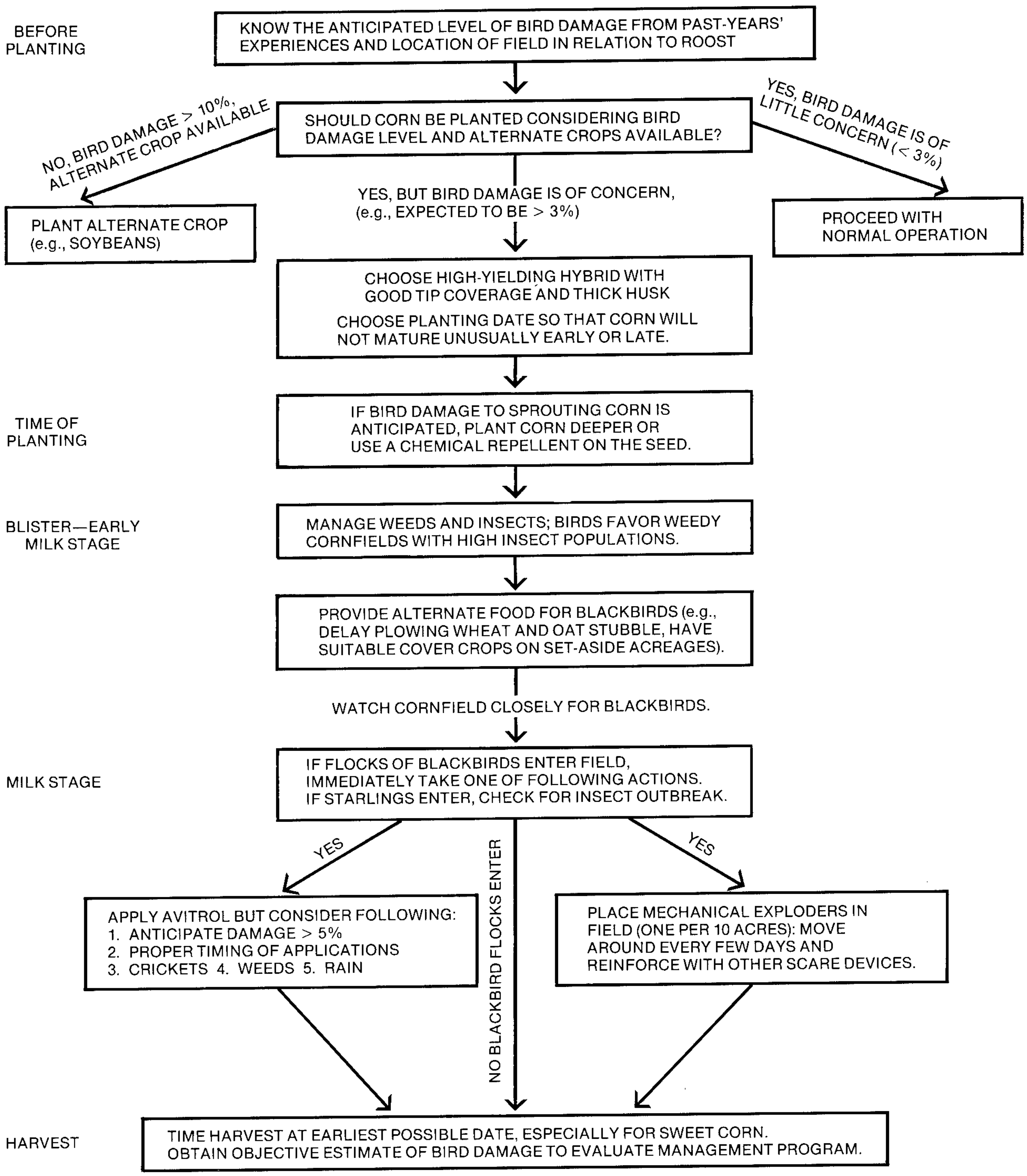

Fig. 10. Schematic chart of integrated management program on farm to reduce blackbird damage to maturing corn.

the amount of corn destroyed to the nearest 1% on each ear examined (e.g., 2% destroyed, 15% destroyed). For an average-size ear, six kernels represent about 1% of the corn on that ear. When finished, he simply determines the average damage on the 100 ears to estimate the percentage of the crop destroyed by birds.

