Brown-Headed Cowbird (*Molothrus ater*) Response to Pyrotechnics and Lethal Removal in a Controlled Setting

Thomas W. Seamans, Bradley F. Blackwell and Travis L. DeVault
USDA-APHIS-Wildlife Services, National Wildlife Research Center, Ohio Field Station, Sandusky, Ohio

ABSTRACT: Pyrotechnics have long been used to frighten birds from specific areas but birds might habituate to them. Anecdotal and limited published reports suggest that killing a flock member can reduce habituation. However, little behavioral work has been conducted in this area. We exposed brown-headed cowbirds (*Molothrus ater*) to noise from either 0.22 caliber blanks or 15-mm pyrotechnics in a series of controlled, cage experiments to determine if killing a flock member increased the time that cowbirds respond to pyrotechnics. Cowbirds responded no differently to pyrotechnics following the death of a flock member either before or after habituation to pyrotechnics. Our results might have been influenced by cage effects or perceived inconsequence of the death of a conspecific. Further work with other species is warranted, particularly with regard to sociality.

KEY WORDS: brown-headed cowbirds, habituation, lethal control, *Molothrus ater*, pyrotechnics

Proceedings of the 15th Wildlife Damage Management Conference.
(J. B. Armstrong, G. R. Gallagher, Eds). 2013. Pp. 56-62.

INTRODUCTION

Large flocks or sometimes individual birds can create conflicts with humans (e.g., damage to agriculture, structures, aviation safety). These conflicts are often mitigated with various nonlethal control techniques. One such technique is the use of pyrotechnics, devices that explode in the air, creating a loud sound similar to the report of a firearm. The use of pyrotechnics to frighten birds has long been recognized as an effective, humane, non-lethal means of causing birds to move away from conflict situations (Boudreau 1975, Mott 1980, Hadidian et al. 1997). However, birds often fail to respond to pyrotechnics after multiple exposures (Blokpoel 1976, Inglis 1980, Slater 1980, Summers 1985). Such a degradation in response to repeated stimulation is termed habituation (Blumstein and Fernández-Juricic 2010). The often-suggested method of overcoming habituation is to lethally remove one or more birds with a firearm to reinforce the threat posed by the explosion of a pyrotechnic (Hochbaum et al. 1954, Slater 1980, Summers 1985, Smith et al. 1999). There is limited published work however that directly supports this claim. Baxter and Allan (2008) demonstrated that free-flying gulls responded to lethal reinforcement of pyrotechnics, whereas corvids did not respond similarly to the shooting of conspecifics at the same location. Cook et al. (2008) examined a variety of gull control techniques and found that those which were primarily nonlethal, yet included a lethal component, were more effective than those techniques with no lethal component.

Still, the behavioral cues associated with a bird killed (as opposed to a bird dead amidst a flock) may be critical to enhancing the response by flock members to pyrotechnics. For example, in studies of turkey vulture (*Cathartes aura*; Avery et al. 2002, Seamans 2004), Canada goose (*Branta canadensis*; Seamans and Bernhardt 2004), and gull effigies (Seamans et al. 2007), the mere presence of a dead conspecific elicited inconsistent reactions of targeted birds. Seamans (2004) showed that although turkey vultures abandoned roosts when effigies were hung head-down and allowed to move with the wind, they did not abandon the roosts when static effigies were lying on the ground. Canada geese, despite showing strong initial reaction to effigies, quickly habituated to their presence (Seamans and Bernhardt 2004). In contrast, behaviors associated with perceived predation can elicit antipredator behaviors among flock members or conspecifics (e.g., ring-billed gull [*Larus delawarensis*] response to human intrusion into a colony and handling of young; Conover 1987). We note that response by waterfowl and blackbirds to lethal enhancement of pyrotechnic treatments has not been documented.

Our purpose was to determine if, within a brown-headed cowbird (*Molothrus ater*) flock, the death of a flock member would enhance the effects of pyrotechnic treatment such that we could extend the duration of response to pyrotechnics and thus the time period until habituation. Our hypothesis was that the lethal removal of an individual from a conspecific flock would be associated, by the remaining flock members, with the sound of a pyrotechnic exploding at the time of lethal removal, thus resulting in a longer effective time of pyrotechnics until habituation.

