

University of Nebraska - Lincoln

DigitalCommons@University of Nebraska - Lincoln

USDA National Wildlife Research Center - Staff
Publications

U.S. Department of Agriculture: Animal and Plant
Health Inspection Service

2017

Frightening Devices

Michael L. Avery

USDA National Wildlife Research Center, michael.l.avery@aphis.usda.gov

Scott J. Werner

USDA-APHIS-Wildlife Services, Scott.J.Werner@aphis.usda.gov

Follow this and additional works at: https://digitalcommons.unl.edu/icwdm_usdanwrc



Part of the [Life Sciences Commons](#)

Avery, Michael L. and Werner, Scott J., "Frightening Devices" (2017). *USDA National Wildlife Research Center - Staff Publications*. 2001.
https://digitalcommons.unl.edu/icwdm_usdanwrc/2001

This Article is brought to you for free and open access by the U.S. Department of Agriculture: Animal and Plant Health Inspection Service at DigitalCommons@University of Nebraska - Lincoln. It has been accepted for inclusion in USDA National Wildlife Research Center - Staff Publications by an authorized administrator of DigitalCommons@University of Nebraska - Lincoln.

CHAPTER 9

Frightening Devices

Michael L. Avery

National Wildlife Research Center
Gainesville, Florida

Scott J. Werner

National Wildlife Research Center
Fort Collins, Colorado

CONTENTS

9.1	Auditory Frightening Devices	160
9.1.1	Bioacoustics	160
9.1.2	Artificial Aural Deterrents	161
9.1.3	Combatting Habituation.....	162
9.2	Visual Frightening Devices	163
9.2.1	Balloons	164
9.2.2	Hawk Kites	164
9.2.3	Reflective Tape.....	165
9.2.4	Flags and Streamers.....	166
9.2.5	Effigies and Models	166
9.2.6	Hazing with Aircraft	166
9.2.7	Remote Controlled Models and Drones	167
9.2.8	Falconry	167
9.3	Light and Color.....	168
9.3.1	Lasers.....	168
9.3.2	Ultraviolet Wavelengths.....	169
9.3.3	Aposematic Colors.....	169
9.4	Summary	170
	References.....	171

By their nature, avian frightening devices are intended to provide temporary (days, weeks) relief from a specific depredation or conflict situation. Ideally, the method applied will produce an immediate fright response, causing depredating birds to leave and to stay away as long as the method is in place. Longer-term (months, years) resource protection would involve methods such as crop varietal improvement, blackbird population management, or habitat manipulation. Frightening devices primarily affect the avian auditory and visual senses. With few exceptions (e.g., avian distress or alarm calls), frightening devices are not species-specific.

Very few frightening devices have been subjected to adequate scientific evaluation, so their efficacy under field conditions is often unknown. When field tests have been conducted, flaws in experimental design and analysis have rendered most trials inconclusive as to their effectiveness (Bomford and O'Brien 1990). Anderson et al. (2013) surveyed fruit crop producers in five states and reported that >50% of respondents considered "auditory scare devices" to be "slightly effective" or "not effective" in reducing bird damage. The specific types of auditory deterrents were not indicated. Relatively few published reports of frightening devices include testing against blackbirds. Therefore, the usefulness of many aural and visual devices for managing blackbirds can only be judged by extrapolating from studies that have focused on species other than icterids, such as corvids and gulls, in settings such as landfills and orchards, which are not usually associated with blackbirds.

9.1 AUDITORY FRIGHTENING DEVICES

Red-winged blackbirds (*Agelaius phoeniceus*) live in a rich auditory environment and they employ a wide array of vocalizations affecting almost all aspects of their natural history, including mate selection, territory maintenance, brood rearing, flock foraging, predator avoidance, and migration (Yasukawa and Searcy 1995). In general, birds display less aural sensitivity and a more narrow frequency range than humans (Beason 2004). The range of sensitivity to sound frequencies has been determined for relatively few species. Redwings and brown-headed cowbirds (*Molothrus ater*) have upper limits of 9.6–9.7 kHz (Heinz et al. 1977). Similar determinations have not been made for the common grackle (*Quiscalus quiscula*) or yellow-headed blackbird (*Xanthocephalus xanthocephalus*). In discussing auditory deterrents, we distinguish naturally produced sounds from those created by humans for the purpose of scaring birds.

9.1.1 Bioacoustics

Bioacoustics is "concerned with the production of sound by and its effects on living organisms" (Merriam-Webster 2016). An alternative term, *biosonics*, is "the use of an animal's natural vocalizations to influence the behavior of that species" (Gorenzel and Salmon 2008). In the context of resource protection, researchers have investigated the potential use of avian alarm and distress calls to disperse nuisance roosts or to protect crops from depredations for several decades (e.g., Frings et al. 1955; Boudreau 1968; Brough 1969; Schmidt and Johnson 1983). Birds give alarm calls to warn of imminent danger, such as when a predator is near, and distress calls are emitted when a bird is captured or in pain (Jaremovic 1990). Actual alarm or distress calls are considered superior to artificial noises for bird control because they (1) are less prone to habituation, (2) can be broadcast at lower intensities, (3) are species-specific (although Gorenzel and Salmon 2008 list this as a disadvantage), and (4) are less annoying to humans (Jaremovic 1990). Species-specific, biologically meaningful sounds (alarm and distress calls) have greater effects on bird behavior than do devices that produce noises not biologically relevant, which at most provide short-term relief but no lasting effect on food intake and use of space (Bomford and O'Brien 1990).

Broadcast recordings of corvid distress calls have been used successfully, alone and in combination with other tactics, for roost dispersal and crop protection with various crow species (Naef-Daenzer 1983; Gorenzel and Salmon 1993; Delwiche et al. 2005; Avery et al. 2008). Distress calls of European starlings (*Sturnus vulgaris*) have long been applied successfully for roost dispersal (Frings and Jumber 1954; Zajanc 1963; Pearson et al. 1967). Berge et al. (2007) incorporated alarm and distress calls with conventional methods (reflective tape, propane cannons, pyrotechnics) to

reduce grape damage by European starlings, American robins (*Turdus migratorius*), and house finches (*Carpodacus mexicanus*). Their results showed that supplementing with the calls reduced bird damage more effectively than applying the conventional methods without the calls. Heidenreich (2007) noted that “New York studies have shown distress call devices to be effective for 7–10 days in plantings with high bird pressure. Use of predator models in conjunction with distress call units gave further reduction in feeding. Best results were obtained when units were moved regularly and used in conjunction with visual scare devices.” Cook et al. (2008) reached similar conclusions regarding the effectiveness of several bird control methods in dispersing gulls (*Larus fuscus*, *Larus argentatus*, and *Chroicocephalus ridibundus*) from landfills in the United Kingdom. Distress calls, falconry, and lethal and nonlethal shooting were the most effective methods tested, but Cook et al. (2008) recommended rotating the control techniques used and applying them in combination for the most effective results.

