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The Effectiveness of Visual Scaring Techniques Against Grey Herons, *Ardea cinerea*

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ABSTRACT: Heron streamers/droppings, which are electrical conductors, have caused power outages at electrical substations and transmission towers. It is necessary to understand the effectiveness of techniques for scaring herons to prevent electrical outages caused by their streamers. Here, we focused on bird-management techniques using visual deterrents and evaluated the deterrent effects of light-emitting diodes (LED), lasers, and a robotic approach. Grey herons were observed on the outdoor steel structure of the High Power Testing Laboratory of the Central Research Institute of the Electric Power Industry in Yokosuka, before and after dawn. LED lights were attached to the uppermost steel structure of the laboratory to evaluate the deterrent effects. A green laser was installed 60 m north of the steel structure. The lights and laser were fired manually when herons landed on the steel structure and we evaluated the response of the birds to the stimuli. We also installed a commercial mobile robot, which was programmed to move underneath the steel structure after dawn. To investigate the deterrent effect of the size of the robot, we put a scarecrow on the robot and compared the proportions of herons deterred by the robot with and without the scarecrow. Both the LED and laser were effective before dawn, but their deterrent effects decreased significantly as the ambient illuminance increased. In the robot experiment, more than 78% of the herons were deterred from the steel structure when the scarecrow was attached, while less than 6% of the herons were deterred when we used the robot without the scarecrow. Our findings suggest the effectiveness of visual scaring techniques for herons. Bird-management strategies combining LED, lasers, and robots may be useful for deterring herons during both the day and night.

KEY WORDS: *Ardea cineria*, bird damage control, efficacy, electrical power outage, feces, grey heron, hazing, lasers, non-lethal techniques, visual deterrent

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INTRODUCTION

Electrical outages on substations and transmission towers are an important source of power disturbances. These outages have a variety of causes, including fires, lightning, insulator pollution, and tree contact (Minnaar et al. 2012). Important causes of outages that have hitherto been often overlooked are bird streamers/droppings (Frazier 2001). Bird streamers are known to be conductive with some species of birds producing streamers of two to three meters in length (Gale et al. 2001). The streamer could short-circuit the air gap clearance of substations and transmission towers, causing insulator or bushing flash-overs and possible electrical outages (Sundararajan et al. 2004, IEEE Power and Energy Society 2015).

To prevent the electrical outages, several techniques are available for repelling birds in transmission system operators (TSOs) in Japan, but few are both practical and effective. Many operators harass birds by installing artificial bird effigies that imitate the natural enemies, such as falcons. They may also install devices with sound stimuli, in order to drive the birds away from their facilities (Narita et al. 2016, Shirai et al. 2019). However, such techniques eventually lose their effectiveness because of habituation by birds (Bomford and O'Brien 1990, Shirai et al. 2019). In addition, sound stimuli might also affect human activities, thus it is difficult to install on substations and transmission towers, especially in urban areas (Shirai, unpubl. data). Although physical barriers such as metal or plastic spikes provide varying degrees of protection, they are prohibitively expensive and may interfere with other operations and maintenances. Thus, novel approaches are needed to improve the performance of bird deterrent techniques on electrical transmission systems in Japan.

Grey herons, *Ardea cinerea*, are sedentary and widely distributed in Japan and their streamers/droppings are known to cause electrical outages (Ornithological Society of Japan 2012, Shirai et al. 2018). Unlike in crows and starlings, there is limited information on the techniques for repelling herons in Japan. It is therefore necessary to evaluate the effectiveness of the techniques for scaring herons to prevent electrical outages caused by their streamers. In this study, we aimed to test visual scaring techniques for grey herons in the field and to understand their pros and cons.

METHODS

Field Procedure

Our study was conducted at the High Power Testing Laboratory of the Central Research Institute of Electric Power Industry in Yokosuka, Kanagawa Prefecture, Japan. The outdoor steel structures of the laboratory have often been used by grey herons as perches (Figure 1). Since grey herons are usually observed at the laboratory between June

Figure 1. High Power Testing Laboratory of the Central Research Institute of the Electric Power Industry in Yokosuka, Kanagawa, Japan. Solid and dotted arrows represent grey herons landing on steel structures and the structure-attached LED light, respectively.

and August (Shirai et al. 2018), field tests were performed from July to August 2019.

As deterrent stimuli for grey herons, we used a green laser, flashing light-emitting diodes (LED), or a mobile robot (Figure 2). Most heron landings on the laboratory were observed to occur around dawn (Shirai et al. 2018). Therefore, we conducted all the tests sometime between 0400 and 0600 hours. Ambient illuminance level around the outdoor steel structure of the laboratory were measured during the field tests using an illuminance data-logger (TR-74Ui, T&D Corp., Matsumoto, Nagano, Japan), which was set at one min-interval. During the tests, we observed grey herons landing on the steel structures by using binoculars from a point 60 m north of the laboratory. We also recorded the number of herons which landed on, and those that were deterred from, the steel structure using a digital video (GZ-HM880-B, JVC Kenwood Corp., Yokohama, Kanagawa, Japan) and thermal imaging cameras (FLIR Scout TK, FLIR Systems Inc., Goleta, CA) (Gallagher 2018).