STUDY AREA

This study was conducted at the National Aeronautics and Space Administration Plum Brook Station (PBS), Erie County, Ohio (41°27′N, 82°42′W). PBS is a 2,200-ha fenced facility with large tracts of open, fallow fields, interspersed with woodlots, and surrounded by agricultural fields. The station is home to a resident population of brown-headed cowbirds and is a staging area for migrating cowbirds.

METHODS

During April 2009 and 2010 we captured 180 and 162 male brown-headed cowbirds, respectively, in decoy traps, and held them in an enclosed aviary where they were fed a millet-sunflower mix and given water and grit ad libitum. Our protocol (QA-1564) was approved by the National Wildlife Research Center's Institutional Animal Care and Use Committee. We conducted our experiments between April and July in both years.

In 2009 our experimental protocol included isolation of test birds in a 2.4- x 2.4- x 1.8-m cage without food for 12 hours, but with water provided ad libitum. After 2009, we recognized that birds were not feeding extensively when placed in the test cage therefore, in 2010 we provided isolated birds food and water ad libitum to better simulate field conditions. The test cage (3.6- x 17.0- x 2.4-m) was located in a grassy area and contained 1 perch on either end, as well as food and water in 45-cm diameter pans placed either in the center of the cage or about 1-m from center towards an end of the cage, depending upon the experiment. By using a sole site for the experiment we reduced any impact distance to escape cover would have on mitigating bird behavior under threatening conditions. We mowed all grass to about 8-cm tall in the cage and within 4-m of the edge of the cage either the day before or the morning of a test. We moved 6 naive birds from the holding cage into the test cage on the morning of a test at about the same time each morning.

In 2009 we conducted 3 experiments, with each experiment including 10 groups of 6 birds (N = 60 birds). All observations were made from a ground blind set adjacent to the end of the test cage (Fig. 1a). We placed a similar blind at the other end of the cage but did not occupy that blind because shots taken from there would have been towards a road and deemed unsafe. We placed food and water pans towards the end of the cage closest to the occupied blind. For each experimental replicate, we allowed 15 minutes for the group of birds to acclimate to the cage before beginning treatment and observations.

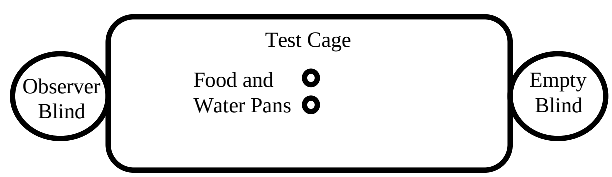

Figure 1A. Orientation of observation blinds (2.0-m x 2.0-m x 1.8-m) and test (3.6-m x 17.0-m x 2.4-m) cage during the first year of testing (HSH and SH experiments).

Our experiments were designed to simulate possible field scenarios in which a wildlife manager disperses birds with pyrotechnics and lethally removes some individuals in an attempt to enhance the nonlethal harassment. Across experiments, we varied the extent of use and timing of pyrotechnics and lethal removal. We also included control scenarios to investigate possible differential use of the cage by undisturbed flocks.

In 2009 our first experiment simulated a situation in which a manager kills a bird after habituation to pyrotechnics occurs. This experiment involved the firing of 0.22-caliber blanks from a pyrotechnic pistol and was designated the habituate-shoot-habituate (HSH) experiment. We chose to use blanks instead of actual pyrotechnics because we were so close to the cage that any pyrotechnic would have exploded well beyond the cage and logically would not have been associated with the end of the cage being defended. After the 15-min acclimation period, we fired one blank immediately every time at least 1 bird landed anywhere on the ground, perch or cage within the half of the cage containing the food and water (i.e., closest to the occupied blind). The number of shots taken and the rate of shots were solely dependent on bird presence in the defended half of the cage. When >3 birds closest to the blind did not react to the shot (measured by noting whether birds flew, jumped, walked or ran away), but continued what they were doing for 5 consecutive shots fired within about 10 seconds, the flock was considered habituated. At this point we killed 1 of the non-reacting birds, via a 0.22-caliber AirForce Talon SS™ pellet rifle equipped with a sound reducing barrel, while simultaneously shooting a blank from the pyrotechnic pistol. We then continued to fire blanks as described above until ≥3 birds again demonstrated habituation by not responding to 5 consecutive shots.

