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History of Regulations, Policy, and Research Related to Conflicts between Blackbirds and People

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CHAPTER 1

History of Regulations, Policy, and Research
Related to Conflicts between Blackbirds and People

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The United States and Canada have invested substantial resources over the past 60 years for developing methods to reduce blackbird (Icteridae) damage to agricultural crops, to manage large winter roosts that create nuisance and public health problems, and to mitigate conflicts with endangered species. It is an indication of the challenging nature of the conflicts with these abundant, highly mobile birds that we are still attempting to improve existing methods and develop new approaches to mitigate the problems. Scientists have tested chemical frightening agents and repellents, mechanical scare devices, bird-resistant sunflowers, decoy crops, habitat management, population management, and cultural modifications in cropping. Methods development proceeds within a framework of federal and state laws and agency policies. Here, we review key laws and policies that guide scientists focused on methods development, and we briefly recount the history of applied blackbird research in the United States and Canada.

1.1 MIGRATORY BIRD TREATY ACT

The Migratory Bird Treaty Act (MBTA) of 1918 is the legal framework governing decisions on management and conservation of native migratory birds in the United States and Canada. The US federal law was first enacted in 1916 in order to implement the convention for the protection of migratory birds between the United States and Great Britain (acting on behalf of Canada). Later amendments implemented treaties between the United States and Mexico (1936), Japan (1972), and the Soviet Union (1976, now Russia).

Blackbirds are native migratory birds and thus come under the jurisdiction of the MBTA. The statute makes it unlawful without a waiver to pursue, hunt, take, capture, kill, or sell birds listed therein (“migratory birds”). The statute does not discriminate between live and dead birds and also grants full protection to any bird parts including feathers, eggs, and nests.

1.1.1 U.S. Depredation Order for Blackbirds

Blackbirds are given federal protection in the United States and Canada under the MBTA. Both countries, however, allow protection of resources and human health compromised by blackbirds, including the use of nonlethal and lethal methods. Blackbirds may be legally killed in the United States under the *Depredation Order for Blackbirds, Cowbirds, Grackles, Crows, and Magpies* (50 CFR 21.43), when found “committing or about to commit depredations upon ornamental or shade trees, agricultural crops, livestock, or wildlife, or when concentrated in such numbers and manner as to constitute a health hazard or other nuisance.”

In 2010, rusty blackbirds (*Euphagus carolinus*) were removed from the depredation order and given full protection by the MBTA, as has always been the case for the tri-colored blackbird (*Agelaius tricolor*) (U.S. Department of Interior 2010). Another revision was that nontoxic shot must be used when taking birds by shotgun under the authority of CFR 21.43. Moreover, persons taking blackbirds under CFR 21.43 must provide the U.S. Fish and Wildlife Service (FWS) the following information at the end of each calendar year: name and address, species and number taken, month when birds were taken, state and county where birds were taken, and a general explanation of why the birds were taken. Some states and municipalities have additional restrictions on killing blackbirds. European starlings (*Sturnus vulgaris*), which often associate with blackbirds during the nonbreeding season, are not native to North America and are not protected by the MBTA.

1.2 CANADIAN WILDLIFE SERVICE

The Canadian Wildlife Service is Canada’s national wildlife agency. Its core area of responsibility is the protection and management of migratory birds and their nationally important habitats.

Wildlife management in Canada is a constitutionally shared responsibility among the federal, provincial/territorial, and aboriginal governments (Government of Canada 2016a). In Canada, most species of birds are protected under the Migratory Birds Convention Act, 1994 (MBCA). The MBCA was passed in 1917 and updated in 1994 and 2005 to implement the Migratory Birds Convention (Government of Canada 2016b).

A person who owns, leases, or manages land, however, can seek a permit from provincial authorities to scare or kill migratory birds that are causing or are likely to cause damage. Any person may, without a permit, use equipment other than an aircraft or firearms to scare migratory birds. A permit must be acquired to use aircraft or firearms for this purpose.