The result of years of research and development is that numerous types of avian alarm/distress call units are now marketed to discourage bird use of crop fields, airports, roosts, and so on. Some units incorporate predator calls as well as avian alarm or distress calls. Most are programmable as to the interval between calls, species of bird, and randomization of calls. Units can be battery, solar, or electrically powered. Smaller units cover up to 1.5 ha; larger, more extensive systems reportedly can cover up to 12 ha (Heidenreich 2007). Prices can range up to several thousand dollars depending on the size of the area to be protected, power supply, cables, and number of speakers needed. Some auditory units even come packaged in the form of predators such as owls and eagles (Heidenreich 2007). There is minimal information available on the reliability and effectiveness of specific brands or models, other than what is found on the websites of manufacturers and suppliers.

9.1.2 Artificial Aural Deterrents

Although many new devices have been developed and marketed during the past 30 years, there is little evidence of any marked improvement in the efficacy of auditory deterrents for crop protection. Propane cannons remain the most popular of numerous auditory methods available for scaring birds from crop fields (Bomford and O’Brien 1990). Newer models are automatic, multi- or single-shot, ground-mounted, and rotate 360° for wide coverage. The intervals between detonations are adjustable. These units cost up to several hundred dollars each. Cummings et al. (1986) tested a combined propane exploder and pop-up scarecrow in sunflower fields and found that it was effective, particularly if it was used before a habitual feeding pattern had developed. The effectiveness of propane cannons, however, was shown to be limited to relatively small areas. Cummings et al. (1986) suggested that to be effective, at least one cannon should be used for each 2–3 ha area of sunflower crop. In the upper Midwest, sunflower field sizes are often 65 ha or larger; therefore, for propane cannons to be economically effective, the expected field damage should exceed 18%, which is a high level of bird damage for sunflower in the upper Midwest (Cummings et al. 1986). For best results, cannons should be moved often, installed so that the direction and timing of the explosions vary, and be augmented with pyrotechnics or live ammunition (Linz et al. 2011).

Pyrotechnics are standard tools for dispersing problem birds (Garner 1978). The cartridges are launched from a shotgun or pistol, usually in close proximity to the target flock of depredating birds. Bird bombs or bangers create a loud bang when they detonate in the air. Screamers emit a high-pitched whistling sound and smoke trail as they fly through the air after launch. These are versatile tools, easy to obtain and use, but the effect is usually short-lived. Thus, they perform best when used in conjunction with other tactics (Cook et al. 2008; Gorenzel and Salmon 2008).

Swaddle et al. (2016) have developed and tested a method called a *sonic net* in which artificial noises that overlap the frequency range perceived by target birds are broadcast to deter the birds' use of an airport, crop field, or other site to be protected. Presumably, the broadcast noise inhibits or masks auditory communications among the birds, including predator detection, which causes the affected birds to abandon the area. The results to date have been promising, but efficacy and cost-effectiveness of this approach under various field situations remain to be determined.

Another recent development in sonic deterrents is the Long Range Acoustic Device (LRAD). LRADs can direct loud, painful sound signals (up to 160 dB) in a fairly narrow beam (30°) that can be heard over 3,000 m away (TONI 2016). The LRAD was developed for antipersonnel use by military and law enforcement, but other applications, including bird management, have surfaced. Several companies market LRADs for bird dispersal at airports, landfills, mine waste ponds, and wind farms (American Technology Corporation 2009). The units can broadcast alarm or distress calls of the target species, raptor calls, or other loud noises disturbing to birds. We are not aware of any studies that have examined the cost–benefit of employing an LRAD system for any application including management of blackbird crop depredations or roost dispersal.

Ultrasonic devices (frequency of 20 kHz or greater) are prominent on avian pest control websites. For example, Bird-X (2016) advertises a unit “tuned at 20kHz,” which is recommended for use in indoor and semi-enclosed areas. Grackles, starlings, and “blackbirds” are among the target species listed. However, the upper limit of sensitivity for red-winged blackbirds, brown-headed cowbirds, and starlings is <10 kHz (Heinz et al. 1977; Dooling 1982). There are also recent claims of effectiveness of ultrasonic devices in agricultural settings in Africa (e.g., Ezeonu et al. 2012). Bird species differ in their sensitivity to frequencies of sound (Beason 2004), so conceivably some species might be responsive to ultrasound. To our knowledge, however, this has yet to be demonstrated in blackbirds (Bishop et al. 2003; Beason 2004).

Fitzgerald (2013) suggests best results with auditory deterrents are obtained when:

- Scaring devices are implemented at the early stages of crop ripening, before birds have established a habit of visiting the site.
- Sounds are presented at random intervals.
- A variety of different sounds and frequencies are used.
- The sound source is moved frequently and only used for the minimum time needed to get a response.
- Sounds are supported by other methods, such as visual deterrents.
- Sounds are reinforced by actual danger (e.g., shooting).

Fitzgerald's (2013) prescription serves as useful guidance for almost any avian crop protection situation. Adoption of an integrated avian management approach offers the highest probability for significant damage reduction.

9.1.3 Combatting Habituation

Habituation occurs with prolonged exposure to auditory devices and is the bane of effective avian crop pest control (Bomford and O'Brien 1990). Most animals will habituate to noises, even actual predator calls, that occur repeatedly but result in no real threat to them. Habituation is an adaptive response because if animals did not habituate to nonthreatening stimuli, they would be constantly expending time and energy taking flight, seeking refuge, and producing alarm calls. Most of the suggestions by Fitzgerald (2013), Heidenreich (2007), and others for increasing the effectiveness of auditory deterrents represent tactics to combat habituation.

Some authors advocate limited, judicious lethal control, usually shooting, to reinforce and enhance the effectiveness of nonlethal methods (e.g., Cleary and Dolbeer 2005; Linz et al. 2011; Fitzgerald 2013). Despite offering no supporting evidence, Beason (2004, 95) states: “The most effective use of acoustic signals is when they are reinforced with activities that produce death or a

painful experience to some members of the population.” This concept is intuitively appealing as a means to retard habituation to nonlethal deterrents and to minimize the application of lethal control. The acceptance of this tactic as a recommended crop protection practice, however, is based on scant quantitative information. Instead, anecdotal reports and observations by field personnel comprise the basis for its inclusion in avian crop protection planning.