Alternate Crops and Resistance of Different Hybrids of Corn

If anticipated bird damage is 5% or more, and especially if the field is located within a few kilometers of a traditional roost site and damage is potentially over 10%, the selection of an alternate crop, such as soybeans, might be the most cost-effective strategy. However, if the decision to grow corn is made, the first line of defense is the selection of a hybrid that is resistant to bird damage. Research has shown that hybrids of corn vary widely in their susceptibility to bird attack (Linehan 1977) and tip coverage by the husk is probably the single most important ear characteristic that determines this susceptibility (Thompson 1963; Fig. 12). Thus, if other desirable factors such as yield and maturation time are equal, the hybrid with the longest husk extension beyond the ear tip should be selected. In addition, the planting date should be scheduled, weather permitting, to ensure that the corn does not mature unusually early or late; early- or late-maturing fields are often the most likely to receive heavy damage.

Management to Reduce Loss of Sprouts

After planting, the first type of bird damage to corn can be to the sprouting seeds. This loss is caused primarily by grackles, pheasants (*Phasianus colchicus*), pigeons, and crows (*Corvus brachyrhynchos*). Rodents also remove sprouting corn. The problem is sporadic and generally of minor concern in Ohio (Stone and Mott 1973*b*), although occasionally the corn in a field may be damaged substantially. There are no objective estimates of loss for the State.

If his experience with a field indicates that sprout pulling by birds may be a problem, a farmer has three management measures that may reduce the loss. First, increasing the depth of planting can reduce damage. For example, in a test in Florida, plots with seeds planted 10.7 cm (4.2 inches) deep had 36% fewer missing sprouts than did plots with seed planted 2.0 cm (0.8 inch) deep (J. T. Linehan, unpublished report). Second, a repellent can be applied to the seed. Several products are presently registered in Ohio, including Mesurol 50% Hopper Box Treater for blackbirds and pheasants, Ortho Isotox Seed Treater-F for pheasants, and Stanley's Crow Repellent for crows. Third, bird-frightening devices can be used to repel the birds from the field. These devices are discussed later.

Fig. 11. Damage to corn by blackbirds (top) and raccoons (bottom) can sometimes be confused. Blackbirds usually slit or shred the husk and peck out the soft contents of kernels, leaving the kernel coat. Raccoons and squirrels chew through the husk and bite off the kernels.

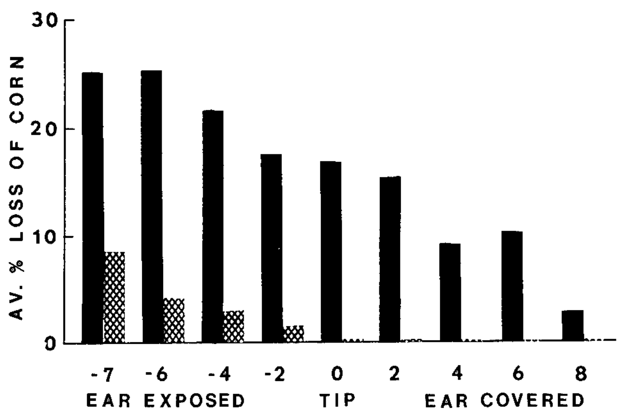

Fig. 12. In fields where blackbird damage is a problem, hybrids of corn with long tip coverage should be grown. The more extensive the coverage of the husk tip over the ear, the less bird damage occurs. The solid bars represent a test involving eight hybrids and high bird damage; the hatched bars, a test involving six hybrids and low damage. (J. T. Linehan, unpublished data.)

