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Red lasers are ineffective for dispersing deer at night

Kurt C. VerCauteren
USDA-APHIS-Wildlife Services, kurt.c.vercauteren@aphis.usda.gov

Scott E. Hygnstrom
University of Nebraska-Lincoln, shygnstrom1@unl.edu

Michael J. Pipas
United States Department of Agriculture/Animal and Plant Health Inspection Service/Wildlife Services/National Wildlfie Research Center

Paul B. Fioranelli
United States Department of Agriculture/Animal and Plant Health Inspection Service/Wildlife Service/National Wildlife Research Center

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

See next page for additional authors

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Authors

Kurt C. VerCauteren, Scott E. Hygnstrom, Michael J. Pipas, Paul B. Fioranelli, Scott J. Werner, and Bradley F. Blackwell

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Abstract Populations of white-tailed deer (*Odocoileus virginianus*) and the number of deer–human conflicts have increased in recent years, emphasizing the need for efficient and inexpensive methods to reduce site-specific deer damage. Recent research using laser technology to disperse a variety of bird species has yielded promising results, prompting wildlife professionals and the public to question whether lasers could play a role in reducing damage and conflict with mammals, primarily deer. We evaluated 2 red lasers (633–650 nm) to determine their effectiveness as devices to frighten deer. No differences occurred in flight response between lasers or between the control and lasers. We suggest that deer were not frightened by either model of laser because they could not detect red laser beams or their intense brightness. Red lasers do not appear to have potential as frightening devices for deer.

Key words agriculture, animal damage, frightening devices, integrated pest management, lasers, *Odocoileus virginianus*, white-tailed deer, wildlife damage

With the concomitant growth in populations of humans and white-tailed deer (*Odocoileus virginianus*) in North America, deer–human conflicts have increased in both rural and urban environments. Conflict includes damage to agricultural crops and to ornamental and native vegetation, deer-vehicle collisions, and disease transmission. Damage-abatement techniques that can be applied throughout the year and in a variety of settings are needed. Hunting is an effective tool for controlling deer populations in rural and urban or suburban areas, though it may not be acceptable or practical in all urban or suburban settings (VerCauteren and Hygnstrom 1998, VerCauteren and Hygnstrom 2001). In general, the American public prefers nonlethal control methods over lethal methods (Dolbeer 1998, DeNicola et al. 2000). Several nonlethal methods effectively reduce deer damage (Craven and Hygnstrom 1994). A variety of fence designs exclude deer (Craven and Hygnstrom 1994), but the most effective are often too expensive and labor-intensive to be practical. Traditional frightening devices, like propane cannons and effigies, are generally ineffective because deer habituate to them (Koehler et al. 1990, Belant et al. 1996). Practical, efficient, and inexpensive nonlethal methods are needed to reduce site-specific deer damage in both rural and urban settings (DeNicola et al. 2000). New techniques should be easy to implement prior to or during the period that damage occurs, and should be part of an integrated deer management program. Deer-activated frightening devices have potential to reduce deer damage by reducing habituation (Belant et al. 1998), and several devices are currently being evaluated (K. C. VerCauteren, National Wildlife Research Center,

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Address for Kurt C. VerCauteren, Michael J. Pipas, and Scott J. Werner: United States Department of Agriculture/Animal and Plant Health Inspection Service/Wildlife Services/National Wildlife Research Center, 4101 LaPorte Avenue, Fort Collins, CO 80521-2154, USA; e-mail for VerCauteren: Kurt.C.VerCauteren@aphis.usda.gov. Address for Scott E. Hygnstrom: University of Nebraska-Lincoln, 202 Natural Resources Hall, Lincoln, NE 68583-0819, USA. Address for Paul B. Fioranelli: United States Department of Agriculture/Animal and Plant Health Inspection Service/Wildlife Services/National Wildlife Research Center, P. O. Drawer 6099, Mississippi State University, Starkville, MS 39762-6099, USA. Address for Bradley F. Blackwell: United States Department of Agriculture/Animal and Plant Health Inspection Service/Wildlife Services/National Wildlife Research Center, Ohio Field Station, 6100 Columbus Dr., Sandusky, OH 44870, USA.

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unpublished data). Cost and long-term effectiveness, however, remain concerns.