One exception is the study by Baxter and Allan (2008), who explicitly assessed the effectiveness of blank rounds alone and blank rounds in combination with live rounds for dispersing gulls and corvids at a landfill in England. The numbers of gulls and corvids each declined with the onset of harassment with blank rounds, but within 5 weeks the gulls and corvids had habituated to the treatment. After a 4-wk break, control resumed using a combination of blank rounds and live ammunition (number 5 shot). Live rounds were only fired when birds attempted to land at the site. The combination treatment caused gull numbers to be reduced drastically, but corvid numbers were not affected. Baxter and Allan (2008) concluded that the departure of the gulls meant reduced competition for food, so corvids might have been induced to remain even with the onset of enhanced harassment measures.

Investigation of the concept of lethal reinforcement of nonlethal crop damage control methods could be a very fruitful area of study. Although it has become entrenched in the lore of avian pest management, to date there is no definitive information to support its general use in crop protection or other dispersal strategies. The careful study by Baxter and Allan (2008) revealed disparity in the responses of gulls and corvids to the “reinforced” harassment method. Thus, interspecific variation should be expected, and more information obtained through carefully controlled studies is needed to identify and determine the range of such differences.

Glahn (2000) employed a different study design to compare the effectiveness of pyrotechnics and lethal shooting in dispersing roosts of double-crested cormorants (*Phalacrocorax auritus*). He selected five pairs of cormorant roosts based on numbers of birds and the areas occupied. He randomly assigned the members of each roost pair to receive either pyrotechnic or shotgun dispersal. Glahn (2000) found no differences between treatments in the effort required to disperse the roosts or in the length of time before the roosts were reoccupied. He concluded that shooting and pyrotechnics were equally effective as cormorant roost dispersal tools.

9.2 VISUAL FRIGHTENING DEVICES

Scarecrows have existed for millennia. The first scarecrows in recorded history were used by Egyptians to protect wheat fields from depredating flocks of quail in the Nile valley (Warnes 2016). In North America, scarecrows used by Native Americans and European settlers resembled the human form, made to look frightening, at least in the eyes of the persons making them, so that birds would stay away (Warnes 2016). Despite centuries of experience addressing problems of bird damage to crops and other resources, human ingenuity continues to struggle to develop a consistently effective scarecrow.

Many commercially available bird scare devices today incorporate motion (e.g., Stickley and King 1995; Loria 2014). Intuitively, an animated device is more likely to draw attention and create uncertainty among a flock of birds than a static device. Nevertheless, without an added element of surprise or unpredictability even a moving scarecrow will lose effectiveness over time and with repeated exposure (Marsh et al. 1992; Stickley and King 1995). Unpredictability is achieved by using triggering systems programmed to activate at random intervals or by linking the scare device to a motion detector so that the animal itself activates the unit (Gilsdorf et al. 2002).

Motion can be imparted by wind to various types of balloons, kites, tapes, and flags. Such units sometimes provide short-term relief because of neophobic responses by the birds, but the area thus protected is limited and effectiveness wanes quickly as birds acclimate to the presence of the non-threatening device (Bishop et al. 2003).



Figure 9.1 Eyespot balloons are sold as bird-scaring devices and might provide short-term, localized relief. (Courtesy of John S. Humphrey.)

9.2.1 Balloons

Balloons can be suspended from poles so that they swing freely in the wind, or they can be inflated with helium and tethered to float above the area to be protected (Figure 9.1).

Mott (1985) deployed helium-filled balloons of various colors in five mixed-species blackbird roosts across three nights and recorded an 82% reduction in roosting birds. When winds exceeded 16 km/hr, however, the balloons became entangled in roost vegetation. In Japan, Shirota et al. (1983) floated a 2.6-m-diameter helium-filled balloon upon which large eyespots were painted above 3.5 ha of experimental grape, cherry, and peach plantings and successfully protected the fruit from white-cheeked starling (*Spodiopsar cineraceus*) depredation. Avery et al. (1988) evaluated a smaller version of the eyespot balloon in a large flight pen and determined that it did not affect pecking of oranges by boat-tailed grackles (*Quiscalus major*). Tipton et al. (1989) painted red and black eyespots on white beach balls (50 cm diameter), which they suspended from poles about 1 m above trees in three citrus groves. Damage to the fruit by great-tailed grackles (*Quiscalus mexicanus*) was virtually the same as in groves without beach balls.

9.2.2 Hawk Kites

Results from field trials indicate that the responses vary among species and some birds habituate more rapidly than others to the presence of hawk kites (Hothem and DeHaven 1982; Conover 1983, 1984; Seamans et al. 2002). The zone of best protection is directly below the kite, so these devices have relatively small areas of effectiveness (Figure 9.2).

Densities of approximately 1 unit/ha are indicated for effective protection (Marsh et al. 1991; Seamans et al. 2002). They also require frequent monitoring to avoid deflation and entanglement with vegetation.

9.2.3 Reflective Tape

An Internet search quickly reveals numerous types of reflective tape marketed as “bird-scaring.” The reflecting tape that has been evaluated most often in field tests is approximately 1 cm wide and 0.25 mm thick. This tape is usually twisted and suspended between erect poles in parallel lines above the crop. Its Mylar coating (silver on one side, red on the other) reflects sunlight, which produces a flashing effect. Twisting the tape enhances the reflecting effect and creates an illusion of motion (Figure 9.3).

In windy conditions, vibrations by the tape produce a humming or roaring noise, which might contribute to its deterrent effect (Bruggers et al. 1986; Dolbeer et al. 1986; Tobin et al. 1988). Applications of reflective tape have had mixed success in protecting crops (Conover and Dolbeer 1989). Improper installation or strong wind can cause the tape to become tangled in vegetation.



Figure 9.2 Replicas of hawks or other raptors can be suspended from tall poles or helium balloons as a means to deter depredating birds. (Courtesy of Michael L. Avery.)



Figure 9.3 The flashing appearance of thin Mylar tape suspended between support poles could contribute to successful crop protection strategies. (Courtesy of Richard A. Dolbeer.)

9.2.4 Flags and Streamers

Manikowski and Billiet (1984) installed flags of colored cloth on 2-m poles in 30 rice plots (0.25 ha each) to combat damage by red-billed quelea (*Quelea quelea*). They observed reduced numbers of quelea in flagged plots compared to adjacent untreated plots. White and red flags were the most effective. Mason et al. (1993) found that white plastic flags made from garbage bags effectively deterred wintering snow geese (*Chen caerulescens*) from 10-ha fields of rye grass and winter wheat in New Jersey. Belant and Ickes (1997) successfully disrupted herring (*L. argentatus*) and ring-billed gulls (*Larus delawarensis*) at loafing areas by deploying 1-m long streamers of reflecting tape attached to stakes and wires. This approach was ineffective, however, when applied to herring gull nesting colonies.

