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Behavioral Responses of Red-winged Blackbirds to Simulated Predators: Evidence of Potential Habituation to Video Stimuli

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ABSTRACT: Wildlife damage to crops has a significant impact on crop productivity, and mitigating the impacts of damage requires managers to employ multiple and creative solutions. The development of Unmanned Aerial Systems (UAS, drones) provides a new tool that may be effective in managing bird damage to crops. We used multisensory video/audio playback to assess the behavioral responses of red-winged blackbirds (RWBL) to videos of UAS. Captive birds were individually exposed to movies comprised of five video clips that varied in stimulus content on two occasions. Video stimuli included a known predator, UAS, and avian controls (birds that are not predators of RWBL). Although all test birds interacted with the movies, not all displayed the behaviors that were measured. Of those that did display the behaviors measured, responses to most video stimuli were reduced during the second trial compared to the first. These findings suggest that blackbirds are responding to videos; however, they habituate to video stimuli perceived as a non-threat and adjust their behavioral responses accordingly.

KEY WORDS: *Agelaius phoeniceus*, habituation, hazing, red-winged blackbirds, unmanned aerial systems (UAS)

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INTRODUCTION

Damage to food crops by migratory birds across North America results in significant costs to producers (Klosterman et al. 2013, Tillman et al. 2000). These migratory bird communities consist of species that capitalize on the seasonal production and concentration of high quality food sources. For example, blackbird (Icterinae) damage to agricultural crops is a significant economic problem for farmers in the Great Plains Region of North America. During the non-breeding season blackbirds form large mixed flocks that often forage in mature agricultural crops (Dolbeer et al. 1978). Recent damage estimates to corn and sunflower crops in the Prairie Pothole Region of North Dakota were $1.3 million and $3.5 million, respectively (Klosterman et al. 2013).

The impact on agricultural resources has created a need for methods to reduce blackbird population size and damage to crops. More specifically, there is a public preference for developing non-lethal control methods (McIvor and Conover 1994). Devices such as Unmanned Aerial Systems (UAS) have the potential as a non-lethal control method to reduce crop damage by blackbirds. Recently, UASs have been employed for low-altitude surveys of animal populations (Chabot and Bird 2012, Sardá-Palomera et al. 2012, Watts et al. 2010) and may serve as a tool to scare birds from airports (Blackwell et al. 2012). Additionally, autonomously controlled UAS equipped with scare tactic devices have been suggested as a method for controlling pest bird populations in vineyards (Grimm et al. 2012). Vehicles elicit anti-predator behavioral responses in birds (Blackwell et al. 2009, Bernhardt et al. 2010, Blackwell et al. 2012), and therefore UAS could be used as a management tool to deter birds from foraging in crops.

For this experiment, we used video and audio stimuli to assess the behavioral responses of blackbirds to UAS compared to other predatory and non-predatory stimuli. Video playback has been used to successfully elicit context appropriate behavioral responses in spiders (Pruden and Uetz 2004), fish (Clark and Stephenson 1999), frogs (Rosenthal et al. 2004), reptiles (Macedonia and Stamps 1994), birds (Partan et al. 2005), and mammals (Capitanio 2002). Video imagery has been used to assess courtship behavior, social interactions, and predatory-prey relationships in animals. Much of the previous research has focused on the use of videos to elicit courtship behavior and recognition in animals, but few have looked at predator-prey relationships (Table 1). Although animals will respond to video images alone (Macedonia and Stamps 1994), the combination of visual and acoustic signals elicit stronger context appropriate responses in frogs (Rosenthal et al. 2004) and birds (Partan et al. 2005, Galoch and Bischof 2007). For example, female rock doves (*Columba livia*) respond to the combination of video and audio playback of courting males with typical courtship behaviors more often than when either stimuli was employed alone (Partan et al. 2005). Additionally, male zebra finches (*Taeniopygia guttata*) responded to video of female zebra finches more strongly when videos were accompanied audio of the female (Galoch and Bischof 2007). Likewise, Rosenthal et al. (2004) found that female túngara frogs

Table 1. List of behavioral studies that used video playback to elicit behavioral responses in animals. Studies are organized based on the behavior assessed.