In situations where scaring migratory birds is not a sufficient deterrent, a permit can be obtained to kill offending birds in a specific time frame and area. A person who controls an area of land may seek a permit to collect and destroy the eggs of migratory birds and to dispose of the eggs in the manner provided in the permit. Where a permit is issued to kill migratory birds that are causing or are likely to cause damage to crops, no person mentioned in the permit shall shoot migratory birds elsewhere than on or over fields containing such crops or shall discharge firearms within 50 m of any water area.

1.3 U.S. DEPARTMENT OF AGRICULTURE

In the United States, the U.S. Department of Agriculture (USDA) Animal and Plant Health Inspection Service (APHIS) Wildlife Services (WS) provides federal leadership and expertise to resolve wildlife conflicts to allow people and wildlife to coexist. The WS program's primary statutory authority is found in the Animal Damage Control Act of 1931. This act gives WS broad authority to investigate, demonstrate, and control mammalian predators, rodents, and bird pests. In 1985, Congress transferred the Animal Damage Control Program (now WS) from the Department of the Interior to the USDA. Another amendment in 1987 gave WS the authority to enter into agreements with public and private entities in the control of mammals and birds that are a nuisance or are reservoirs for zoonotic diseases (Tobin 2012).

The WS Office of the Deputy Administrator, located in Washington, DC, provides national program oversight, with field operations directed from the Eastern Regional Office in Raleigh, North Carolina, and the Western Regional Office in Fort Collins, Colorado. The National Wildlife Research Center (NWRC), headquartered in Fort Collins, is the methods development arm of the WS program. The WS program is aimed at helping to resolve wildlife damage to a wide variety of resources and to reduce threats to human health and safety. Funding for the WS program is a combination of federal appropriations and cooperator-provided funds.

1.4 NATIONAL ENVIRONMENTAL POLICY ACT

In 1969, the National Environmental Policy Act (NEPA) was enacted to establish a national framework for protecting the environment (U.S. Environmental Protection Agency 2015; U.S. Department of Interior 2016). NEPA was intended to assure that all branches of government give proper consideration to the environment prior to undertaking any major federal action that significantly affects the environment. NEPA compliance involves the development of an environmental assessment (EA) to determine if the proposed federal action will have a significant effect on the environment. If the EA shows that the federal action will not have a significant effect on the human environment, then a Finding of No Significant Impact is prepared. If the EA determines that a federal action will have a significant effect on the human environment, then an Environmental Impact Statement (EIS) is prepared. An EA is typically a shorter document than an EIS, and its preparation offers fewer

opportunities for public comment or involvement than an EIS. EAs have fewer procedural requirements and therefore take less time and fewer resources to prepare on average than an EIS.

Preparation of an EIS requires public input, and it must be available for 30 days for public review and comment before a final decision is made. Generally, an EIS includes detailed discussions of the following: a statement of the purpose and need for the proposed action, a description of the affected environment, alternatives to the proposed action, and an analysis of environmental impacts and ways to mitigate such impacts. Failure to follow the NEPA process or providing inadequate documentation to support a particular action can result in legal actions to rectify these errors (Cirino 2016).

In 1997, WS completed a national EIS that addressed the need for wildlife damage management (U.S. Department of Agriculture 1997). States with blackbird populations that could impact human endeavors have developed EAs that analyze management options for reducing damage and health hazards (e.g., U.S. Department of Agriculture 2007 and 2015).

1.5 WILDLIFE SERVICES DECISION MODEL

When requests for assistance are received, WS employees are required to use the WS decision model to determine the appropriate damage management strategy (Policy Directive 2.201; Slate et al. 1992; U.S. Department of Agriculture 2014). Requests from the public for assistance include nuisance wildlife, wildlife damage to crops and livestock, and wildlife hazards related to public safety.

If a cursory review of the request is deemed an actionable problem within the purview of WS, the extent and magnitude of the damage is detailed during a site visit (Figure 1.1). The next step is to evaluate available methods for practicality, including legal, administrative, and environmental considerations. This evaluation sometimes occurs during the development of an EA or, less commonly, an EIS. Assuming management options are available, biologists formulate a control strategy that usually includes practical nonlethal methods as a first option. Lethal methods are sometimes an alternative when deemed to be appropriate and to show promise for resolving the conflict (e.g., Dolbeer et al. 1993).