We designed the second experiment to simulate a situation in which a manager kills a bird first and then employs pyrotechnics. This experiment involved blanks and was designated the shoot-habituate (SH) experiment. Here, after the acclimation period we killed the first bird that landed near the food pan, via the pellet rifle and simultaneously fired a blank. We then fired blanks whenever a bird landed within the end of the cage containing the food and water. When ≥3 birds closest to the defended end did not react but continued what they were doing for 5 consecutive blank shots, the flock was considered habituated and the experiment ended.

For our control experiment we observed the birds for 2 hours from within the blind, noting the location of each bird within each half (the "defended" or not defended ends from the treatment portion of the experiment) of the cage and whether it was on a perch, the ground, cage, feed, or water pan once every 3 minutes. Bird locations recorded as "cage" indicate that a bird was perched on some portion of the cage other than the provided perches. No birds were killed and no blanks were fired.

In 2010 we moved the blind so that it was centered on the east side of the cage and 6 m from the edge of the cage (Fig. 1b).

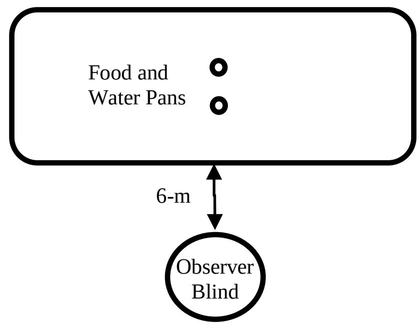

Figure 1B. Orientation of the observation blind to the test cage during the second year of testing (DSH and DHSH experiments both in and outside of the blind).

We chose this location so that we were not looking into the sun during observations and it provided a safe background when we shot birds. We also placed food and water pans in the center of the cage and increased the acclimation period to 30 minutes. Additionally, now that we were farther from the cage and could direct pyrotechnics to explode near a desired end we switched from shooting 0.22-caliber blanks to a 15-mm "Bird Bomb®" or bird banger (Zink-Feuerwerk, Cleebronn, Germany) from a pyrotechnic pistol. Although we did not measure the sound levels produced by blanks and bangers, it is apparent the banger is louder than a blank. We conducted 5 experiments, 2 from within the blind and 3 while positioned immediately in front of the blind, yet following the same procedure as when in the blind. For these experiments, we used 6 naive birds per group and 5 groups per experiment (N = 30 birds/experiment). During the acclimation period in all experiments, we noted the location of all birds once every 3 minutes to determine which end of the cage was apparently favored.

Our first two experiments in 2010 were designed to simulate a scenario where a manager kills a bird before the targeted species habituates to pyrotechnics. We designated these experiments as the defend-shoot-habituate (DSH) experiments and were completed either from within or immediately in front of the blind. In this manner, we included the potential effect of human presence. Following the acclimation period, we defended the preferred side of the cage by firing a pyrotechnic beyond the defended end whenever a bird landed anywhere in that end. We continued to defend the preferred end for a maximum of 60 minutes. In addition, we recorded the location of each bird within the cage (by end of cage and location within that end) once every 3 minutes. Following the defense portion of the test, we killed 1 bird that was near at least 2 others with the pellet rifle. Simultaneously to killing 1 bird, we fired a pyrotechnic towards the same end of the cage. From this point on, we fired a pyrotechnic past the end of the cage in which the majority of the birds had landed. We continued this continuous fire until we had 5 consecutive shots with no reaction (e. g., birds did not fly, jump or run at the moment of the shot) by ≥ 3 birds.

We designed 2 additional experiments to simulate the scenario of a manager firing pyrotechnics until birds habituate to them, with the manager then attempting to enhance the pyrotechnics by killing a bird. These experiments were designated the defend-habituate-shoot-habituate (DHSH) experiments. Following the acclimation period, we defended the preferred side of the cage for a maximum of 60 minutes by firing pyrotechnics every time a bird landed on this side. We then chased birds from 1 end of the cage to the other by firing pyrotechnics past the end of the cage in which the majority of the flock had landed. We continued chasing until >3 birds did not respond to the pyrotechnic for 5 consecutive shots. We then killed 1 non-reactive bird in the flock that was near at least 2 other birds with the pellet rifle. Simultaneously to killing 1 bird, we fired a pyrotechnic towards the end of the cage where the fatality occurred. We then resumed chasing the birds with pyrotechnics until ≥ 3 did not react for 5 consecutive shots. We completed 5 replications outside of the blind and 6 replications in the blind. We used 6 birds for each replication.