The utility of lasers to frighten or haze birds was first evaluated by Lustick (1973), and all such research on vertebrates to date has focused on birds, for which the technique has shown mixed results. Briot (1999) observed anecdotally that gulls (*Laridae*) moved away from laser beams. Glahn et al. (2000) reported that lasers were effective for dispersing double-crested cormorants (*Phalacrocorax auritus*) from night roosts. In pen trials, Blackwell et al. (2002) demonstrated strong avoidance of laser light by Canada geese (*Branta canadensis*), initial avoidance followed by habituation by rock doves (*Columbia livia*) and mallards (*Anas platyrhynchos*), and no avoidance by brown-headed cowbirds (*Molothrus ater*) and European starlings (*Sturnus vulgaris*). Responses in these studies appeared to be species- and context-specific. For example, avoidance of lasers may be more pronounced and consistent in natural settings where escape is possible. Regardless, lasers appear more effective than several traditional frightening devices for reducing bird damage and are being used commonly in a variety of situations. Likewise, lasers have the potential to be more effective at reducing deer damage than traditional frightening devices.

No studies have been conducted to determine the effectiveness of lasers for dispersing mammals. Lasers may have potential to reduce many types of damage associated with the adaptable and wide-ranging white-tailed deer. Lasers can be used without acoustically disturbing nearby human residents, unlike propane cannons and other acoustic frightening devices. Lasers can also be used selectively to target individuals or groups of animals in specific areas. Our objective was to determine the efficacy of 2 models of laser for dispersing deer from agricultural fields and meadows at night.

Methods

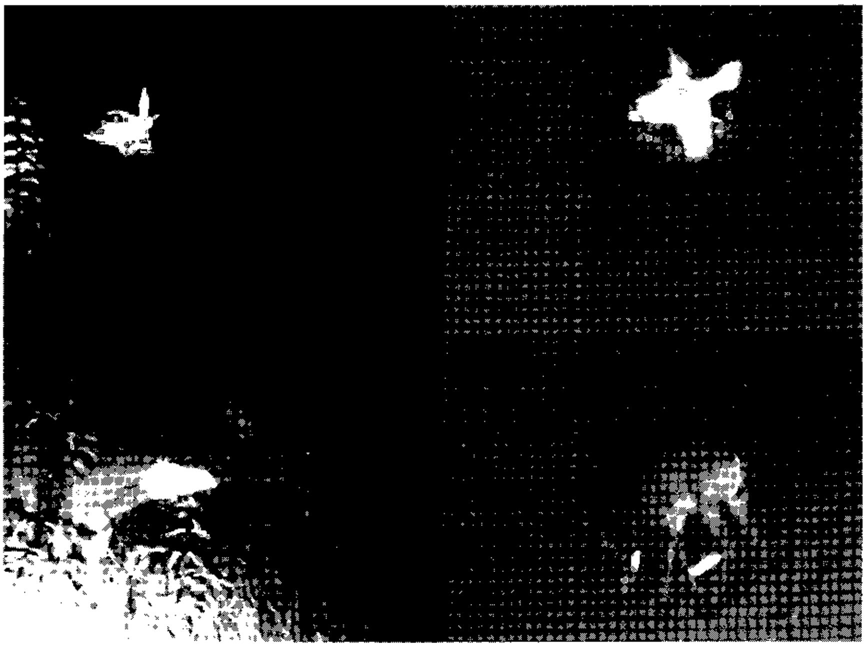
The study was conducted in a 200-km^2 area encompassing DeSoto and Boyer Chute National Wildlife Refuges in eastern Nebraska and western Iowa. Most deer were hunted during fall and typically avoided close association with humans. We used 32 fields planted to agricultural crops (alfalfa, soybeans, wheat) or native grass throughout the study.

We evaluated 2 models of laser: the Desman® and the Dissuader™ (use of trade names does not imply endorsement by the United States Department of Agriculture). The Desman model FL R 005 (Desman S. A. R. L., Ste. Marie de Campan, France) is a red (633-nm wavelength) 12V battery-powered helium-neon laser configured as a rifle with a 3–9-power scope. It is a class-IIIB device with a power of 5 mW and a fixed-beam diameter of 12 mm effective to 2.5 km. The Desman laser was designed specifically for optically startling birds. The Dissuader Physical Security Device (SEA Technology, Albuquerque, N.M., USA) is a red (650-nm wavelength) 4AA battery-powered diode laser configured as a flashlight. The Dissuader incorporates a quick-focusing ring to manually change spot size of the beam at any distance. Marketed as a class-II device, it has a power rating of 68 mW effective at up to 500 m at night. The Dissuader laser illuminator is marketed as a threat-deterrent device for security personnel. Both lasers pose little risk of eye damage and have been used to disperse birds (OSHA 1991, Glahn et al. 2000, Blackwell et al. 2002). See OSHA (1991) for additional information on laser safety and classification.