9.2.5 Effigies and Models

For roost dispersal, crow and vulture effigies are effective components of integrated management strategies (Avery et al. 2002a, 2008; Tillman et al. 2002; Seamans 2004). These devices are replicas of crows or vultures, sometimes even carcasses or taxidermic preparations (Figures 9.4 and 9.5). Use of actual feathers in the effigies seems to be important in their success.

Plastic models of owls or other images meant to scare birds generally are innocuous. Monk parakeets did not respond to a taxidermic parakeet effigy or a flying owl predator model (Avery et al. 2002b). Canada geese did not respond to effigies of dead geese during the nesting season and repellent effects lasted for only 5 days during the late summer postbreeding season (Seamans and Bernhardt 2004). To our knowledge, there have been no tests of effigies in blackbird roosts.

9.2.6 Hazing with Aircraft

Flying fixed-wing aircraft over sunflower fields beset with flocks of depredating blackbirds proved marginally useful in North Dakota (Handegard 1988). Some rice producers also employ aircraft to haze blackbirds from their fields, but the extent to which this is used and the efficacy of the technique is not known (Cummings et al. 2005). High operating costs and safety have been major impediments to widespread use of this crop protection method (DeHaven 1971; Linz et al. 2011). Mott (1983) observed that low-level helicopter flights over mixed blackbird–starling winter roosts



Figure 9.4 Commercially available crow replicas, or effigies, can be useful in integrated roost dispersal efforts. (Courtesy of John S. Humphrey.)

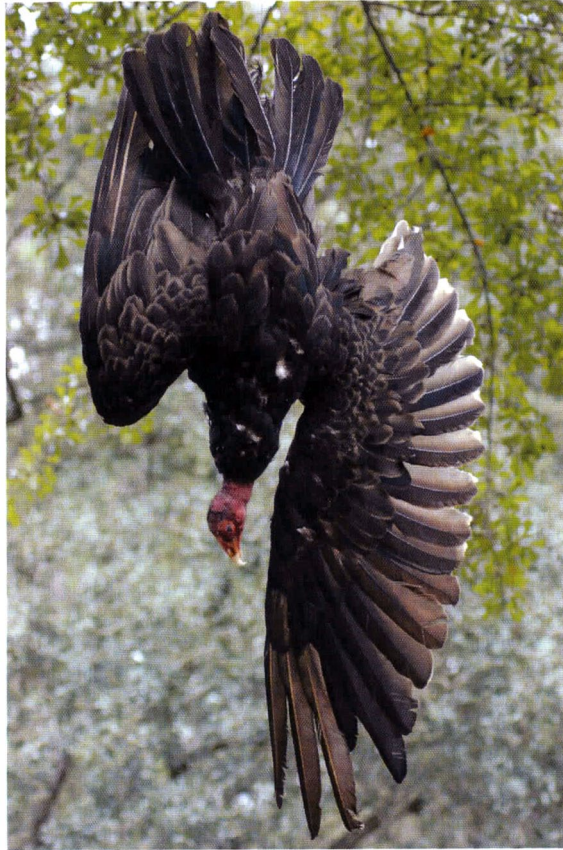


Figure 9.5 Taxidermic vulture effigies, suspended upside down, are effective tools for vulture roost dispersal. (Courtesy of Eric A. Tillman.)

caused birds to flush on clear nights but not when it was overcast. Birds did not abandon the roosts but instead resettled soon after the aircraft left.

9.2.7 Remote Controlled Models and Drones

Managers have operated model aircraft to haze birds at airports, landfills, and aquaculture facilities (e.g., Solman 1981; Coniff 1991). Constraints include that it requires a skilled operator, only relatively small areas can be covered, inclement weather inhibits operation, and it is labor-intensive. With new technological advances, drones have replaced model aircraft in this method of pest bird management (Figure 9.6). Many are advertised online for bird control applications (BBC 2014).

Automated drone technology incorporating GPS-guided, programmed flight paths offers promise for new, improved effective hazing options in the near future (Ampatzidis et al. 2015).

9.2.8 Falconry

The sight of a live raptor, especially one in flight, evokes alarm calls and, if the perceived threat is sufficiently close, evasive action by feeding birds. The presence of an airborne raptor might cause the feeding flock to leave the crop area. Such a deterrent effect will persist as long as the raptor is present. When the raptor is gone, so is the threat, and the feeding flock is free to resume depredations.



Figure 9.6 Unmanned aerial vehicles (drones) offer new opportunities for scaring depredating birds from large crop fields. (Courtesy of Michael L. Avery.)

Erickson et al. (1990) considered falconry to be too costly as a tool for dispersing birds in agricultural settings. Dolbeer (1998) found no evidence that a falconry program reduced bird strikes at JFK International Airport beyond levels already achieved with a conventional program of bird frightening, shooting, and habitat management. Nevertheless, falconry has great human-interest appeal and in some cases might prove useful in an integrated management context.

9.3 LIGHT AND COLOR

9.3.1 Lasers

The potential for unexpected or especially intense lights to be aversive to birds has been posited for many years (e.g., Lustick 1973). For the most part this has been unfounded as a basis for bird management, and in some cases lights have been demonstrated to be attractive to birds rather than aversive (Gorenzel and Salmon 2008). Lasers are the principal exception.

Development of the laser dates to the late 1950s. The term *laser* is an acronym for “light amplification by stimulated emission of radiation,” first articulated by Gould (1959). Once exotic and seemingly formidable, lasers are now common in many aspects of everyday life, including medical care, consumer electronics, entertainment, business and industry, law enforcement, and national defense. Modern communications through fiber optic systems rely on lasers. The unique aspect of the laser lies in the coherence of the emitted light. Coherence allows the laser beam to be very narrowly focused and for the beam to remain narrow over long distances. Since the early 1990s, laser devices have been marketed for bird dispersal uses (Glahn et al. 2001; Blackwell et al. 2002). Currently, both red and green lasers are commercially available specifically for bird management.

Properly used, the commercial bird-deterrent lasers are safe for birds and people, and they have utility as a management tool. However, there are constraints to their use and to their effectiveness. Laser pointers and similar devices are readily available to the public, and their misuse has generated legitimate concerns for human health and safety as related to aircraft piloting. There have been

numerous instances of persons on the ground shining laser pointers or other laser devices at low flying aircraft and causing pilot disorientation. Such dangerous actions can cast suspicion on the legitimate use of lasers by trained wildlife personnel engaged in bird control. Thus, before applying a laser to roost dispersal or other bird management efforts, always consult local laws, ordinances, and regulations governing their use.