Behavior Assessed	Species	Citation
Courtship/breeding	**Three-spine stickleback** (*Gasterosteus aculeatus*)	Rowland 1995
	Cichlid (*Neolamprologus brichardi*)	Balshine-Earn and Lotem 1998
	Túngara frog (*Physalaemus pustulosus*)	Rosenthal et al. 2004
	Jacky dragon (*Amphibolurus muricatus*)	Ord et al. 2002
	Anole lizard (*Anolis graham*)	Macedonia and Stamps 1994
	Zebra finch (*Taeniopygia guttata castanotis*)	Ikebuchi and Okanoya 1999 Swaddle et al. 2006 Galoch and Bischof 2007
	Rock dove (*Columba livia*)	Partan et al. 2005
	Bengalese finch (*Lonchura striata* var. *domestica*)	Ikebuchi and Okanoya 1999
Image discrimination/ individual and species recognition	**Cichlid** (*Neolamprologus brichardi*)	Balshine-Earn and Lotem 1998
	Anole lizard (*Anolis graham*)	Macedonia and Stamps 1994
	Tiger barb (*Puntius tetrazona*)	Clark and Stephenson 1999
	Zebra finch (*Taeniopygia guttata castanotis*)	Galoch and Bischof 2007 Adret 1997
	Rook (*Corvus frugilegus*)	Bird and Emery 2008
	Chicken (*Gallus gallus domesticus*)	D'eath and Dawkins 1996 Clarke and Jones 2001
Social interactions	**Chicken** (*Gallus gallus domesticus*)	Evans and Marler 1991 Evans et al. 1993*a*
	Rook (*Corvus frugilegus*)	Bird and Emery 2008
	Rhesus monkey (*Macaca mulatta*)	Capitanio 2002
Predator-prey interactions	**Chicken** (*Gallus gallus domesticus*)	Evans et al. 1993a,b
	Blue Jay (*Cyanocitta cristata*)	Ingalls 1993
	Wolf spider (*Schizocosa* spp.)	Pruden and Uetz 2004

(*Physalaemus pustulosus*) preferred video playback of calling males accompanied with advertisement calls to acoustic stimuli alone.

As previously mentioned, little research has been done using video imagery to assess predator-prey relationships, even less has focused on antipredator behavior. Research on chickens (*Gallus gallus domesticus*) suggests that computer-generated and video-recorded images of predators do elicit antipredator behavior (Evans et al. 1993a, Evans et al. 1993b). Male chickens presented with a moving image of an aerial predator produce aerial alarm calls and crouch, whereas those presented with video of ground predators produce ground alarm calls and seek cover (Evans et al. 1993a). Therefore, we sought to use video playback techniques to determine behavioral responses of red-winged blackbirds (*Agelaius phoeniceus*) to UAS.

We predicted that red-winged blackbirds would respond similarly to video of UAS (a predator mimic) as they would to video of falcons. Additionally, we predicted that antipredator behavioral responses of individuals would be more pronounced in response to the predator and predator-mimic videos in comparison to the videos of non-threatening stimuli. Furthermore, due to the tendency of pest species to habituate to scare tactics, we sought to determine if red-winged blackbirds would habituate to the video stimuli.

METHODS

Lab Experiment

Wild-caught red-winged blackbirds were color banded and allowed to acclimate to an outdoor aviary enclosure for a minimum of 14 days prior to experimental trials. A two-compartment cage, modified (i.e., dimensions increased to 91.44 × 60.96 × 35.56 cm) from Galoch and Bischof's (2007) design to accommodate the larger size of our model species compared to theirs, was used to present video stimuli to birds (Figure 1). Movies were displayed on a thin film transistor screen (Dell Ultrasharp 24" Monitor, Model No. U2412Mb, Dell Inc., Round Rock, TX) with two speakers (Dell Stero Speaker System, Model No. AX210CR). The behavior of

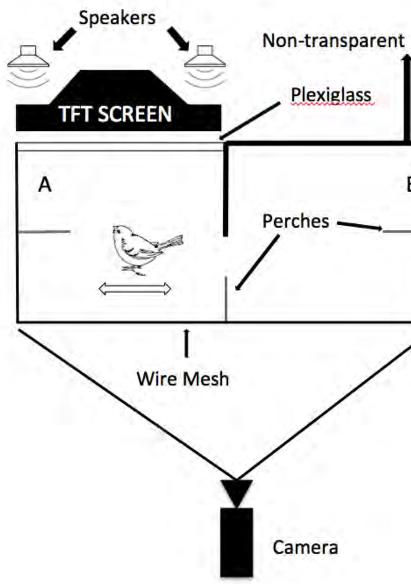

Figure 1. Experimental enclosure from above. (A) The TFT side where videos could be seen. (B) The refuge side where watching videos was not possible. Three perches were provided, one on either side and one in the center.