The costs and benefits of using short-term versus long-term solutions and the relative effectiveness of a method or combination of methods are considered. Technical assistance provided includes advice, information, and materials for use in managing the damage problem. Alternately, when funding is available, a wildlife damage specialist can provide direct on-site control, which is particularly appropriate when hazardous materials are used, when endangered species are known to inhabit an area, or when public property is involved. Finally, the wildlife specialist normally monitors the results during site visits to determine effectiveness and whether additional or alternate methods are needed.

1.6 BLACKBIRD RESEARCH IN CANADA

From the mid-1960s to the 1980s, university scientists and graduate students at Carleton University, Ottawa, Ontario, Canada; the Macdonald campus of McGill University, Ste-Anne-de-Bellevue, Quebec, Canada; and University of Guelph, Guelph, Ontario, Canada, conducted the majority of blackbird research related to management of damage to corn and sunflower. This research was largely funded by Agriculture Canada, le Ministère de l'Agriculture du Québec, and the Ontario Department of Agriculture and Food. These scientists published results from numerous studies focused on blackbirds, including roost dynamics, sex-specific food habits, economic and ecological impacts, use of surfactants to manage populations, movement patterns, use of decoy traps, and indirect assessment of damage (e.g., Dyer 1967; Bendell et al. 1981; Weatherhead 1982; Weatherhead et al. 1982). The use of decoy traps and surfactants (wetting agents) to reduce blackbird

Figure 1.1 The USDA Wildlife Services decision model provides a step-by-step process to address requests for assistance with wildlife damage.

populations were found to be ineffective (Weatherhead et al. 1980a, 1980b). Weatherhead et al. (1982) provided a method of indirectly assessing bird damage and concluded government estimates of bird damage to corn were grossly overestimated. One of the lead researchers, Patrick J. Weatherhead, moved to the University of Illinois at Urbana–Champaign, where he studied the behavior and ecology of birds, including red-winged blackbirds, for many years (e.g., Weatherhead 2005; Weatherhead and Dufour 2000; Weatherhead and Sommerer 2001).

Scientists at the Canada Department of Agriculture Research Station in Winnipeg, Manitoba, contributed information on food habits of red-winged blackbirds in corn and sunflower and provided some of the earliest data showing that blackbirds are attracted to sunflowers (Bird and Smith 1964).

A 5-year project to study the biology and management of blackbirds in relation to corn and sunflower was funded by the Canada/Manitoba Subsidiary Agreement on Value-Added Crop Production (Harris 1983). The project concentrated on testing propane cannons, decoy traps, acoustic devices, pyrotechnics, shotguns, a chemical frightening agent, and bird-resistant sunflower. Harris (1983) reported that acoustic devices were most effective when combined with shotguns and pyrotechnics, whereas decoys traps and a chemical frightening agent were found to be ineffective. Harris participated in an early test of Bird-Resistant Synthetic Sunflower Variety 1 (BRS1), which was developed to thwart blackbird damage (Mah and Neuchterlein 1991). The data showed that blackbirds preferred to eat a commercial oilseed sunflower variety rather than BRS1, which had a lower oil content.

1.7 BLACKBIRD RESEARCH IN THE UNITED STATES

The WS-NWRC is the lead research institution in the United States for developing and evaluating wildlife damage management methods that emphasize practicality, environmental safety, cost-effectiveness, and wildlife stewardship. Scientists study human–wildlife conflicts, wildlife damage, nuisance and pest animals, wildlife disease, invasive species, overabundant wildlife, and overall ecosystem health. To accomplish certain aspects of this research, scientists at headquarters in Fort Collins, Colorado, and field stations throughout the United States collaborate with WS state operational programs, other state and federal agencies, universities, private industries, and non-governmental organizations. For example, WS cooperated with Utah State University to establish the Jack H. Berryman Institute to enhance education, extension, and research on human–wildlife interactions. This institute was later expanded to include an eastern counterpart at Mississippi State University.