In terms of bird management, there are two basic limitations to laser use:

- Lasers consist of light, so in order to affect bird behavior, the laser light needs to be visible to the birds. In sunny, daylight conditions, lasers are at best barely visible at short range. Operators cannot see the beam to aim and use it effectively. And birds cannot detect the beam and thus are unaffected. So, lasers are not useful in well-lit situations. Because blackbirds feed during the day, lasers are not appropriate as a tool to prevent feeding in crops. Homan et al. (2010) did note that the green laser they tested appeared much brighter in daylight than the red one.
- Lasers affect birds by startling them. Birds are unfamiliar with the red or green beam and therefore respond as they would to a sudden unexpected loud noise, such as from a propane cannon. Thus, as with pyrotechnics or other loud noises, birds are initially startled by laser lights but are not driven off permanently. Roosting blackbirds appear to be particularly recalcitrant to laser dispersal, although the number of properly controlled trials is minimal (Homan et al. 2010).

The advantage to laser dispersal compared to pyrotechnics is that lasers are silent. Lasers can disperse roosting birds from towers or other structures without aggravating nearby residents. However, as with pyrotechnics, lasers do not provide permanent solutions. When the laser stimulus is removed, so is the deterrent effect and birds readily repopulate the roost unless other actions are implemented (e.g., Avery et al. 2002b; Gorenzel et al. 2002). For dispersal of crow or vulture roosts, lasers are potentially very useful components of integrated management strategies (Avery et al. 2008).

9.3.2 Ultraviolet Wavelengths

Among diurnal birds, there are two distinct classes of color vision, violet sensitive (VS) and ultraviolet sensitive (UVS). Retinal cones in VS species have maximum absorption in the 402–426 nm range, whereas UVS species have cones maximally sensitive in the 355–380 nm range (Odeen and Hasted 2013). The red-winged blackbird is among the avian species having retinal cones that are maximally sensitive in the near ultraviolet (UV), at 370 nm (Chen et al. 1984). The ability of blackbirds and many other species to see in the UV portion of the spectrum is a trait they share with insects and numerous other taxa but one that is distinct from humans and most other mammals. UV perception in birds is known to function in mate selection (e.g., Bennett et al. 1997), foraging (e.g., Burkhardt 1982; Schaefer et al. 2006), and flight orientation (e.g., Kreithen and Eisner 1978).

Management applications of avian UV sensitivity have started to emerge. Pole-mounted windmills with spinning blades painted with UV-reflecting paint are sold as “scare windmills” to frighten birds including wild turkeys (*Meleagris gallopavo*) and geese (Anonymous 2002; JWB Marketing 2014). We are aware of no objective controlled evaluation of these units, but they are frequently included in discussions of management alternatives for protecting crops from bird damage (e.g., Eaton 2010).

9.3.3 Aposematic Colors

Avian response to color has management applications in areas of crop protection (Greig-Smith and Rowney 1987), pesticide avoidance (Kalmbach and Welch 1946; Gionfriddo and Best 1996), and collision avoidance (Blackwell et al. 2012). Birds react differently to different colors. Avery et al. (1999) exposed red-winged blackbirds and boat-tailed grackles to rice seeds of several colors in a series of cage and pen tests; blue was consistently the least-preferred color.

Color alone will not prevent birds from feeding on a crop or occupying a roost site, but color can serve as a sign or warning signal. Such warning, or aposematic, colors are found throughout the natural world and advertise to predators the presence of toxic or debilitating chemical compounds in a potential prey item (e.g., Berenbaum 1995). Although blackbirds are frequently used as test subjects in feeding trials and they can be conditioned to avoid food associated with specific colors (e.g., Mason and Reidinger 1983; Werner et al. 2008), it is unclear that an aposematic color approach can be successfully applied in crop protection scenarios. Limited attempts to improve efficacy of crop protection through application of color cues in field applications of chemical repellents have produced mixed results. Elmahdi et al. (1985) reported enhancement of methiocarb repellency against red-billed quelea with calcium carbonate added to the treatment on sorghum. They concluded that the presence of the white paint residue from calcium carbonate signaled to depredating birds that the crop was inedible even after the methiocarb was no longer present. Conversely, Dolbeer et al. (1992) reported that the white markings left on sorghum plants by calcium carbonate spray did not reduce blackbird damage beyond applications of methiocarb alone.

Avery (2002) hypothesized that the UV reflectance of anthraquinone enhances the birds' ability to associate the appearance of treated food with the adverse postgestional consequences and thereby learn more rapidly to avoid the treated food. Werner et al. (2012) exposed red-winged blackbirds to sunflower treated with 0.25% anthraquinone (wt/wt) during 2 days of repellent conditioning. Relative to unconditioned blackbirds, three test groups previously exposed to the UV-absorbent, postgestive repellent subsequently avoided sunflower treated with 0.2% of an UV-absorbent cue and 0%, 0.025%, or 0.05% anthraquinone throughout a 14-day preference test. Similarly, an independent group of red-winged blackbirds exposed to the UV-absorbent, postgestive repellent subsequently avoided UV-reflective food (Werner et al. 2012). In the absence of negative postgestive consequences, however, UV cues alone are unlikely to elicit food avoidance among wild birds (Lyytinen et al. 2001).

Relative to the repellency of food treated only with an anthraquinone-based repellent, synergistic repellency (i.e., a 45%–115% increase) was observed when 0.2% of the UV feeding cue was combined with 0.02% or 0.035% anthraquinone (wt/wt; Werner et al. 2014). In contrast, <10% repellency was observed for 0.2% of a non-UV feeding cue (red number 40 aluminum lake dispersion) paired with 0.02% anthraquinone. Aversion performance was therefore not attributed to characteristics of either conditioned or unconditioned stimuli but their combinations, and enhanced repellency of anthraquinone plus the UV-absorbent cue was attributed to UV wavelengths. Thus, the addition of an UV feeding cue can enhance avian repellency at repellent concentrations realized from previous field applications on agricultural crops (e.g., <0.1% anthraquinone; Werner et al. 2014).

9.4 SUMMARY

The number and variety of auditory and visual frightening devices available for short-term bird management are greater than ever, as is the need for such tools. Human ingenuity coupled with technological advances and economic incentive ensure that new, improved options will continue to be developed. Much less available, however, are objective evaluations of the efficacy, or cost-effectiveness, of frightening devices, especially as related to blackbird management. For many devices, performance measures are little more than testimonials on a vendor's website. Even when a field trial of a frightening device is conducted, appropriate scale, replication, and controls are seldom part of the study design, perhaps because of constraints imposed by cost and resource limitations (Bomford and O'Brien 1990). Producers thus continue to rely on familiar tools such as propane cannons and shooting as short-term blackbird management options.