stimulus birds was recorded for 19 min with a video camera (Sony Handycam HDR-CX220, Sony Corp. of America, New York, NY) and behaviors were assessed following Blackwell et al. (2009). We recorded whether the individual spent time in refugia, flight response into the stimuli screen, and displaced aggression pecking during each video clip (Galoch and Bischof 2007). Time in refugia is a measure of seeking cover from the video stimulus. Flight into the TFT screen was used as a measure of lack of fear of the stimulus. Displaced aggresion pecking is a sign of distress in birds (Vestergaard et al. 1997); here, we used it as a sign of distress to video stimuli. Stimuli birds were exposed to 19-minute movies composed of three-minute video clips of the following scenes, presented in random order:

1) A video clip showing an empty cage (Control)
2) A video clip of a falcon in flight with call (Predator)
3) A video clip of a mallard in flight with call (Avian Control)
4) A video clip of a UAS in flight with natural motor sound (Predator Mimic)
5) A video clip of a UAS in flight with falcon call (Predator Mimic)

Movie segments were separated by one-minute intervals displaying an empty cage. Birds were allowed to acclimate to the testing environment for 30 minutes prior to starting the video clips, and individuals were run through the experimental trial twice. The minimum time between trials was 14 days. Behavioral trials were conducted between 15 December 2013 and 27 February 2014.

Statistical Analyses

Due to the variability of behavioral responses amongst individuals (and the potential it posed to unfairly weight the evaluation of those responses), we used contingency analyses to assess differences among behavioral responses. Statistical analyses were performed in JMP® statistical software (SAS Institute Inc., Cary, NC). Figures were created in R (R Foundation for Statistical Computing 3.2.0, Vienna, Austria).

Animal Care

All animals were housed at the NDSU-Conservation Research Center, an outdoor flight aviary located at the Red River Zoo, Fargo, ND. Birds were provided food (suet cakes and a mixture of sunflower seed, mealworms, raisins, non-medicated chick starter feed, and peanuts) and water *ad libitum* and allowed access to refugia from environmental elements. All experimental procedures were conducted according to those outlined in NDSU IACUC (#A14068), USFWS (MB39327B-0) and NDGF (GNF03646160) permits.

RESULTS

Twenty-one red-winged blackbirds were used in Trial 1, and of those, 19 were used in Trial 2. Though fewer blackbirds sought refuge during Trial 2 than during Trial 1, the proportion that sought refuge did not differ among treatments (i.e., videos) in either trial (Figure 2). The proportion of blackbirds that attempted to fly into the screen did not differ among treatments for Trial 1 or Trial 2 (Figure 3). The proportion of blackbirds that attempted to fly into the screen was lower during Trial 2 compared to Trial 1 for all video treatments. However, the differences were not significant. A lower proportion of blackbirds displayed displaced aggression pecking behavior during Trial 2 than Trial 1 except for the empty cage treatment (Figure 4), though the difference was not significant. There were no differences in the proportion of blackbirds that displayed displaced aggression pecking behavior among treatments (Figure 4).

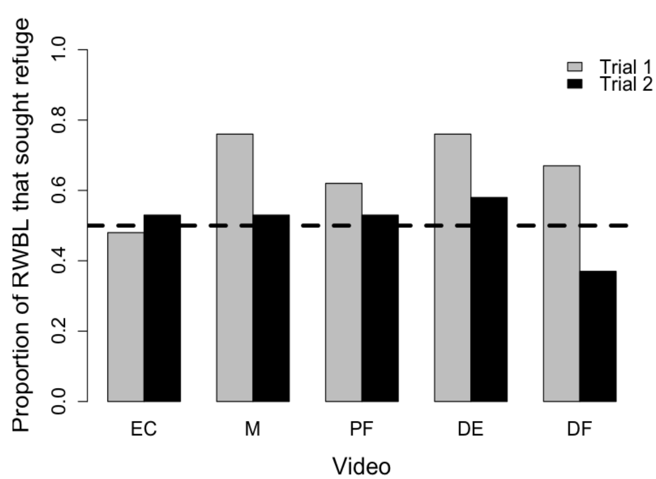

Figure 2. The proportion of RWBL that sought refuge did not differ among video treatments within trials or between trials. EC = Empty cage, M = Mallard, PF = Peregrine falcon, DE = Drone (engine), DF = Drone (falcon), Trial 1 (*n* = 21), Trial 2 (*n* = 19). The hashed line indicates a predicted value of 0.5.