In addition, we conducted control experiments which included a 30-minute acclimation period and 90-minute observation period, during which we recorded bird locations once every 3 minutes. As before, bird locations recorded as "cage" indicate that a bird was perched on some portion of the cage other than the provided perches. No pyrotechnics or lethal control treatments were used. Also, all observations were made from in front of the blind, thus exposing each group to human presence, as was done in 3 experiments. We completed 6 replications and used 6 birds for each replication.

We did not replicate experiments between years, but instead our data represent a series of experiments replicated within a year, each with the same response variable. We did run experiments during approximately the same time each day and under similar weather conditions in order to reduce any bias associated with time of day, wind or precipitation. Thus, because a year effect was not concern, we conducted our analysis as a comparison across experiments, with elapsed time to habituation after lethal removal serving as the response variable. As noted earlier, our control experiments served to indicate whether birds used areas of the test cage differentially and we did not compare years.

Our data were distributed normally across experiments within and between years. We used a one-way analysis of variance (ANOVA) to compare the total duration of each experiment (i.e., time until habituation for SH, HSH, DSH, DHSH scenarios), excluding acclimation periods and number of shots fired. Subsequent to the ANOVA we used the Tukey pairwise comparisons test with Bonferroni correction. To determine whether human presence influenced cowbird reaction, we compared the mean time spent and number of shots fired while defending the desired end of the cage during the 2010 experiments when we were either within or outside of the blind. For control groups, we assessed the use of cage areas and ends relative to observer presence, also using a Welch's ANOVA.

RESULTS

The overall time to habituation within all tests differed ($F_{5, 36} = 6.49$, $P < 0.01$) with the HSH experiment (where blanks were fired) being shortest in duration and all bird banger experiments being similar in duration (Table 1).

Table 1. The mean number of shots fired per minute (standard deviation) toward brown-headed cowbirds and the mean length of time (standard deviation) of experiments (see text for description) during the initial defense of the desired end of a flight cage (Max. = 60 minutes) and the chase portion of the test.

Observer Location	Experiment	Period	Time (sd)	Shots/min (sd)
In Blind	DSH	Defense	60.0 (00.0)	0.4 (0.2)
In Blind	DHSH	Defense	53.5 (15.9)	0.6 (0.5)
Outside Blind	DSH	Defense	60.0 (00.0)	1.4 (0.4)
Outside Blind	DHSH	Defense	37.2 (28.2)	1.4 (1.1)
In Blind	DSH	Chase	17.6 (09.8)	4.1 (1.6)
In Blind	DHSH	Chase	12.0 (10.7)	3.7 (1.4)
Outside Blind	DSH	Chase	10.0 (08.9)	3.8 (1.9)
Outside Blind	DHSH	Chase	20.4 (27.5)	2.5 (2.2)
End Cage	SH	Defense	56.0 (27.0)	0.6 (0.3)
End Cage	HSH	Defense	31.8 (15.1)	0.9 (0.3)

We compared the DSH and DHSH experiments to determine if the obvious presence of a human firing pyrotechnics influenced the response times of cowbirds. The mean time spent defending the preferred end of the cage was similar ($F_{3, 17} = 2.22$, $P = 0.12$) for all experiments. The mean number of bird bangers fired each minute while defending the preferred end of the cage differed ($F_{3, 17} = 3.87$, $P = 0.03$) between experiments with those experiments where we were outside of the blind generally requiring more shots fired than when we were in the blind (Table 1). The mean length of time spent chasing birds ($F_{3, 17} = 0.29$, $P = 0.83$) and number of bird bangers fired each minute while chasing birds from end to end was similar ($F_{3, 17} = 0.78$, $P = 0.52$) whether we were in or out of the blind in all 4 experiments (Table 1).