REFERENCES

- American Technology Corporation. 2009. *American Technology announces LRAD® order for bird and waterfowl control and protection*. <http://www.marketwired.com/press-release/american-technology-announces-lradr-order-bird-waterfowl-control-protection-nasdaq-atco-1246276.htm> (accessed August 30, 2016).
- Ampatzidis, Y., J. Ward, and O. Samara. 2015. Autonomous system for pest bird control in specialty crops using unmanned aerial vehicles. *2015 ASABE Annual International Meeting*. New Orleans, LA.
- Anderson, A., C. A. Lindell, K. M. Moxcey, W. F. Siemer, G. M. Linz, P. D. Curtis, J. E. Carroll, C. L., et al. 2013. Bird damage to select fruit crops: The cost of damage and the benefits of control in five states. *Crop Protection* 52:103–109.
- Anonymous. 2002. “Scare Windmill” repels pest birds. *Farm Magazine* 26:27.
- Avery M. L. 2002. Avian repellents. In: Plimmer J. R., editor. *Encyclopedia of agrochemicals*. Hoboken, NJ: Wiley. p. 122–128.
- Avery, M. L., D. E. Daneke, D. G. Decker, P. W. Lefebvre, R. E. Matteson, and C. O. Nelms. 1988. Flight pen evaluation of eyespot balloons to protect citrus from bird depredations. *Vertebrate Pest Conference* 13:277–280.
- Avery, M. L., E. C. Greiner, J. R. Lindsay, J. R. Newman, and S. Pruett-Jones. 2002b. Monk parakeet management at electric utility facilities in south Florida. *Vertebrate Pest Conference* 20:140–145.
- Avery, M. L., J. S. Humphrey, D. G. Decker, and A. P. McGrane. 1999. Seed color avoidance by captive red-winged blackbirds and boat-tailed grackles. *Journal of Wildlife Management* 63:1003–1008.
- Avery, M. L., J. S. Humphrey, E. A. Tillman, K. O. Phares, and J. E. Hatcher. 2002a. Dispersing vulture roosts on communication towers. *Journal of Raptor Research* 36:45–50.
- Avery, M. L., E. A. Tillman, and J. S. Humphrey. 2008. Effigies for dispersing urban crow roosts. *Vertebrate Pest Conference* 23:84–87.
- Baxter, A. T., and J. R. Allan. 2008. Use of lethal control to reduce habituation to blank rounds by scavenging birds. *Journal of Wildlife Management* 72:1653–1657.
- BBC. 2014. Suffolk farm uses drone to scare pigeons off rape crop. <http://www.bbc.com/news/uk-england-suffolk-27069825> (accessed August 30, 2016).
- Beason, R. C. 2004. What can birds hear? *Vertebrate Pest Conference* 21:92–96.
- Belant, J. L., and S. K. Ickes. 1997. Mylar flags as gull deterrents. *Great Plains Wildlife Damage Control Workshop* 13:73–79.
- Bennett, A. T. D., I. C. Cuthill, J. C. Partridge, and K. Lunau. 1997. Ultraviolet plumage colors predict mate preference in starlings. *Proceedings of the National Academy of Science U S A* 94:8618–8621.
- Berenbaum, M. R. 1995. Aposematism and mimicry in caterpillars. *Journal of the Lepidopterists’ Society* 49:386–396.
- Berge, A., M. Delwiche, W. P. Gorenzel, and T. Salmon. 2007. Bird control in vineyards using alarm and distress calls. *American Journal of Enology and Viticulture* 58:135–143.
- Bird-X. 2016. QuadBlaster QB-4. http://www.bird-x.com/quadblaster-qb-4-products-82.php?page_id=103 (accessed September 15, 2016).
- Bishop, J., H. McKay, D. Parrott, and J. Allan. 2003. Review of international research literature regarding the effectiveness of auditory bird scaring techniques and potential alternatives. Unpublished report prepared by Central Science Laboratory for the Department for Environment, Food & Rural Affairs, London.
- Blackwell, B. F., G. E. Bernhardt, and R. A. Dolbeer. 2002. Lasers as nonlethal avian repellents. *Journal of Wildlife Management* 66:250–258.
- Blackwell, B. F., T. L. DeVault, T. W. Seamans, S. L. Lima, P. Baumhardt, and E. Fernandez-Juricic. 2012. Exploiting avian vision with aircraft lighting to reduce bird strikes. *Journal of Applied Ecology* 49:758–766.
- Bomford, M., and P. H. O’Brien. 1990. Sonic deterrents in animal damage control: A review of device tests and effectiveness. *Wildlife Society Bulletin* 18:411–422.
- Boudreau, G. W. 1968. Alarm sounds and responses of birds and their application in controlling problem species. *Living Bird* 7:27–46.
- Brough, T. 1969. The dispersal of starlings from woodland roosts and the use of bioacoustics. *Journal of Applied Ecology* 6:403–410.