Other university-based scientists contributed important ideas toward our understanding of the impact of blackbirds on crops. For example, Wiens and Dyer (1977) advocated a model-based, indirect approach that included population dynamics, bioenergetics, and diet composition to estimate bird damage to ripening crops. Dyer and Ward (1977) reviewed various bird management strategies and concluded that a single tool approach cannot be used across all bird damage scenarios. Over the last four decades, these concepts were refined and promulgated in numerous publications (e.g., Dolbeer 1980; Dolbeer 1990; Peer et al. 2003; Linz et al. 2011; Linz et al. 2015; Dolbeer and Linz 2016).

1.7.1 National Wildlife Research Center Headquarters

The NWRC is headquartered at the Foothills Campus of Colorado State University (CSU) in Fort Collins (Figure 1.2). Approximately two-thirds of NWRC’s 150-person staff is in Fort Collins; the remainder are at field stations in eight states, where they address a range of wildlife damage management issues.

Figure 1.2 The USDA Wildlife Services National Wildlife Research Center (NWRC) headquarters is located on the foothills campus of Colorado State University, Fort Collins, Colorado, USA. The NWRC has eight field stations that conduct research on specific human–wildlife interaction issues.

SIDEBAR 1.1 HISTORY OF THE NATIONAL WILDLIFE RESEARCH CENTER

- 1886: C. Hart Merriam established the Division of Economic Ornithology and Mammalogy at the United States Department of Agriculture (USDA) and, with A.K. Fisher, pioneered research on methods for controlling damage to agriculture by wildlife.
- 1905: The USDA Control Methods Research Laboratory in Albuquerque, New Mexico, conducted field and laboratory experiments on various methods for controlling rodent damage to agriculture.
- 1920: The headquarters were moved from Albuquerque to Denver, Colorado, in 1920 and research was begun on the food habits of wildlife and diseases that affected wildlife. A decade later, the USDA Food Habits Laboratory was established to study the food habits and economic impact of predators, other mammals, and birds in the western United States.
- 1940: The Fish and Wildlife Service (FWS) was created within the U.S. Department of the Interior (USDI), and the Denver Wildlife Research Laboratory was formed under the FWS. Scientists conducted food habits studies and developed animal control methods.
- 1948: The Denver Wildlife Research Laboratory initiated a study of blackbird damage to rice in Arkansas. A one-person field station was maintained at Stuttgart from 1950 to 1955 (Meanley 1971).
- 1956: The FWS was reorganized in 1956 to include the Bureau of Sport Fisheries and Wildlife, which expanded research to include studies of relationships between wildlife populations and their habitats.
- 1959: The Denver Wildlife Research Laboratory was renamed the Denver Wildlife Research Center (DWRC) and expanded to study the effects of pesticides on wildlife through the Pesticide–Wildlife Ecology Program.
- 1960: The Section of Animal Damage Control Studies was formed at the FWS Patuxent Wildlife Research Center (PWRC) in Laurel, Maryland, to investigate wildlife damage issues in the eastern United States. Field stations were established in Gainesville, Florida; Newark, Delaware; and Sandusky, Ohio. All personnel and field stations were transferred administratively to the DWRC in 1976.
- 1967: DWRC scientists took the lead in a long-term international research program in cooperation with the US Department of State's Agency for International Development aimed at discovering, developing, and applying new and better methods to protect world food crops from the ravages of "rats, bats, and noxious birds." Numerous DWRC scientists took assignments lasting 1 to 5 years in various countries in Africa, Asia, and Central and South America. This program ended in 1993.
- 1970s: The U.S. Environmental Protection Agency's (EPA) registrations for several important chemical tools for managing wildlife damage were canceled, resulting in renewed efforts at the DWRC to develop new, more effective chemical methods for wildlife damage management. Further, the DWRC assumed nationwide leadership for all wildlife damage management research within the FWS.
- 1980: The DWRC merged with the FWS's National Fish and Wildlife Laboratory. The DWRC's research included a broad array of vertebrate systematic investigations, ecologic and zoogeographic studies, and marine mammal research.
- 1985: Congress transferred the USDI's Animal Damage Control Program, including part of the DWRC and some of its field stations involved in wildlife damage research, from the FWS to the USDA's Animal and Plant Health Inspection Service (APHIS). The sole focus of DWRC research then became wildlife damage management.
- 1990 to present: In the 1990s, a state-of-the-art facility was planned and developed on the Colorado State University Foothills Research Campus in Fort Collins. The DWRC was closed and all personnel at DWRC were transferred to Ft. Collins by 1999. Due to the national and international scope of research conducted at this facility, a more fitting name was chosen—the National Wildlife Research Center (NWRC). Facilities on the campus include offices, chemistry laboratories, indoor and outdoor animal research facilities, and a Biosafety Level 3 building for studying diseases transmitted by aerosols or the causes of severe disease.