Observations during the control experiments indicated that birds used areas within the cage differently but generally used both ends of the cage equally. Specifically, when observed from the blind at the end of the cage, mean bird use of areas within the cage differed ($F_{5, 22.6} = 22.76$, $P < 0.01$). But, cage and ground areas of defended or non-defended (areas closest to or furthest from the blind) ends were used similarly, whereas the non-defended perch was used more (Table2). When observed from outside of a blind placed 6-m away and centered from the side of the cage, mean bird use of areas within the cage differed ($F_{5, 15.8} = 12.48$, $P < 0.01$), but when comparing left and right side of the cage for cage and ground use they were similar. Left and right perch use again differed with the right perch being used more than the left (Table 2).

Table 2. The mean number of observations (standard deviation) of brown-headed cowbirds as noted during control observations from a blind located adjacent to the end of a flight cage and from the front of a blind 6-m to the side of the flight cage. The defended end was the end closest to the blind while the left and right sides are from perspective of the observer. No scare tactics were deployed during the observation period.

		Area		
Blind	End	Cage (sd)	Ground (sd)	Perch (sd)
Adjacent	Defended	0.04 (0.25)	1.80 (2.06)	0.55 (1.30)
Adjacent	Non-defended	0.12 (0.48)	1.77 (2.12)	0.95 (1.59)
Side	Left	0.47 (1.05)	2.03 (2.28)	0.13 (0.61)
Side	Right	0.38 (0.87)	2.06 (2.33)	0.62 (1.33)

DISCUSSION

Under conditions associated with an outdoor experimental cage, brown-headed cowbirds showed little to no evidence of responding to the shooting of a flock member, whether before or after habituation to pyrotechnics. In all experiments we observed members of the flock standing on or adjacent to the dead bird when the dead bird was next to or in the food pan. When a bird died near the edge of the cage, we again observed birds foraging next to or walking over the body. There seemed to be no recognition of an additional hazard associated with pyrotechnic treatment by killing the bird. This finding differs from gull reaction whereby the death of a conspecific enhances a non-lethal control method (Seamans et al. 2007, Baxter and Allen 2008, Cook et al. 2008).

Baxter and Allen (2008) also showed that variation in response to death of a conspecific exists, as corvids did not react to the killing of a conspecific. Lack of response by cowbirds could therefore be due to interspecific variation. However, as our experiments were conducted in a flight cage, there may have been a cage effect and birds might have recognized that they could not escape, resulting in similar behaviors between experiments due to their inability to escape. Additionally, no escape cover was provided in our experiments, and that also may have contributed to a cage effect. It is also possible that birds tired from being chased and could not react to the sound due to exhaustion. However, as we did not observe any obvious signs of exhaustion (e.g., breathing with mouth open, stumbling or crash landings) we discount that possibility. Alternatively, it is also possible that bird response to the death of a conspecific may vary depending on the social structure of the flock or the evaluation of risk by individuals within the flock (Lima and Dill 1990, Lima 1994, Creswell et al. 2000). In addition, food deprivation during the 2009 experiments may have influenced their behavior, as birds are more likely to risk a predation event when hungry (Grubb and Greenwald 1982, Lima 1988).

Despite the potential limitations caused by the cage effect, the lack of response by flock members to a dead conspecific suggests that cowbirds are not influenced by observing the death of a conspecific. Predicting which family or species of birds will react to the death of a conspecific is not possible at this time. Potential variables that may influence efficacy of lethal enhancement could include reproductive status at the time of a control effort, species mean lifespan, flock social structure, age of bird killed, physical condition of the flock, perception of risk in relation to the immediate environment, or other unknowns.

We suggest that additional work is necessary, particularly with waterfowl. For example, based on anecdotal reports, Canada geese respond to the death of a conspecific. Canada geese do initially respond to a dead goose effigy (Seamans and Bernhardt 2004), and this would seem to indicate that response to the death of a conspecific is likely. However, no published data is available to support or refute this idea. Future work with a variety of species that accounts for at least some of the variables discussed above may allow biologist the ability to predict when lethal enhancement will be effective.