Experimental design

We conducted the experiment on 8 consecutive nights (16–23 July 2001), from $\geq$30 minutes after sunset to $\geq$30 minutes before sunrise. Each field was randomly assigned the Desman, the Dissuader, or control and retained this designation throughout the study. One observer drove and operated lasers while another located deer initially and recorded data. Time spent in the field each night was dictated by number of deer encounters. We defined an encounter as a sighting of $\geq$1 deer lasting long enough that observers could document deer reactions to a laser and the presence of the vehicle and observers, or just the vehicle and observers in the case of controls. A flight response occurred when deer fled the field they were initially in and were out of observers' sight by the conclusion of the encounter.

Deer were located initially with a 2-million-candlepower, hand-held spotlight (Koehler-Bright Star, Wilkes-Barre, Pa., USA). We illuminated fields with visible light and extinguished it after deer were located and distance from the vehicle was determined with a laser rangefinder (Yardage Pro, Bushnell Sports Optics Worldwide, Overland Park, Kans., USA). To minimize potential for the deer's eyes to adjust to the spotlight, we illuminated the area for <3 seconds and did not shine the spotlight directly



Top 2 images show deer being illuminated with the Desman® laser; bottom 2 show deer being illuminated with the Dissuader™ laser.

at deer. Once deer were located, we used night-vision binoculars (United States Army) to observe behavior throughout the encounter. We used spotlights to initially locate deer in fields because night vision did not provide sufficient resolution to discriminate deer >70 m away, and for practical applications, spotlights provided a cost-effective means to locate deer, whereas night-vision equipment costs >$1,000.

Control encounters entailed observing deer with night-vision binoculars for 2 minutes. At the conclusion of the encounter, the spotlight was used to ascertain definitively whether deer had fled out of sight. If they had not, the laser rangefinder was used to determine their current distance from the vehicle. Treatment encounters were identical to control encounters, with the addendum that observers applied the laser treatment for 2 minutes. The lasers were first directed at vegetation close to and in front of deer and moved vigorously in a zigzag manner. If this did not prompt a flight response within 15 seconds, the laser beam was moved in the same manner across the bodies and heads of deer.

Data recorded for each encounter included: field number, treatment (Desman, Dissuader, or control), number of deer per group by sex and age class, initiation and termination times of the encounter, geographic location (UTM coordinates of vehicle), distance and compass bearing from vehicle to deer at initiation and termination of the encounter, deer behavior during the encounter (fleeing, other-bedded, walking, feeding), and vegetation type (alfalfa, wheat, soybeans, or grass) in which deer were located at the initiation and termination of the encounter. We recorded data on preconfigured forms and noted general weather conditions each night. We determined UTM coordinates with a hand-held Global Positioning System unit (GPS III, Garmin International, Olathe, Kans., USA). All procedures were approved by the United States Department of Agriculture/Animal and Plant Health Inspection Service/Wildlife Services/National Wildlife Research Center's Institutional Animal Care and Use Committee (QA-899).

Data analysis

We summarized frequency data with cross-tabulation tables. Due to ineffectiveness of the laser in eliciting a flight response, sample sizes were small, limiting chi-square tests of homogeneity and correlation to one comparison: flight response versus treatment (SAS Institute Inc. 1988). We classed group size into 3 categories: 1, 2-3, or ≥4 deer. Group size versus flight response was examined descriptively by treatment and across treatments. To determine the magnitude of relationships, we calculated odds ratios (Fleiss 1973) for treatment versus flight response by treatment and across treatment. We also calculated mean distance from vehicle to deer by group size and by treatments.