1.7.2 Blackbird Research—Headquarters

In 1976, all federal animal damage control research was consolidated under the DWRC within the U.S. Department of Interior (USDI) (Sidebar 1.1). Prior to that time, scientists at the Patuxent Wildlife Research Center, Laurel, Maryland; Ohio Field Station, Sandusky, Ohio; and Florida Field Station, Gainesville, Florida, made important scientific contributions in relation to blackbird damage to corn and rice (e.g., Dolbeer 1980, 1990; Meanley 1971). The Ohio Field Station and Florida Field Station continued to research blackbird damage to corn and rice, respectively (e.g., Brugger and Dolbeer 1990; Holler et al. 1982). Concurrently, scientists at DWRC headquarters in Denver focused on corn damage in the Dakotas in the 1950s through the 1970s, and in the late 1970s and 1980s on sunflower damage in North Dakota, South Dakota, and Minnesota (e.g., DeGrazio 1964; Guarino 1984). Scientists during this time spent significant resources over two decades developing the use of 4-aminopyridine, a chemical frightening agent, for protecting ripening corn and sunflower (e.g., Besser and Guarino 1976; Knittle et al. 1988). The product produced inconsistent results due to a variety of reasons, including dense crop canopies obscuring the baits, loss of chemical on baits, poor bait acceptance, and insufficient dosage due to broken bait particles (Knittle et al. 1988). This product is no longer available for protecting growing crops due to extreme toxicity to birds and mammals but is available for other uses (Avitrol Corporation 2013).

Starting in the 1990s and continuing until the present day, scientists from headquarters also conducted research on rice damage in the southeastern United States (e.g., Cummings and Avery 2003; Cummings et al. 2005). Their current research is focused on the development of bird repellents for ripening and sprouting crops (e.g., Werner et al. 2010).

Throughout the history of blackbird research, all of these scientists and their collaborators have conducted both short- and long-term studies that fall into three major research areas: (1) problem definition—defining the extent, magnitude, and frequency distribution of crop losses in relation to roosts, field location, and habitat; (2) ecological studies—estimating breeding and postbreeding populations, investigating food habits, and determining local and migratory movement patterns; and (3) methods development—developing cost-effective and environmentally safe chemical, cultural, and mechanical methods to alleviate damage (Guarino 1984).

1.7.3 Blackbird Research—Field Stations

1.7.3.1 Ohio Field Station

Ohio grows millions of hectares of corn and harbors historically large blackbird breeding populations, including 2.6 million common grackles (*Quiscalus quiscula*) and 2.5 million red-winged blackbirds (Partners in Flight 2013). In the 1960s, blackbird damage levels appeared to be increasing at an alarming rate, and Ohio farmers formed the Bye-Bye Blackbird Committee in 1965 to lobby for government action in reducing crop losses from blackbirds (Figure 1.3). Two years later, this group became the Ohio Coordinating Committee for the Control of Depredating Birds, which attracted congressional attention that resulted in the establishment of a research station in Ohio in 1968. The WS-NWRC Ohio Field Station is located near Sandusky and Lake Erie at Plum Brook Station, a 2,258-ha, fenced facility in Erie County operated by Glenn Research Center, National Aeronautics and Space Administration (NASA). The field station was initially administered from the U.S. Fish and Wildlife Service Patuxent Wildlife Research Center, located in Laurel, Maryland.