- Bruggers, R. L., J. E. Brooks, R. A. Dolbeer, P. P. Woronecki, R. K. Pandit, T. Tarimo, All-India Co-ordinated Research Project on Economic Ornithology, and M. Hoque. 1986. Responses of pest birds to reflecting tape in agriculture. *Wildlife Society Bulletin* 14:161–170.
- Burkhardt, D. 1982. Birds, berries and UV. *Naturwissenschaften* 69:153–157.
- Chen, D.-M., J. S. Collins, and T. H. Goldsmith. 1984. The ultraviolet receptor of bird retinas. *Science* 225:337–340.
- Cleary, E. C., and R. A. Dolbeer. 2005. *Wildlife hazard management at airports: A manual for airport personnel*. Second edition. Washington: Federal Aviation Administration, Office of Safety and Standards.
- Coniff, R. 1991. Why catfish farmers want to throttle the crow of the sea. *Smithsonian* 22:44–55.
- Conover, M. R. 1983. Pole-bound hawk-kites failed to protect maturing cornfields from blackbird damage. *Bird Control Seminar* 9:85–90.
- Conover, M. R. 1984. Comparative effectiveness of avitrol, exploders, and hawk-kites in reducing blackbird damage to corn. *Journal of Wildlife Management* 48:109–116.
- Conover, M. R., and R. A. Dolbeer. 1989. Reflecting tapes fail to reduce blackbird damage to ripening cornfields. *Wildlife Society Bulletin* 17:441–443.
- Cook, A., S. Rushton, J. Allan, and A. Baxter. 2008. An evaluation of techniques to control problem bird species on landfill sites. *Environmental Management* 41:834–843.
- Cummings, J. L., C. E. Knittle, and J. L. Guarino. 1986. Evaluating a pop-up scarecrow coupled with a propane exploder for reducing blackbird damage to ripening sunflower. *Vertebrate Pest Conference* 12:286–291.
- Cummings, J. L., S. A. Shwiff, and S. K. Tupper. 2005. Economic impacts of blackbird damage to the rice industry. *Wildlife Damage Management Conference* 11:317–322.
- DeHaven, R. W. 1971. Blackbirds and the California rice crop. *Rice Journal* 74:7–8.
- Delwiche, M. J., A. P. Houk, W. P. Gorenzel, and T. P. Salmon. 2005. Electronic broadcast call unit for bird control in orchards. *Applied Engineering in Agriculture* 21:721–727.
- Dolbeer, R. A. 1998. Evaluation of shooting and falconry to reduce bird strikes with aircraft at John F. Kennedy International Airport. *International Bird Strike Committee Meeting* 24:145–158.
- Dolbeer, R. A., P. P. Woronecki, and R. L. Bruggers. 1986. Reflecting tapes repel blackbirds from millet, sunflowers, and sweet corn. *Wildlife Society Bulletin* 14:418–425.
- Dolbeer, R. A., P. P. Woronecki, and R. W. Bullard. 1992. Visual cue fails to enhance bird repellency of methiocarb in ripening sorghum. In *Chemical signals in vertebrates VI*, eds. R. L. Doty and D. Müller-Schwarze, pp. 323–330. New York: Plenum Press.
- Dooling, R. 1982. Auditory perception in birds. In *Acoustic communication in birds* (Vol. 1), eds. D. Kroodsma and E. Miller, pp. 95–130. New York: Academic Press.
- Eaton, A. 2010. *Bird damage prevention for northern New England fruit growers*. University of New Hampshire Cooperative Extension Service. https://extension.unh.edu/resources/files/Resource001797_Rep2514.pdf (accessed July 11, 2016).
- Elmahdi, E. M., R. W. Bullard, and W. B. Jackson. 1985. Calcium carbonate enhancement of methiocarb repellency for quelea. *Tropical Pest Management* 31:67–72.
- Erickson, W. A., R. E. Marsh, and T. P. Salmon. 1990. A review of falconry as a bird-hazing technique. *Vertebrate Pest Conference* 14:314–316.
- Ezeonu, S. O., D. O. Amaefule, and G. N. Okonkwo. 2012. Construction and testing of ultrasonic bird repeller. *Journal of Natural Sciences Research* 2:8–17.
- Fitzgerald, S. 2013. *Managing bird damage in crops*. Ontario Fruit and Vegetable Growers Association. <https://onvegetables.files.wordpress.com/2013/06/managing-bird-damage-in-crops-factsheet-final.pdf> (accessed July 11, 2016).
- Frings, H., M. Frings, B. Cox, and L. Peissner. 1955. Recorded calls of herring gulls (*Larus argentatus*) as repellents and attractants. *Science* 121:340–341.
- Frings, H., and J. Jumber. 1954. Preliminary studies on the use of a specific sound to repel starlings (*Sturnus vulgaris*) from objectionable roosts. *Science* 119:318–319.
- Garner, K. M. 1978. Management of blackbird and starling winter roost problems in Kentucky and Tennessee. *Vertebrate Pest Conference* 8:54–59.
- Gilsdorf, J. M., S. E. Hygnstrom, and K. C. Vercauteren. 2002. Use of frightening devices in wildlife damage management. *Integrated Pest Management Review* 7:29–45.

- Gionfriddo, J. P., and L. B. Best. 1996. Grit color selection by house sparrows and northern bobwhites. *Journal of Wildlife Management* 60:836–842.
- Glahn, J. F. 2000. Comparison of pyrotechnics versus shooting for dispersing double-crested cormorants from their night roosts. *Vertebrate Pest Conference* 19:44–48.
- Glahn, J. F., G. Ellis, P. Fioranelli, and B. S. Dorr. 2001. Evaluation of moderate and low-powered lasers for dispersing double-crested cormorants from their night roosts. *Wildlife Damage Management Conference* 9:34–48.
- Gorenzel, W. P., B. F. Blackwell, G. D. Simmons, T. P. Salmon, and R. A. Dolbeer. 2002. Evaluation of lasers to disperse American crows, *Corvus brachyrhynchos*, from urban night roosts. *International Journal of Pest Management* 48:327–331.
- Gorenzel, W. P. and T. P. Salmon. 1993. Tape-recorded calls disperse American crows from urban roosts. *Wildlife Society Bulletin* 21:334–338.
- Gorenzel, W. P. and T. P. Salmon. 2008. *Bird hazing manual; techniques and strategies for dispersing birds from spill sites*. Publication 21638. University of California Agriculture and Natural Resources Communication Services, Oakland, CA.
- Gould, G. R. 1959. The LASER, Light Amplification by Stimulated Emission of Radiation. In *The Ann Arbor Conference on Optical Pumping*, eds. P. A. Franken and R. H. Sands, p. 128, University of Michigan, Abstract. June 15–18, 1959. Ann Arbor, MI.
- Greig-Smith, P. W., and C. M. Rowney. 1987. Effects of colour on the aversions of starlings and house sparrows to five chemical repellents. *Crop Protection* 6:402–409.
- Handegard, L. L. 1988. Using aircraft for controlling blackbird/sunflower depredations. *Vertebrate Pest Conference* 13:293–294.
- Heidenreich, C. 2007. *Bye birdie – Bird management strategies for small fruit*. Cornell Cooperative Extension. <http://www.fruit.cornell.edu/berry/ipm/ipmpdfs/byebyebirdiesmallfruit.pdf> (accessed July 11, 2016).
- Heinz, R., J. M. Sinnott, and M. B. Sachs. 1977. Auditory sensitivity of the redwing blackbird (*Agelaius phoeniceus*) and brown-headed cowbird (*Molothrus ater*). *Journal of Comparative and Physiological Psychology* 91:1365–1376.
- Homan, H. J., A. A. Slowik, B. F. Blackwell, and G. Linz. 2010. Field testing class IIIb handheld lasers to disperse roosting blackbirds. *National Sunflower Association Sunflower Research Forum*, January 13–14, 2010. Fargo, ND. <http://u95010.eos-intl.net/U95010/OPAC/Common/Pages/GetDoc.aspx?ClientID=MU95010&MediaCode=4818003>
- Hothem, R. L., and R.W. DeHaven. 1982. Raptor-mimicking kites for reducing bird damage to wine grapes. *Vertebrate Pest Conference* 10:171–178.
- Jaremovic, R. 1990. Bioacoustical scaring trials. In *National Bird Pest Workshop Proceedings*, ed. P. Fleming, I. Temby and J. Thompson, pp. 98–110. University of New England, Armidale, New South Wales, Australia.
- JWB Marketing. 2014. *Scare Windmill: \$89*. <http://www.birdcontrolsupplies.com/windTurkey.htm> (accessed August 30, 2016).
- Kalmbach, E. R., and Welch, J. F. 1946. Colored rodent baits and their value in safeguarding birds. *Journal of Wildlife Management* 10:353–360.
- Kreithen, M. L. and T. Eisner. 1978. Ultraviolet light detection by homing pigeon. *Nature* 273:347–348.
- Linz, G. M., H. J. Homan, S. W. Werner, H. M. Hagy, and W. J. Bleier. 2011. Assessment of bird management strategies to protect sunflower. *BioScience* 61:960–970.
- Loria, K. 2014. Good gyrations; inflatable dancers scare off birds. *Fruit Growers News* 53(3):1, 8.
- Lustick, S. 1973. The effect of intense light on bird behavior and physiology. *Bird Control Seminar* 6:171–186.
- Lyytinen, A., R. V. Alatalo, L. Lindström, and J. Mappes. 2001. Can ultraviolet cues function as aposematic signals? *Behavioral Ecology* 12:65–70.
- Manikowski, S., and F. Billiet. 1984. Coloured flags protect ripening rice against *Quelea guelea*. *Tropical Pest Management* 30:148–150.
- Marsh, R. E., W. A. Erickson, and, T. P. Salmon. 1991. Bird hazing and frightening methods and techniques (with emphasis on containment ponds). *Other Publications in Wildlife Management*. Paper 51. University of California, Davis, CA.
- Marsh, R. E., W. A. Erickson, and, T. P. Salmon. 1992. Scarecrows and predator models for frightening birds from specific areas. *Vertebrate Pest Conference* 15:112–114.