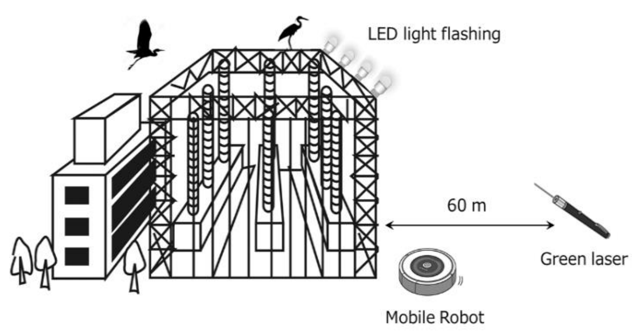

Figure 2. Schematic images of the field test setting of bird repellent devices.

Green Laser

We used a hand-held Class III R 5-mW diode green laser (532 nm) (LP-GL1016BK, Sanwa Supply Inc., Okayama City, Japan) to deter the grey herons. The hand-held laser was connected to a portable power battery (Anker PowerHouse, Anker Japan Co. Ltd., Suita, Osaka, Japan) placed 60 m away from the laboratory (Figure 2).

The laser treatment was standardized in such a manner as to improve accuracy (Gorenzel et al. 2010). The laser was first fired at the ground in front of the operator, lined up with the target, and then steadily raised towards the target. This procedure allowed the operator to easily follow the red laser dot as it moved towards the target.

The laser dot was steadily brought to bear on the target, then when on the target, if necessary, the laser was moved rapidly back and forth, around and onto the target. The target was considered nonresponsive if there was no favorable response after two or three exposures of 10 seconds each; a response was considered favorable if the birds left the site.

Flashing LED Light

As a stimulus to repel grey herons, we also used a LED tube light commonly used for outdoor illumination (thickness: 10 mm, power consumption: 12 W). A 20-m red and blue tube light was placed at the top of the north side of the outdoor steel structure (Figures 1 and 2). A smart plug (Teckin SP20 Smart Plug, Shenzhen Core Image Co.,Ltd, Shenzhen City, China) was installed at the power supply part of the LED light so that it could be remotely switched ON/OFF using a smartphone.

The LED light was flashed for approximately five seconds after the heron landed on the top of the north side of the outdoor steel structure. Then, we visually checked whether the heron would fly away or not.

Mobile Robot

A commercial mobile robot (Roomba® 890, iRobot, Bedford, MA) was used as a stimulus for the grey herons. The robot was set up on the ground on the north side of the outdoor steel structure and set to move automatically at 0530 hours (Figure 2). We counted the number of herons that flew away from the steel structure in the 30 seconds immediately after the robot was activated. We then counted the number of individuals remaining on the steel structures.

To evaluate the effect of the size of the repelling robot, a humanoid balloon scarecrow (70 cm in height) (K-001, Takashiba Gimune MFG. Co., Ltd., Miki, Hyogo, Japan) was placed on the robot, and tested with the deflated and inflated scarecrows (Figure 3).

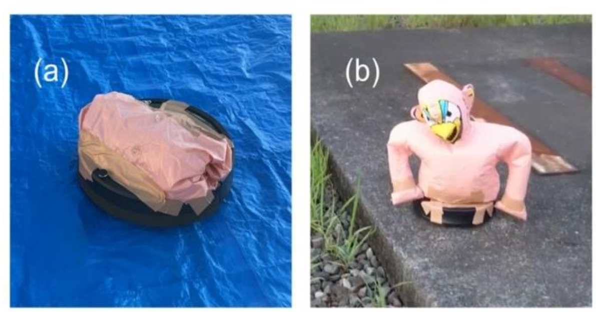

Figure 3. Mobile robots to repel grey herons with (a) a deflated and (b) inflated scarecrow.

Data Analysis

To test the effect of ambient illuminance levels (explanatory variable) and bird repellent devices (explanatory variables with two categories: flashing LED light, and green laser) on the status of birds [response variable with two levels: repelled (p = 1) vs. non-repelled (p = 0)], we used generalized linear models (GLM) with binomial error structure and logit link function. The significance of the model was assessed by a likelihood ratio test, comparing deviance with the null model (comprising only the intercept).

We also used Student's *t*-test to compare the effectiveness of the mobile robots with a deflated and inflated scarecrow. We calculated the ratios of birds repelled by the robots to all the birds that landed on the steel structure before activating the robots. The ratios were arcsine transformed prior to analysis to improve the normality of the dataset.

All data were analyzed using R version 3.0.1. *P* values of less than 0.05 were considered statistically significant.

RESULTS

We tested and fired the laser 10 times and LED light flashing 13 times (Figure 4). Overall, 13 (57%) of 23 grey herons responded favorably by leaving the area. We tested the laser and the flashing LED light in light conditions that ranged from 2.5 to 1,300.0 lux. There was a relationship between light levels and the outcome of both the laser and LED treatments (Z = 2.38, P = 0.018), and most favorable outcomes occurred when light levels were <100 lux (Figure 4).