The restricted-access facility contains native grassland, reverted farmland, marsh, and woodland adjacent to intensively farmed land and urban settings outside the fence. Field station facilities include indoor and outdoor aviaries, several large bird traps, laboratories and shop space, a 2-ha fenced pond for waterfowl research, and conference rooms. The abundant wildlife populations at the facility allows station scientists to test various wildlife damage methods under controlled

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Articles of Incorporation

— OF —

BYE BYE BLACKBIRD ASSOCIATION, INC.
(Name of Corporation)

The undersigned, a majority of whom are citizens of the United States, desiring to form a corporation, not for profit, under Sections 1702.01 et seq., Revised Code of Ohio, do hereby certify:

FIRST. The name of said corporation shall be **Eye Eye Blackbird Association, Inc.**

SECOND. The place in Ohio where the principal office of the corporation is to be located is
Sandusky, Ohio, **Erie** County.
(City, Village or Township)

THIRD. The purpose or purposes for which said corporation is formed are:

To assist farmers, farm societies and agricultural association, in conservation of agricultural resources.

To cooperate and assist with federal, state and local research of predatory control programs.

To conduct predatory bird and animal control programs for the prevention of damage to agricultural crops.

To aid in the development of programs and distribution of information that will improve the economic and general welfare of persons engaged in agricultural.

To do all things necessary and incidental to accomplish the purposes aforesaid.

Figure 1.3 Articles of Incorporation for the Bye-Bye Blackbird Association in Sandusky, Ohio, 1965.

conditions without incurring costs associated with travel. The field station also leases from NASA 16 ha of farmland immediately outside the facility fence for additional wildlife damage studies. Thus, the Ohio Field Station is ideally located to develop methods for reducing blackbird damage to corn.

In the 1970s, scientists at the Ohio Field Station were primarily concerned with research on agricultural conflicts involving blackbirds and European starlings (e.g., Stickley et al. 1976). These scientists studied the population trends and ecology of these birds and tested the effectiveness of chemical repellents to keep birds from eating crops (e.g., Dolbeer 1978; Dolbeer 1980; Dolbeer 1990). They also assisted the FWS with the management of brown-headed cowbirds (*Molothrus ater*) in Michigan to reduce parasitism of Kirtland's warbler (*Setophaga kirtlandii*) nests (U.S. Fish and Wildlife Service 2012). In the following decade, research continued testing different repellent methods and evaluating various crop hybrids to reduce blackbird feeding without decreasing crop yields (Dolbeer et al. 1986). In the 1990s, research continued to analyze bird depredation problems in agriculture but shifted to a new focus on wildlife hazards to aviation—mainly bird strikes. From the 2000s to the present day, the field station has remained the leading U.S. research facility on wildlife hazards to aviation. Blackbird research moved to other units within the NWRC.

1.7.3.2 Florida Field Station

In 1944, the Florida Field Station was established in a small building in downtown Gainesville as one of the nation's first wildlife research stations. At that time, the field station was under the direction of the USDI Patuxent Research Center in Laurel, Maryland.

By 1961, the original facility was no longer adequate for its expanding wildlife research due to proximity to the growing Gainesville population. Thus, a 10.5-ha tract was acquired on the east side of Gainesville, 4.8 km from the University of Florida. The main office and laboratory building as well as a roofed outdoor aviary were constructed in 1963.

Over the years, additional infrastructure has been added to the facility to maintain research capabilities in light of changing priorities. Significant additions include a pole barn and ATV storage shed, three large outdoor flight pens (1486–2044 m² each), 12 smaller outdoor avian test pens, two roofed aviaries (112 m²) for holding and testing birds, and a dedicated animal care building. The latter is part of a recent (2015–2016) modernization of the facility, which also featured a complete upgrade of the 50-year-old main office and lab building.

The original mission of the field station in the 1940s included the study of rodent damage to Florida sugarcane. This remained a focus of the research program until the 1980s. In the 1950s and 1960s, the research mission broadened to include nuisance birds as well as mammals. In addition, from 1958 through the early 1970s, the field station operated a substation in Stuttgart, Arkansas, where biologists conducted extensive field research on red-winged blackbirds and produced seminal information on the distribution, migration, ecology, and management of blackbirds in relation to damage to rice and other agricultural crops.