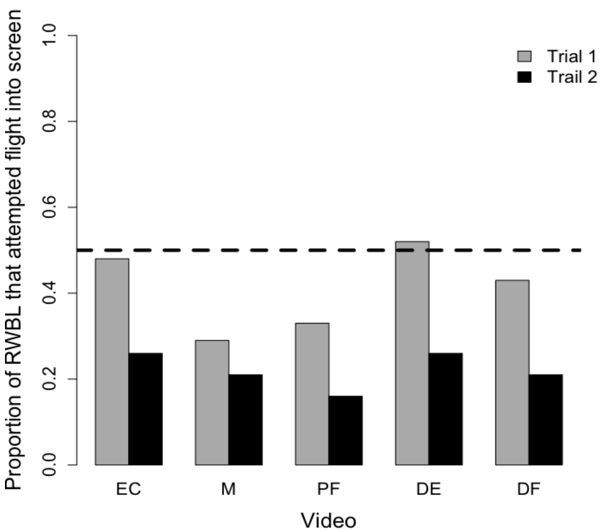

Figure 3. The proportion of RWBL that attempted flight into the screen did not differ among video treatments within trials or between trials. EC = Empty cage, M = Mallard, PF = Peregrine falcon, DE = Drone (engine), DF = Drone (falcon), Trial 1 (n = 21), Trial 2 (n = 19). The hashed line indicates the expected value of 0.5.

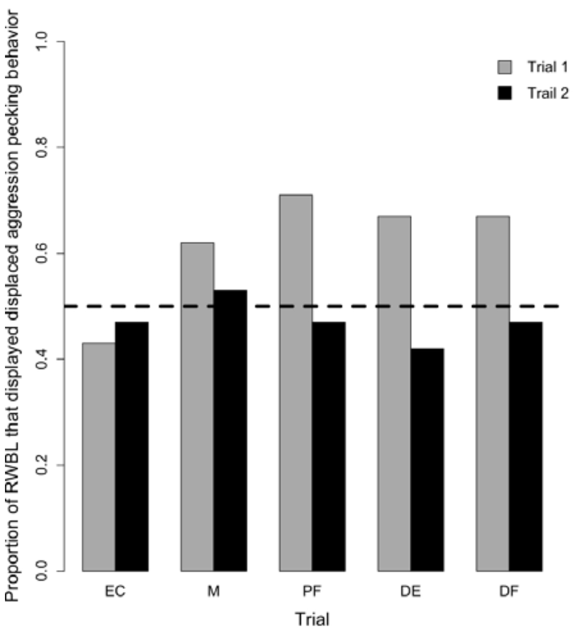

Figure 4. The proportion of RWBL that displayed displaced aggression pecking behavior did not differ among video treatments within trials or between trials. EC = Empty cage, M = Mallard, PF = Peregrine falcon, DE = Drone (engine), DF = Drone (falcon), Trial 1 (*n* = 21), Trial 2 (*n* = 19). The hashed line indicates the expected value of 0.5.

DISCUSSION

The behavioral responses of red-winged blackbirds did not differ between threatening and non-threatening stimuli. Interestingly, behavioral responses of blackbirds were reduced during the second trial compared to the first, suggesting some level of habituation to video stimuli. Fewer blackbirds responded to video stimuli during the second trial as compared to the first except for those that sought refuge and that displayed displaced aggression pecking during the empty cage video. It is possible that the habituation was due to repeated exposure to the stimuli or to personality differences of the individuals (Cook et al. 2008, Rodríguez-Prieto et al. 2010).

Repeated exposure to stress stimuli can result in habituation to the stimuli. For example, Cook et al. (2008) found that of the scare methods used to deploy birds from landfills, only those with a lethal component remained effective over time. However, in some instances only one exposure to novel stimuli is required for animals to habituate; Walker et al. (2006) found that one 15-min visit by humans to magellanic penguins (*Spheniscus magellanicus*) not previously exposed to humans was all that was needed to reduce their response during the next visit. Rodríguez-Prieto et al. (2010) found that habituation in Iberian lizards (*Podarcis hispanica*) was related to personality differences, where bolder individuals were more likely to habituate to a non-threating predator.