Management of Insects and Weeds

Recent studies on sweet corn indicate that blackbirds may often be initially attracted to maturing fields by insects. Flocks of birds may spend considerable time in these fields loafing and feeding on insects and weed seeds for a week or so before damaging any corn. Rootworm beetles in the corn-ear silk may be especially attractive to birds during this period. Thus the birds become habituated to feeding in the fields and can quickly change from insects to corn when the corn enters the vulnerable milk stage.

Experiments in which insect populations in sweet-corn fields were reduced with insecticides during the 1-week period before corn entered the milk stage showed that fewer birds visited the fields and less bird damage occurred to corn during the subsequent vulnerable period than in nearby untreated fields (Stickley and Ingram 1977; P. P. Woronecki, unpublished data). However, additional research is needed to better clarify the relationship between blackbirds and insects in corn before specific management recommendations can be made. In the interim, I can only suggest that the reduction of insect populations in sweet-corn fields generally makes these fields less attractive to blackbirds, and this decrease may in turn reduce bird damage. Although research to date has been limited to sweet corn, observations of birds in field corn, plus the similarities between sweet corn and field corn, suggest that the same principles would apply in field corn.

High weed populations may also increase the attractiveness of cornfields to blackbirds. Controlled experiments have not been conducted to evaluate the relation between weed populations and blackbird damage. But indirect evidence from other studies (Meanley 1971:45; Forbes 1974), plus general observations of the feeding and loafing activity of blackbirds in cornfields during the pre-damage period, indicate that there may be some relation. The control of weeds is also important for the effective use of Avitrol (discussed below) during the milk and dough stages of kernel development.

In summary, good management practices that reduce insect and weed populations in cornfields before the corn reaches the milk and dough stages of development not only increase yield per se but may also indirectly reduce the amount of blackbird damage. In addition, proper management and fertilization of corn produces healthy ears that accentuate the bird-resistant characteristics of the hybrid.

Alternate Food Sources

One point needs to be made before I address the additional management procedures available for repelling blackbirds from cornfields. A common objection voiced about management measures taken to keep blackbirds out of cornfields during the milk and dough stages is that these programs only move the damage to other fields. To some extent this is true, especially where the land is intensively farmed with corn and other row crops, and the birds have few alternate feeding and cover sites. If blackbird feeding on corn during the milk and dough stages of development is to be minimized, alternate food sources must be available outside the cornfields. Fortunately, there are numerous opportunities for providing this alternate food and cover because, as mentioned earlier, blackbirds consume a variety of food besides corn in late summer.

For example, oats and wheat in harvested fields can be important food for blackbirds in late summer (Hintz and Dyer 1970); thus, delayed plowing of small grain stubble can reduce blackbird feeding pressure on maturing corn. The provision of natural and planted plots of cover and wildlife food crops, such as millet, sorghum, smartweed (*Polygonum* spp.), and various grasses (e.g., foxtail or bristlegrass, *Setaria* spp.), on both public wildlife areas and private land, can be beneficial. Such "lure crops" have been used for years in parts of Canada and the United States to reduce waterfowl damage to maturing small-grain crops (Sugden 1976). As a general ecological principle, the more diversity in habitat types that can be maintained in regions of intensive agriculture, the more likely the destructiveness of pest species can be reduced to economically tolerable levels.

Repelling Birds from Maturing Cornfields

Once corn enters the milk stage, the farmer has essentially two management approaches to repel birds from his cornfields if flocks begin feeding on the corn. These choices involve the use of a chemical frightening agent, Avitrol FC-99, or of mechanical frightening devices. Three important factors—species of bird, cost of control measure, and timeliness of application—should be considered before deciding on a particular control procedure.