Gainesville biologists collaborated with DWRC colleagues in the 1960s and 1970s on blackbird and starling research on development and field testing of surfactants for management and dispersal of large winter roosts in the southeastern United States (e.g., Lefebvre and Seubert 1970). Research during this time also included developing applications for a recently identified avian toxicant, compound DRC-1339 (e.g., Lefebvre et al. 1981). Blackbird research in the 1980s brought more emphasis to nonlethal approaches to reduce crop depredation issues, particularly related to chemical repellents such as methiocarb (e.g., Holler et al. 1982; Avery 1987). Throughout the 1990s the research program continued to investigate potential chemical repellents and other nonlethal methods for controlling bird damage to fruit and grain crops using cage and pen tests and field trials (e.g., Avery et al. 1994, 1997, 1998). Research on repellents expanded to include blackbird damage to wild rice in California (Avery et al. 2000), blackbird (*Agelaius ruficapillus*; also known as *Chrysomus ruficapillus*) damage to rice in Uruguay (Rodriguez and Avery 1996), and dickcissel (*Spiza americana*) damage to sorghum in Venezuela (Avery et al. 2001).

In the 2000s, responsibility for blackbird research on rice shifted to the North Dakota Field Station and headquarters. Concurrently, research at the Florida Field Station began a new phase, which continues today, identifying, evaluating, and developing methods to manage depredation, nuisance, and property damage problems associated with native birds such as vultures and crows, as well as various non-native species such as feral swine (*Sus scrofa*), Burmese pythons (*Python bivittatus*), black spiny-tailed iguanas (*Ctenosaura similis*), and monk parakeets (*Myiopsitta monachus*).

1.7.3.3 North Dakota Field Station

The North Dakota Field Station is located on the campus of North Dakota State University (NDSU), Fargo, where the station began in 1989. However, the station's research on blackbird ecology and behavior patterns in relation to sunflower began in 1979 when the U.S. Congress directed funds for research at NDSU. In 1985, DWRC, CSU, and the FWS's Northern Prairie Wildlife Research Center (NPWRC), located in Jamestown, North Dakota, cooperatively agreed to station

a CSU postdoctoral research biologist at the NPWRC facility. The incumbent biologist conducted collaborative studies with DWRC and NDSU scientists on the extent and magnitude of sunflower damage, migration and movement patterns of blackbirds in relation to damage, development of bird-resistant sunflower that featured either chemical or morphological characteristics that were thought to thwart blackbird feeding, and chemical repellents.

The establishment of the field station in 1989 reflected the need for blackbird damage research and the positive benefits of a relationship between NDSU and the NWRC. The field station's primary focus has always been on evaluating, creating, and refining methods used to reduce blackbird damage to sunflowers. From 1996 to 2015, the station was co-located in Bismarck with the North Dakota Wildlife Services operations program. In 1997, both units moved into a new facility that included offices, shops, storage, and bird housing and testing facilities.

After a NWRC field station was formally established at NDSU in 1989, collaborative research across multiple research institutions began with the development of the use of aerial applications of glyphosate herbicide for managing wetland vegetation favored by roosting blackbirds and exploring the use of compound DRC-1339 for population management during spring migration (e.g., Homan et al. 2004; Linz and Homan 2011; Linz et al. 2015). In the 2000s, scientists advanced our understanding of the relationship between blackbird populations, land cover, and climate (e.g., Forcey et al. 2015). Additionally, the use of DRC-1339 for baiting blackbirds feeding in sunflower fields was investigated, bird repellents were tested in the laboratory and in the field, the potential for European starlings to transfer disease within and among feedlots and dairies was elucidated, and the use of wildlife conservation food plots was refined (e.g., Carlson et al. 2011; Hagy et al. 2008; Werner et al. 2011). The addition of Fort Collins personnel in 2008 allowed the expansion of research on the development of bird repellents using test facilities located on the Fort Collins campus. The station's research portfolio expanded to include the movement and migration patterns of European starlings in relation to disease management in the United States. Project biologists later joined a large collaborative group of NWRC and university biologists to discover the role of European starlings in the transfer of disease among feedlots and dairies. Station personnel also were called upon to find methods to deter woodpeckers from damaging wood utility poles and study the movement of American robins (*Turdus migratorius*) and cedar waxwings (*Bombycilla cedrorum*) in relation to fruit damage in Michigan (e.g., Tupper et al. 2010; Eaton et al. 2016).