Additionally, habituation can manifest itself as attenuated physiological and behavioral responses (Romero and Wikelski 2002, Müllner et al. 2004, Campo et al. 2005). Hoatzin (*Opisthocomus hoazin*) and blackbirds (*Turdus merula*) in areas of high human traffic had flush distances far less than those in areas of low human traffic (Rodríguez -Prieto et al. 2009, Müllner et al. 2004). Additionally, magellanic penguins had lower corticosterone responses and fewer defensive head turns after habituating to human disturbance. Furthermore, chickens exposed to sound stimuli briefly had higher heterophil to lymphocyte ratio and prolonged tonic immobility than controls, whereas those exposed to the sound stimuli over an extended period only differed in their tonic immobility response from control birds (Campo et al. 2005). As other bird species exhibit behavioral and physiological habituation to predators perceived as a non-threat, it is possible that the birds used in this study displayed reduced physiological responses once they habituated to the video stimuli. Therefore, the relationship between behavioral and physiological responses to video stimuli of predators should be explored.

LITERATURE CITED

Adret, P. 1997. Discrimination of video images by zebra finches (*Taeniopygia guttata*): direct evidence from song performance. J. Comp. Psych. 111:115-125.

Balshine-Earn, S., and A. Lotem. 1998. Individual recognition in a cooperatively breeding cichlid: evidence from video playback experiments. Behaviour 135(3):369-386.

Bernhardt, G. E., B. F. Blackwell, T. L. DeVault, and L. Kutschbach-Brohl. 2010. Fatal injuries to birds from collisions with aircraft reveal anti-predator behaviours. Ibis 152:830-834.

Bird, C. D., and N. J. Emery. 2008. Using video playback to investigate the social preferences of rooks, *Corvus frugilegus*. Anim. Behav. 76:679-687.

Blackwell, B. F., T. L. DeVault, T. W. Seamans, S. L. Lima, P. Baumhardt, and E. Fernández-Juricic. 2012. Exploiting avian vision with aircraft lighting to reduce bird strikes. J. Appl. Ecol. 49:758-766.

Blackwell, B. F., E. Fernández-Juricic, T. W. Seamans, and T. Dolan. 2009. Avian visual system configuration and behavioral response to object approach. Anim. Behav. 77:673-684.

Campo, J. L., M. G. Gil, and S. G. Dávila. 2005. Effects of specific noise and music stimuli on stress and fear levels of laying hens of several breeds. Appl. Anim. Behav. Sci. 91: 75-84.

Capitanio, J. P. 2002. Sociability and responses to video playbacks in adult male rhesus monkeys (*Macaca mulatta*). Primates 43:169-177.

Chabot, D., and D. M. Bird. 2012. Evaluation of an off-the-shelf unmanned aircraft system for surveying flocks of geese. Waterbirds 35(1):170-174.

Clark, D. L., and K. R. Stephenson. 1999. Response to video and computer-animated images by the tiger barb, *Puntius tetrazona*. Envir. Biol. Fishes 56:317-324.

Clarke, C. H., and R. B. Jones. 2001. Domestic chicks' runway responses to video images of conspecifics. Appl. Anim. Behav. Sci. 70:285-295.

Cook, A., S. Rushton, J. Allan, and A. Baxter. 2008. An evaluation of techniques to control problem bird species on landfill sites. Environ. Mgmt. 41:834-843.

D'eath, R. B., and M. S. Dawkins. 1996. Laying hens do not discriminate between video images of conspecifics. Anim. Behav. 52:903-912.

Dolbeer, R. A., P. P. Woronecki, A. R. Stickley Jr., and S. B. White. 1978. Agricultural impact of a winter population of blackbirds and starlings. Wilson Bull. 90(1):31-44.

Evans, C. S., and P. Marler. 1991. On the use of video images as social stimuli in birds: audience effects on alarms calling. Anim. Behav. 41:17-26.

Evans, C. S., L. Evans, and P. Marler. 1993a. On the meaning of alarm calls: functional reference in an avian vocal system. Anim. Behav. 46:23-38.

Evans, C. S., J. M. Macedonia, and P. Marler. 1993b. Effects of apparent size and speed on the response of chickens, *Gallus gallus*, to computer-generated simulations of aerial predators. Anim. Behav. 46:1-11.

Ikebuchi, M., and K. Okanoya. 1999. Male zebra finches and Bengalese finches emit directed songs to the video images of conspecific females projected onto a TFT screen. Zool. Sci. 16:63-70.

Galoch, Z., and H.-J. Bischof. 2007. Behavioural responses to video playbacks by zebra finch males. Behav. Proc. 74:21-26.