The first consideration is the correct identification of the species of bird in the field. Starlings superficially resemble blackbirds. However, flocks of these birds in cornfields usually signify an insect outbreak—often of armyworms (*Pseudaletia unipuncta*) or earworms (Stewart 1973). Although starlings sometimes are serious pests of man in fruit plantings or around feedlots, they can be beneficial in cornfields. Moreover, their presence can give the observant farmer an early clue to a developing insect problem. Starlings normally do not damage maturing corn.

Obviously, the value of the corn saved should be greater than the cost of the control method used. Thus, it is critical for a farmer to have a fairly accurate idea of the amount of damage he can anticipate in his field. At 1979 corn prices of about $2.25 per bushel, each 1% loss of yield to birds in a field yielding 100 bushels per acre costs the farmer about $2.25 per acre. Thus, if a farmer with yields of 100 bushels per acre is likely to incur a loss of only 3% or less, he cannot afford to use a control technique costing $7 per acre, even if it is nearly 100% effective.

Timeliness of application of the control technique is also very important. Once birds choose a field for feeding, they are likely to return repeatedly for several days (Cardinell and Hayne 1945; Dyer 1967). The longer they are permitted to feed in a field unmolested, the more difficult it becomes to force them out. Moreover, most damage to a field is often inflicted over a period of only a few days when the kernels are soft and full, and thus at their maximum attractiveness; consequently, control techniques have little value if they are applied after most of the damage has been done. For example, Bridgeland (1980) found that, on the average, field-corn fields in New York State incurred 71% of their total bird damage during only a 6-day period. This 6-day period usually began when the corn reached the milk stage, about 20 days after 50% of the ears in the field had silked.

Avitrol FC-99.—Avitrol FC-99 is cracked-corn bait in which 1 of every 100 particles is treated with the chemical, 4-aminopyridine (Fig. 13). The bait is applied to cornfields in swaths, usually by airplane, at the rate of 3.4 kg of cracked corn per hectare (3 pounds per acre) to one-third of the field. Since 3.4 kg of cracked corn contains about 205,000 particles, about 2,050 treated particles are distributed per treated hectare (800 per

Fig. 13. Avitrol FC-99, consisting of cracked-corn bait in which 1% of the particles are treated with 4-aminopyridine, is used to frighten blackbird flocks from cornfields. Bait must be kept from field edges so that it will not be consumed by nontarget birds such as this mourning dove (*Zenaida macroura*).

acre). The ingestion of one or more treated particles by a blackbird induces erratic flight, distress calls, and finally death. This behavior often causes the remaining birds of the flock to leave the field. Avitrol is classified as a restricted-use pesticide in Ohio; thus, the person applying it must have proper State certification.

Avitrol has been evaluated extensively in both field corn and sweet corn in Ohio and elsewhere (e.g., De Grazio et al. 1972; Dolbeer et al. 1976*b*; Stickley et al. 1976; Woronecki et al. 1979). Performance has been mixed; the results have been good in some instances and poor in others. Recent research has identified several key factors influencing the effectiveness of the product that farmers and applicators should be aware of.

The first consideration is the cost and effectiveness of the product in relation to the anticipated level of damage. The cost of three Avitrol applications by air (about $14.80 per ha [$6 per acre] in 1979) is generally equal to 2 or 3% of the cash value of the typical field-corn crop; thus, a farmer with only 3% or less potential damage cannot benefit economically from aerial applications of Avitrol, even if use of the product eliminates all damage. Avitrol has been used under exactly these conditions in Ohio in a number of instances (Woronecki et al. 1979). Since some bird damage occurs even under optimum treatment conditions, and since Avitrol appears to be less effective under low-damage than under high-damage situations, anticipated damage levels should be at least 5% before the product is used. Under special conditions (a high-yielding field, high-value seed, or sweet corn) the cost-benefit ratio, of course, changes.