- Mason, J. R., L. Clark, and N. J. Bean. 1993. White plastic flags repel snow geese (*Chen caerulescens*). *Crop Protection* 12:497–500.
- Mason, J. R., and R. F. Reidinger, Jr. 1983. Importance of color for methiocarb-induced food aversions in red-winged blackbirds. *Journal of Wildlife Management* 47:383–393.
- Merriam-Webster. 2016. *Definition of bioacoustics*. <http://www.merriam-webster.com/dictionary/bioacoustics> (accessed September 15, 2016).
- Mott, D. F. 1983. Influence of low-flying helicopters on the roosting behavior of blackbirds and starlings. *Bird Control Seminar* 9:81–84.
- Mott, D. F. 1985. Dispersing blackbird-starling roosts with helium-filled balloons. *Eastern Wildlife Damage Control Conference* 2:156–162.
- Naef-Daenzer, L. 1983. Scaring of carrion crows (*Corvus corone corone*) by species-specific distress calls and suspended bodies of dead crows. *Bird Control Seminar* 9:91–95.
- Odeen, A., and O. Hastad. 2013. The phylogenetic distribution of ultraviolet sensitivity in birds. *BMC Evolutionary Biology* 13:36. DOI: 10.1186/1471-2148-13-36.
- Pearson, E. W., P. R. Skon, G. W. Corner. 1967. Dispersal of urban roosts with records of starling distress calls. *Journal of Wildlife Management* 31:502–506.
- Schaefer, H. M., D. J. Levey, V. Schaefer, and M. L. Avery. 2006. The role of chromatic and achromatic signals for fruit detection by birds. *Behavioral Ecology* 17:784–789.
- Seamans, T. W. 2004. Response of roosting turkey vultures to a vulture effigy. *Ohio Journal of Science* 104:136–138.
- Seamans, T. W., and G. E. Bernhardt. 2004. Response of Canada geese to a dead goose effigy. *Vertebrate Pest Conference* 21:104–106.
- Seamans, T. W., B. F. Blackwell, and J. T. Gansowski. 2002. Evaluation of the Allsopp Helikite® as a bird scaring device. *Vertebrate Pest Conference* 20:123–128.
- Schmidt, R. H., and R. J. Johnson. 1983. Bird dispersal recordings: An overview. In *Vertebrate pest control and management materials: Fourth symposium ASTM STP 817*, ed. D. E. Kaukeinen, pp. 43–65. American Society for Testing and Materials, Philadelphia, PA.
- Shirota, Y., M. Sanada, and S. Masaki. 1983. Eyespotted balloons as a device to scare grey starlings. *Applied Entomology and Zoology* 18:545–549.
- Solman, V.E.F. 1981. Birds and aviation. *Environmental Conservation* 8:45–52.
- Stickley, Jr., A. R., and J. O. King. 1995. Long-term trial of an inflatable effigy scare device for repelling cormorants from catfish ponds. *Eastern Wildlife Damage Control Conference* 6:89–92.
- Swaddle, J. P., D. L. Moseley, M. K. Hinders, and E. P. Smith. 2016. A sonic net excludes birds from an airfield: Implications for reducing bird strike and crop losses. *Ecological Applications* 26:339–345.
- Tillman, E. A., J. S. Humphrey, and M. L. Avery. 2002. Use of vulture carcasses and effigies to reduce vulture damage to property and agriculture. *Vertebrate Pest Conference* 20:123–128.
- Tipton, A. R., J. H. Rappole, A. H. Kane, R. H. Flores, D. B. Johnson, J. M. Hobbs, P. Schulz, S. L. Beasom, and J. Palacios. 1989. Use of monofilament line, reflective tape, beach balls, and pyrotechnics for controlling grackle damage to citrus. *Great Plains Wildlife Damage Control Workshop* 9:126–128.
- Tobin, M. E., P. P. Woronecki, R. A. Dolbeer, and R. L. Bruggers. 1988. Reflecting tape fails to protect ripening blueberries from bird damage. *Wildlife Society Bulletin* 16:300–303.
- TONI Bird Control Solutions. 2016. *Acoustic solution – Directional beam*. <http://www.birdcontrolsolutions.net/en/solutions/irad.php> (accessed September 15, 2016).
- Warnes, K. 2016. *Scarecrows historically speaking*. <http://historybecauseitshere.weebly.com/scarecrows-historically-speaking.html> (accessed June 25, 2016).
- Werner, S. J., S. T. DeLiberto, S. E. Pettit, and A. M. Mangan. 2014. Synergistic effect of an ultraviolet feeding cue for an avian repellent and protection of agricultural crops. *Applied Animal Behavior Science* 159:107–113.
- Werner, S. J., B. A. Kimball, and F. D. Provenza. 2008. Food color, flavor, and conditioned avoidance among red-winged blackbirds. *Physiology and Behavior* 93:110–117.
- Werner, S. J., S. K. Tupper, J. C. Carlson, S. E. Pettit, J. W. Ellis, and G. M. Linz. 2012. The role of a generalized ultraviolet cue for blackbird food selection. *Physiology and Behavior* 106:597–601.
- Yasukawa, K., and W. A. Searcy. 1995. Red-winged blackbird (*Agelaius phoeniceus*). No. 184. *The Birds of North America*, ed. P. G. Rodewald. Cornell Lab of Ornithology, Ithaca, New York. <https://birdsna.org/Species-Account/bna/species/rewbla> (accessed September 25, 2016).
- Zajanc, A. 1963. Methods of controlling starlings and blackbirds. *Vertebrate Pest Conference* 1:190–212.