Grimm, B. A., B. A. Lahneman, P. B. Cathcart, R. C. Elgin, G. L. Meshnik, and J. P. Parmigiani. 2012. Autonomous unmanned aerial vehicle system for controlling pest bird population in vineyards. Pp. 499-505 *in*: Proc. ASME 2012 Intl. Mechanical Engineering Congress and Exposition, Nov. 9-15, Houston, TX.

Ikebuchi, M., and K. Okanoya. 1999. Male zebra finches and Bengalese finches emit directed songs to the video images of conspecific females projected onto a TFT display. Zool. Sci. 16:63-70.

Ingalls, V. 1993. Startle and habituation responses of blue jays (*Cyanocitta cristata*) in a laboratory simulation of anti-predator defenses of Catocala moths (Lepidoptera Noctuidae). Behaviour 126(1/2):77-96.

Klosterman, M. E., G. M. Linz, A. A. Slowik and H. J. Homan. 2013. Comparisons between blackbird damage to corn and sunflower in North Dakota. Crop Protect. 53:1-5.

Macedonia, J. M., and J. A. Stamps. 1994. Species recognition in *Anolis grahami* (Sauria, Iguanidae): evidence from responses to video playbacks of conspecific and heterospecific displays. Ethology 98:246-264.

McIvor, D. E., and M. R. Conover. 1994. Perceptions of farmers and non-farmers toward management of problem wildlife. Wildl. Soc. Bull. 22:212-219.

Müllner, A., K. E. Linsenmair, and M. Wikelski. 2004. Exposure to ecotourism reduces survival and affects stress response in hoatzin chicks (*Opisthocomus hoazin*). Biol. Conserv. 118:549-558.

Ord, T. J., R. A. Peters, C. S. Evans, and A. J. Taylor. 2002. Digital playback and visual communication in lizards. Anim. Behav. 63:879-890.

Partan, S., S. Yelda, V. Price, and T. Shimizu. 2005. Female pigeons, *Columba livia*, respond to multisensory audio/video playbacks of male courtship behavior. Anim. Behav. 70:957-966.

Pruden, A. J., and G. W. Uetz. 2004. Assessment of potential predation costs of male decoration and courtship display in wolf spiders using video digitization and playback. J. Insect Behav. 17:67-80.

Rodríguez-Prieto, I., E. Fernández-Juricic, J. Martín, and Y. Regis. 2009. Antipredator behavior in blackbirds: habituation complements risk allocation. Behav. Ecol. 20: 371-377.

Rodríguez-Prieto, I., J. Martin, and E. Fernández-Juricic. 2010. Habituation to low-risk predators improves body condition in lizards. Behav. Ecol. Sociobiol. 64:1937-1945.

Romero, L. M., and M. Wikelski. 2002. Exposure to tourism reduces stress-induced corticosterone levels in Gálapagos marine iguanas. Biol. Conserv. 108:371-374.

Rosenthal, G. G., A. S. Rand, and M. J. Ryan. 2004. The vocal sac as a visual cue in anuran communication: an experimental analysis. Anim. Behav. 68:55-58.

Rowland, W. J. 1995. Do female stickleback care about male courtship vigour? Manipulation of display tempo using video playback. Behaviour 132:951-961.

Sardá-Palomera, F., G. Bota, C. Viñolo, O. Pallarés, V. Sazatornil, L. Brotons, S. Gomáriz, and F. Sardá. 2012. Fine-scale bird monitoring from light unmanned aircraft systems. Ibis 154:177-183.

Swaddle, J. P., L. McBride, and S. Malhotra. 2006. Females zebra finches prefer unfamiliar males but not when watching noninteractive video. Anim. Behav. 72:161-167.

Tillman, E. A., A. Van Doom, M. L. Avery. 2000. Bird damage to tropical fruit in south Florida. Proc. Wildl. Damage Manage. Conf. 9:47-59.

Vestergaard, K. S., E. Skadhauge, and L. G. Lawson. 1997. The stress of not being able to perform dustbathing in laying hens. Physiol. Behav. 62:413-419.

Walker, B. G., P. D. Boersma, and J. C. Wingfield. 2006. Habituation of adult magellanic penguins to human visitation as expressed through behavior and corticosterone secretion. Conserv. Biol. 20:146-154.

Watts, A. C., J. H. Perry, S. E. Smith, M. A. Burgess, B. E. Wilkinson, Z. Szantoi, P. G. Ifju, and H. F. Percival. 2010. Small unmanned aircraft systems for low-altitude aerial surveys. J. Wildl. Manage. 74(7):1614-1619.