The second consideration is the proper timing of initial and repeat baitings. The initial application should be made as soon as possible after flocks enter the field, when corn has reached the milk stage. Achieving this degree of timeliness has sometimes been a problem, however, because of scheduling difficulties with aerial applicators. One possible solution is for the farmer (with State certification in vertebrate pest control) to apply the initial baiting with ground-based calibrated equipment (a high-clearance tractor or even on foot with a cyclone hand seeder). This method is especially practical for fresh-market sweet-corn growers. Two repeat baitings spaced 5-7 days apart are generally recommended for field corn; however, the schedule of repeat baitings should remain flexible, depending on bird activity, corn maturity, and weather. Often only one or two applications are sufficient, but under conditions of prolonged bird activity, more than three applications at more closely spaced intervals may be needed.

The final consideration is an awareness of field and weather conditions that may reduce the effectiveness of Avitrol. An obvious problem is that weedy fields reduce the chances of birds finding particles of bait on the ground. Thus, the use of Avitrol should be integrated with a weed control program. A less obvious problem is that of ground insects removing bait. If crickets (*Gryllus* spp.) are conspicuous in a field, the farmer can expect the bait to disappear rapidly. Woronecki et al. (1979) measured a 98% bait loss to crickets in 2 days in some Ohio cornfields. Crickets generally select the untreated particles and leave the treated ones; however, the rapid reduction in total bait reduces the attractiveness of ground feeding for the blackbirds. Because cricket populations are difficult to control, more frequent baitings or another means of bird-damage control may be appropriate under these conditions. A further problem is that of heavy rains covering bait particles with soil or washing them into cracks in the soil. Thus, baitings should be scheduled, if possible, around periods of heavy rain.

Scare devices.—The propane exploder is probably the most common method used in Ohio for repelling blackbirds from corn (Fig. 14). This method may seem old-fashioned to some, but carefully controlled experiments have shown that the method can be effective. Tests in Sandusky and Ottawa counties indicated about 80% reductions in damage in fields where exploders were used (Stickley et al. 1972; J. T. Linehan, unpublished report). However, exploders are not always this successful. Birds can quickly become accustomed to noises, so a farmer must adjust and reinforce these devices to maintain their effectiveness. Three important adjustments are (1) to keep exploders elevated at tassel height, (2) to move the exploders around in the field every few days, and (3) to reinforce their effectiveness with other scare devices such as those mentioned below.

Fig. 14. Propane exploders can be effective in driving birds from cornfields. For best results, they should be elevated near tassle height, moved around periodically, and occasionally backed up with other scare devices.

A propane exploder costs about $150 and should last for at least 5 years. If one exploder is used for 4 ha (10 acres), the cost is less than $7.40 per ha ($3 per acre) per year excluding labor for operation.

By shooting a .22 caliber rifle just over the top of the corn, a person on a stand, stepladder, or truck bed can often frighten birds from a field of up to 16 ha (40 acres). Obviously, care must be taken when shooting in this manner, and the use of limited-range cartridges is recommended. The use of shell crackers, 12-gauge shotgun shells containing firecracker projectiles that explode after traveling up to 165 m (150 yards), can also be effective. A shotgun patrol, using standard bird shot, can often kill a few birds and help to reinforce other scare devices, but usually this technique is not as effective in moving birds as the other devices which have greater range.

A variety of other bird-frightening devices, including electronic noise systems, helium-filled balloons tethered in fields, radio-controlled model planes, and various types of scarecrows are also occasionally used in cornfields. The most popular of these, at least for sweet corn, appears to be electronic noise systems such as Av-Alarm. These techniques have not been evaluated experimentally in Ohio.