Results

In 177 encounters, we documented a flight response only 16 times (9.0%). Flight responses were associated with the Desman laser 4 times (2.2% of total encounters), the Dissuader laser 6 times (3.4% of total encounters), and the control 6 times (3.4% of total encounters). No differences occurred among the control and laser treatments or between the 2 laser treatments ($\chi^2=0.95$, df=2). No association occurred between flight response and laser treatment (Pearson correlation coefficient =-0.02). Independent of group size, deer in control encounters were 1.2 times more likely to flee than those in treatment encounters. Groups of 2-3 deer fled on 2 of 44 encounters (4.5%). Single deer fled 6.5% of the time (7 of 108 encounters), and groups of ≥ 4 deer ($\bar{x}$ group size=6.5, range=4-18) fled 4.0% of the time (1 of 25 encounters). Single deer were 1.4 times more likely to flee during treatment encounters than control encounters. Corresponding values for groups of 2-3 deer and ≥ 4 deer were 0.8 and 0.3, respectively. Of deer that fled, mean distance (m) from the vehicle to deer at initial sighting was greatest for single deer (154.9, SE=26.2). Corresponding mean distance for groups of 2-3 deer and ≥ 4 deer were 115.4 (SE=27.0) and 126.5 (SE=10.8) from the vehicle, respectively. Mean initial distance to deer that did not flee was 105.5 (SE =5.6), 144.1 (SE=11.2), and 178.3 (SE=20.0) for group sizes of 1, 2-3, and ≥ 4 deer, respectively. For the Desman laser, Dissuader laser, and control, mean initial distance to deer that fled was 134.2 (SE= 41.1), 145.1 (SE=34.6), and 138.1 (SE=15.6), respectively.

Discussion

Physiological and genetic studies indicate that the eye of a deer is characterized by 3 photopigments: a short wavelength-sensitive cone pigment (450-460 nm=blue), a middle wavelength-sensitive cone pigment (537-542 nm=yellow-green), and a rod pigment with a peak sensitivity of 497 nm (blue-green) (Jacobs et al. 1994). At night and during crepuscular periods, rods serve a discriminatory role in color vision (Jacobs 1981, Jacobs et al. 1994). With only the short and middle wavelength-sensitive cones supplementing the rods under low-light conditions, deer perceive colors from violet to green but may not perceive red. Despite concerns about the perceptual ability of deer to see the red light, we felt it was important to evaluate the potential of lasers as deer frightening devices because of increasing interest in them as a nonlethal technique for wildlife damage management. Even if deer could not sense long wavelengths (red), they may have been able to perceive the phase contrast of the intense laser light beam, and it could serve to frighten them much as it does birds. Visual systems generally detect contrast to a greater degree than intensity (Land and Nilsson 2002), and laser light intuitively seemed to offer a high level of contrast under scoptic conditions. It was possible that even if deer could not perceive the hue, they could discern other characteristics of the laser such as contrast, brilliance, or luminance, and exhibit an avoidance response. In general, however, white-tailed deer in our study did not respond to either model of laser light by fleeing. On >25 occasions lasers were shone on deer for 2 minutes at <50 m and caused no discernible reaction.

The differential response of birds (Glahn et al. 2000, Blackwell et al. 2002) and deer to laser light is likely due to differences in visual systems of these very different taxonomic groups, as well as species-specific differences in threat perception and avoidance behavior. The avian eye is typically more developed than the ungulate eye in terms of color discrimination and depth perception (Welty 1982, Hildebrand 1988).

We found no relationship between deer group size and response to laser light. LaGory (1987) noted that larger groups (≥ 3) of deer in forested habitat were more likely to flee from an observer during daylight hours than were smaller groups. Factors other than group size could not be elucidated from our data. More intensive studies are needed to address factors such as proximity to hiding cover and prior exposure to spotlighting. We do not believe that deer were habituated to spotlighting from previous exposure because in the 10 years we have been studying deer in the area we have not seen others spotlighting and our own spotlighting activity was limited.

LaGory (1987) indicated that white-tailed deer were less likely to flee with increasing distance from the observer, especially beyond distances of 100 m. In our study, 69% of the deer that fled were >100 m from the vehicle. LaGory's study differed from ours in that it was conducted during the day with no disturbances (lasers, lights, vehicles) other than the observer. The amount of ambient light may influence the flight response of deer.