The North Dakota Field Station is currently charged with testing mechanical and chemical bird repellents, developing strategies to provide alternative food sources for blackbirds repelled from sunflower fields, studying blackbird movement and roosting behavior in relation to sunflower damage, and developing the use of unmanned aerial vehicles for hazing blackbirds and delivering repellents. The field station leader oversees MS and PhD students tasked with specific studies aimed at developing and improving blackbird management tools. In addition, the field station leader collaborates with scientists and graduate students at NDSU and other research institutions while interacting with key stakeholders such as the National Sunflower Association, North Dakota Wildlife Services, and the North Dakota Department of Agriculture to manage the conflict between agriculturalists and blackbirds.

1.7.3.4 Kentucky Field Station

The FWS established the Kentucky Field Station at Bowling Green, Kentucky, in 1977 to conduct research on blackbirds and starlings using winter roosts in the southeastern United States. Studies included the behavior and ecology of winter roosting birds, problem definition, and methods development. In 1988, the Kentucky Field Station staff was transferred to a newly established field station on the campus of Mississippi State University to study fish-eating birds known to prey on farm-raised catfish. During the 11 years of its existence, Kentucky Field Station personnel developed the use of a sprinkler irrigation system for applying PA-14 surfactant to blackbirds and

starlings roosting in trees (Heisterberg et al. 1987). The application of PA-14 sometimes reduced roost numbers dramatically. They successfully tested the use of DRC-1339 for reducing starling numbers at feedlots and blackbirds damaging sprouting rice (e.g., Glahn and Wilson 1992). Finally, field station personnel banded 20,000 blackbirds and starlings in Kentucky and Tennessee and discovered that the majority of blackbirds nested in the northeastern United States, whereas nearly 50% of the starlings were hatched in the subject state (Mott 1984).

1.7.3.5 California Field Station

The FWS established the California Field Station at Dixon in the early 1960s to conduct research on blackbirds in California. The station was closed in the mid-1980s when wildlife damage management was moved from the USDI to the USDA. Station personnel collaborated with scientists and graduate students at University of California–Davis. This field station primarily addressed bird depredations on ripening rice and grapes but also conducted studies on blackbird damage to sunflower (Avery and DeHaven 1984). The field station had office space, aviaries, a shop, and a laboratory.

1.8 SUMMARY

The blackbird–agriculture conflict in North America spawned a robust research effort in the 1950s that continues today. We tip our hats to the many scientists who spent countless hours conducting field and laboratory studies, some over several decades. We can learn much from their documented experiences and publications. Classic experimental studies using free-ranging blackbirds in commercial fields were found to be challenging because of the great mobility of foraging bird flocks, changing cropping patterns, and unpredictable precipitation patterns that change the availability of roosting habitat in relation to crops (Stickley et al. 1976; Jaeger et al. 1983; Knittle et al. 1988; Linz et al. 2011). Thus, testing the plethora of mechanical frightening devices, chemical agents, bird-resistant crop hybrids, and lure crops over the years often yielded inconsistent results, partially due to high variability in blackbird foraging behavior between treatments. Scientists are now relying more heavily on cage test designs to screen potential repellents and netted enclosures stocked with blackbirds to simulate replicated field trials. Although these testing strategies are useful, moving from encouraging test results of a particular repellent with captive birds to successful application under field conditions remains difficult when applied to ripening crops.

Budget constraints and shifting research priorities have reduced the number of scientists assigned to this challenging problem. We are cautiously optimistic, however, that progress will be made as a result of new and improved technologies and innovations integrated into an overall pest management strategy.

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