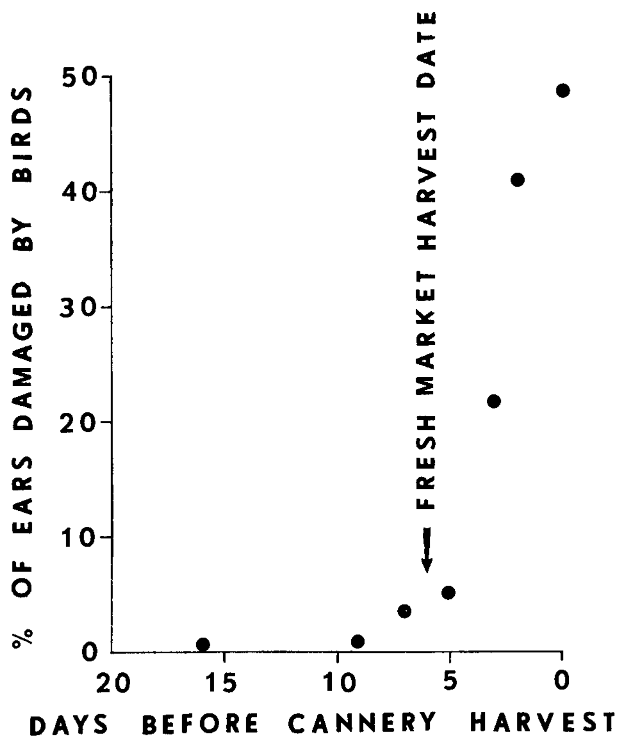

Fig. 15. Timing of harvest can be critical for keeping blackbird damage to a minimum in sweet corn. Most damage occurs during the 5-day period between the optimum time of fresh-market harvest and cannery harvest. These data are from two fields in Ottawa County, Ohio. (K. M. Coté, unpublished report).

Timing of Harvest

As shown in Fig. 15, the timing of harvest can have a dramatic influence on the level of bird damage in sweet corn and may be the most effective management tool available for reducing bird damage in this crop. Blackbirds are apparently sensitive to the level of maturity of a field of sweet corn and inflict most damage during the critical period between optimum fresh-market harvest and cannery-corn harvest.

For example, in a test in Ottawa County, Ohio, 12 experimental fields were assessed for bird damage on the day of fresh-market harvest, 7 days after an average of 50% of the silks were brown. Although flocks of up to several hundred birds had been frequenting most of the fields for 1 to 2 weeks, less than 1% of the ears had been damaged by birds in any field. However, only 5 days later, at cannery-harvest date, the 12 fields averaged 26% of the ears damaged and in 4 fields, over 50% of the ears were damaged (Stickley and Ingram 1977).

Blackbirds obviously like sweet corn at about the same stage of maturity as humans do. If the corn can be harvested as early as possible, especially if birds have initiated damage, the total damage can be reduced considerably.

Although the adjustment of harvest date cannot help field-corn growers reduce blackbird damage during milk and dough stages, harvesting at the earliest possible date after the corn has dried sufficiently can reduce damage by flocks of grackles. These fall flocks do not normally inflict the high levels of damage that late-summer flocks cause when the corn is soft, but in some fields this fall damage can be significant. In a study in northern Ohio, birds removed an average of 0.3% of the corn from nine unharvested fields in early October, and one of these fields sustained a 3.8% loss. In another field, grackles removed 1.5% of the corn during 1 day in early November (P. P. Woronecki, unpublished data).

Conclusions and Recommendations

The red-winged blackbird and common grackle are adaptable birds that appear to thrive in the habitats available today in Ohio. Some changes in population numbers of these species may occur over the years, such as the current decline exhibited by the redwing population, but as long as corn is grown in Ohio, there will most likely be conflicts between blackbirds and people.

I conclude that under present circumstances solutions to the conflict between blackbirds and corn growers in Ohio should not involve programs aimed at direct reduction of blackbird populations. In addition to the fact that no safe means are presently available for substantially reducing late-summer roosting populations, the reasons for this conclusion are as follows: (1) serious depredation problems are localized near major blackbird roosts and generally affect relatively few farmers, yet blackbird populations from entire regions of Ohio and adjacent States would be affected by population reduction programs; (2) blackbirds are well adapted to habitats available, have high reproductive rates, and are quite mobile, thus population reduction programs would have to be repeated frequently to provide any lasting impact; and (3) population reduction programs do not consider the aesthetic or economically beneficial attributes of blackbirds which, although not presently quantified, may be important.