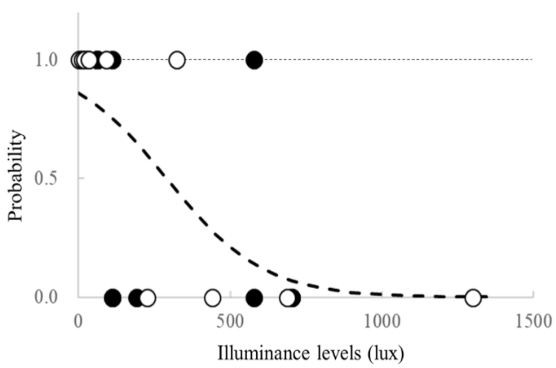

Figure 4. Probability of bird repellence of flashing LED light (solid circle) and green laser (open circle) in relation to ambient illuminance levels.

We also tested the mobile robot with the deflated and inflated scarecrow four times in total (Figure 5). The mobile robot with the deflated scarecrow repelled only one of 17 grey herons staying on the steel structure in the first experiment. In the second experiment, none of the 27 birds on the steel structure left due to the movement of the robot with the deflated scarecrow. On the other hand, 33 of 34 herons left from the steel structure just after activating the robot with the inflated scarecrow at the first experiment. In the second experiment of the robot with the inflated scarecrow, 78% of landed herons (seven of nine individuals) were deterred. Consequently, the effectiveness of the robot with the scarecrow was statistically significantly higher than that of the robot without the scarecrow (t = 5.56, P = 0.031) (Figure 5).

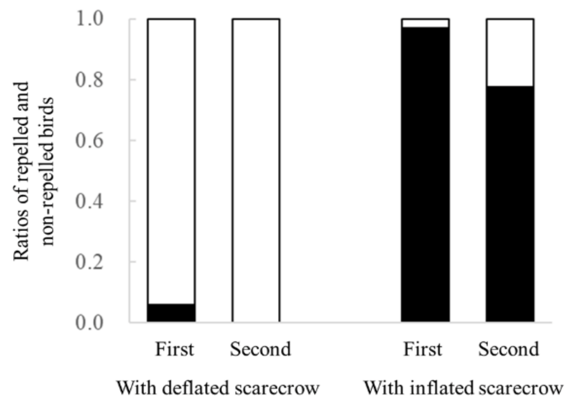

Figure 5. Ratios of repelled (black bar) and non-repelled (white bar) grey herons by a mobile robot during first and second tests with deflated and inflated scarecrow.

DISCUSSION

Our results suggested that the grey herons perceived and reacted to the flashing LED light and green laser by immediately leaving the outdoor steel structures under low-light conditions, although the probability of the deterrence significantly decreased with increasing ambient illuminance levels (Figure 4). This corresponded with the results of previous research that laser and light approaches were more effective in reducing the numbers of birds at night rather than reducing the numbers during the day (Harris and Davis 1998, Sherman and Barras 2004). Several studies have also documented that lasers and lights offer effective means for dispersing other herons (Littauer 1990, Gorenzel et al. 1994, Gorenzel et al. 2010). For instance, Gorenzel et al. (2010) determined that the numbers of roosting herons were reduced by 1-2% upon treatment with a red laser, although they are present in the same number the next morning. On aquaculture facilities, strobe lights, amber barricade lights, and revolving lights are effective in deterring night-feeding herons (Salmon et al. 1986, Littauer 1990). Therefore, our results confirmed that hazing could disperse grey herons from problematic areas with green lasers and LED light flashing at night, as shown in previous studies (Littauer 1990, Gorenzel et al. 1994, Gorenzel et al. 2010).

Our trials showed that the mobile robot with a humanoid balloon scarecrow is effective to repel grey herons but not without the scarecrow (Figure 5). Among bird species, grey herons are known to have one of the largest flight initiation distances (>40 m, Lin et al. 2012). Grey herons thus tend to be distributed over areas with less disturbances such as people and vehicles (Suzuki 2010). The top of the outdoor steel structure landed on by the herons is approximately 30 m high; thus, the ground under the structure may also be within the range of their flight initiation distance. The favorable response obtained in our study may be therefore related to the ability of grey herons to easily flee from disturbances.

As similar approach to the mobile robot, trained border collies alone, and border collies used in conjunction with remote-controlled boats, have been used effectively to chase problematic birds out of some areas (Castelli and Sleggs 2000, Holevinski et al. 2007). However, the technique only temporarily removed birds from the hazing sites, as they returned multiple times when the dogs were not present (Holevinski et al. 2007). In addition, the use of dogs around electrical power equipment is usually less applicable, presumably because they may interfere with other operations and maintenance. Since autonomous robots could be left in the problem areas, the approach of using mobile robots might improve both the practicality and effectiveness in bird repellence.

In conclusion, we showed that all the visual scaring techniques we used led to flight in grey herons and a concomitant decrease in the potential costs associated with electrical outages. However, our results also suggest that each technique has limitations, and their effectiveness might decrease in some uses. These limitations could be solved by combining several techniques, such as a mobile robot with an illuminated scarecrow. Further studies are needed to evaluate the combined effects of these scaring techniques for bird damage control.

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