MANAGEMENT IMPLICATIONS

Lethal enhancement of pyrotechnics appears to be a species specific behavioral response. Employment of lethal enhancement should be accompanied with objective measurements (e.g., number of pyrotechnics fired per hour) to indicate whether or not the efficacy of pyrotechnics is enhanced. Altering the type of pyrotechnic used may reduce habituation and thus some sort of rotation of pyrotechnics should be included in a pyrotechnic program.

ACKNOWLEDGMENTS

Funding for this study was provided by the USDA/National Wildlife Research Center and U.S. Federal Aviation Administration's (FAA) William J. Hughes Technical Center. Opinions expressed in these studies do not necessarily reflect current FAA policy decisions governing the control of wildlife on or near airports. We thank D. Steyer and L. Tyson for their assistance with field work and J. Beasley and 2 reviewers for their assistance with the manuscript.

LITERATURE CITED

AVERY, M. L., J. S. HUMPHREY, E. A. TILLMAN, K. O. PHARES, and J. E. HATCHER. 2002. Dispersing vulture roosts on communication towers. Journal of Raptor Research 36:45–50.

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.

Blokpoel, H. 1976. Bird hazards to aircraft. Books Canada, Buffalo, NY, USA.

BLUMSTEIN, D. T., and E. FERNÁNDEZ-JURICIC. 2010. A primer on conservation behavior. Sinauer Associates, Sunderland, Massachusetts, USA.

BOUDREAU, G. W. 1975. How to win the war with pest birds. Wildlife Technology, Hollister, California, USA.

CONOVER, M. R. 1987. Acquisition of predator information by active and passive mobbers in ring-billed gull colonies. Behaviour 102: 41–57.

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.

CRESSWELL, W., G. M. HILTON, and R. D. RUXTON. 2000. Evidence for a rule governing the avoidance of superfluous escape flights. Proceedings of the Royal Society B 267:733–737.

GRUBB, T. C., JR., and L. GREENWALD. 1982. Sparrows and a brushpile: foraging responses to different combinations of predation risk and energy cost. Animal Behaviour 30:637–640.

HADIDIAN, J., G. R. HODGE, and J. W. GRANDY. 1997. Wild neighbors: the humane approach to living with wildlife. The Humane Society of the United States. Fulcrum Publishing, Golden, CO, USA.

HOCHBAUM, H. A., S. T. DILLON, and J. L. HOWARD. 1954. An experiment in the control of waterfowl depredations. North American Wildlife Conference 19:176–185.

INGLIS, I. R. 1980. Visual bird scarers: an ethological approach. Pages 121–143 *in* E. N. Wright, I. R. Inglis, and C. J. Feare, editors. Bird Problems in Agriculture. BCPC Publications, London, England.

LIMA, S. L. 1988. Initiation and termination of daily feeding in dark-eyed juncos: influences of predation risk and energy reserves. Oikos 53:3–11.

LIMA, S. L. 1994. Collective detection of predatory attack by birds in the absence of alarm signals. Journal of Avian Biology 25:319–326.

LIMA, S. L., and L. M. DILL. 1990. Behavioral decisions made under the risk of predation: a review and prospectus. Canadian Journal of Zoology 68:619–640.

MOTT, D. F. 1980. Dispersing blackbirds and starlings from objectionable roost sites. Proceedings of the Vertebrate Pest Conference 9:38–42.

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. Proceedings of the Vertebrate Pest Conference 21:104–106.

SEAMANS, T. W., C. R. HICKS, and K. J. PREUSSER. 2007. Dead bird effigies: a nightmare for gulls? <http://www. bird strike canada.com/Papers.htm>. Accessed 15 Feb 2009.

SLATER, P. J. B. 1980. Bird behaviour and scaring by sounds. Pages 105–114 *in* E. N. Wright, I. R. Inglis, and C. J. Feare, editors. Bird Problems in Agriculture. BCPC Publications, London, England.

SMITH, A. E., S. R. CRAVEN, and P. D. CURTIS. 1999. Managing Canada geese in urban environments. Jack Berryman Institute Publication 16, and Cornell Cooperative Extension, Ithaca, New York, USA.

SUMMERS, R. W. 1985. The effect of scarers on the presence of starlings (*Sturnus vulgaris*) in cherry orchards. Crop Protection 4:520–528.