Since most programs to reduce blackbird damage to corn are carried out on the individual farm, I have emphasized a series of practical management measures and general guidelines for their use. No single management procedure prevents all corn damage, but control can be of significant help if available methods are used in a conscientious manner and integrated with normal farming practices to bring about the maximum return for each control dollar spent.

Obviously, additional research is needed to improve many of the available management measures. However, to make major advancements in such techniques as chemical and mechanical repellents, cultural practices and damage-resistant hybrids, increased effort will be necessary in some basic areas of research. Specifically, major improvements are needed in our understanding of the key factors that influence blackbirds in their selection of cornfields in which to feed and in our ability to predict levels of damage for particular fields. Also, we need a better understanding of the relationship between the effectiveness of various damage-reduction measures and the availability of alternative food sources for the birds. Lastly, we need quantitative data on the possible beneficial aspects of blackbird populations so that we can more accurately assess the full impact of these birds in the environment.

Government Technical Assistance

Because blackbirds are native bird species covered under the Federal Migratory Bird Treaty Act, the prime responsibility for management and research comes under the jurisdiction of the U.S. Department of the Interior, Fish and Wildlife Service. Important contributions are also made by State agencies involved in agricultural sciences and wildlife management.

Research

In Ohio, the U.S. Fish and Wildlife Service maintains a research field station in Sandusky to deal with various bird-people conflicts. The Ohio Field Station, along with several other research stations dealing with bird problems in other parts of the United States, is a part of the Denver Wildlife Research Center, the U.S. Department of the Interior's major facility for animal damage control research. The College of Agriculture, School of Natural Resources, Ohio State University, in conjunction with the Ohio Agricultural Research and Development Center, also supports research on blackbird problems in Ohio.

As new, effective, and safe control methods are developed, they are made known to farmers and the public. The goal of the research and management programs is to develop means of effectively managing blackbird problems in economical and environmentally safe ways that are acceptable to the public.

Services and Information

In Ohio, the U.S. Fish and Wildlife Service, Division of Animal Damage Control, currently maintains a main office in Columbus (Federal Building, Room 405, 200 North High Street) and a district office in Sandusky (c/o Plum Brook Station, Taylor and Columbus Roads) to assist farmers and others in implementing blackbird damage reduction programs. Most other States also have Animal Damage Control offices. The addresses can be supplied by county agricultural agents.

Acknowledgments

This publication draws upon the research and management efforts of many people, most of whom are named in references at the end of this report. I specifically acknowledge the work and help of my colleagues, past and present, in the U.S. Fish and Wildlife Service in Ohio who have produced the major share of the assembled information: D. A. Andrews, M. I. Dyer, W. J. Francis, C. R. Ingram, M. E. Laderach, J. T. Linehan, C. L. McGriff, J. L. Seubert, R. N. Smith, R. A. Stehn, A. R. Stickley, Jr., R. O. Winters, and P. P. Woronecki. T. M. Stockdale, Extension Wildlife Specialist, Ohio State University, has also provided much information and has been helpful in many other ways as have M. L. Giltz and W. B. Jackson, professors at Ohio State University and Bowling Green State University, respectively. Finally, I acknowledge the Ohio Coordinating Committee for the Control of Depredating Birds, whose support and encouragement have been instrumental in maintaining research and management programs in Ohio. I especially single out Chairmen D. W. Simeral and J. W. Steckel and farmers, L. C. Gibbs, C. Oyler, L. E. Toll, and W. E. Warner. D. G. Meeker provided the sketch on the front cover.

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