Additional research is needed to evaluate lasers as frightening devices for deer. Lasers of shorter wavelengths (green or blue) than the red lasers we evaluated may hold more promise as frightening devices for deer and should be evaluated in field conditions. Further, lasers of various wavelengths (red, green, blue) should be tested under scotopic and photopic conditions in different environmental settings (e.g., field versus forest, urban versus rural). Finally, lasers of varying wavelengths should be evaluated on a variety of mammalian species that cause human-wildlife conflicts to address the potential and scope of applicability of this technique.

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Literature cited

Belant, J. L., T. W. Seamans, and C. P. Dwyer. 1996. Evaluation of propane exploders as white-tailed deer deterrents. Crop Protection 15:575-578.

Belant, J. L., T. W. Seamans, and L. A. Tyson. 1998. Evaluation of electronic frightening devices as white-tailed deer deterrents. Proceedings of the Vertebrate Pest Conference 18: 107-110.

Blackwell, B. F., G. E. Bernhardt, and R. A. Dolbeer. 2002. Lasers as non-lethal avian repellents. Journal of Wildlife Management 66:250-258.

Briot, J. L. 1999. The use of laser for bird frightening. Pages 201-206 *in* Bird Strike '99, Proceedings of Bird Strike Committee - USA/Canada Meeting, Vancouver, B. C., Canada. Transport Canada, Ottawa, Ontario, Canada.

Craven, S. R., and S. E. Hygnstrom. 1994. Deer. Pages D25-40 *in* S. E. Hygnstrom, R. M. Timm, and G. E. Larson, editors. Prevention and Control of Wildlife Damage. University of Nebraska Cooperative Extension, Lincoln, USA.

DeNicola, A. J., K. C. VerCauteren, P. D. Curtis, and S. E. Hygnstrom. 2000. Managing white-tailed deer in suburban environments: a technical guide. Cornell Cooperative Extension, Ithaca, New York, USA.

Dolbeer, R. A. 1998. Population dynamics: the foundation of wildlife damage management for the 21st Century. Proceedings of the Vertebrate Pest Conference 18:2-11.

Fleiss, J. L. 1973. Statistical methods for rates and proportions. John Wiley. New York, New York, USA.

Glahn, J. F., G. Ellis, P. Fioranelli, and B. S. Dorr. 2000. Evaluation of moderate and low-powered lasers for dispersing double-crested cormorants from their night roosts. Proceedings of the Eastern Wildlife Damage Management Conference 9: 34-35.

Hildebrand, M. 1988. Analysis of vertebrate structure, 3rd edition. John Wiley. New York, New York, USA.

Jacobs, G. H. 1981. Comparative color vision. Academic Press, New York, New York, USA.

Jacobs, G. H., J. F. Deegan II, J. Neitz, B. P. Murphy, K. V. Miller, and R. L. Marchinton. 1994. Electrophysiological measurements of spectral mechanisms in the retinas of two cervids: white-tailed deer (*Odocoileus virginianus*) and fallow deer (*Dama dama*). Journal of Comparative Physiology 174: 551-557.

Koehler, A. E., R. E. Marsh, and T. P. Salmon. 1990. Frightening methods and devices/stimuli to prevent mammal damage-a review. Proceedings of the Vertebrate Pest Conference 14: 168-173.

Land, M. F., and D. E. Nilsson. 2002. Animal eyes. Oxford University Press, Oxford, England.

LaGory, K. E. 1987. The influence of habitat and group characteristics on the alarm and flight response of white-tailed deer. Animal Behavior 35:20-25.

Lustick, S. 1973. The effect of intense light on bird behavior and physiology. Proceedings of the Bird Control Seminar 6: 171-186.

[OSHA] Occupational Safety & Health Administration. 1991. Guidelines for laser safety and hazard assessment. Directives PUB 8-1.7. U.S. Occupational Safety & Health Administration, Washington, D.C., USA.

SAS Institute Inc. 1988. SAS/STAT® User's guide. Release 6.03 edition. Cary, North Carolina, USA.

VerCauteren, K. C., and S. E. Hygnstrom. 1998. Effects of agricultural activities and hunting on home ranges of female white-tailed deer. Journal of Wildlife Management 62: 280-285.

VerCauteren, K. C., and S. E. Hygnstrom. 2002. Efficacy of hunting for managing a suburban deer population in eastern Nebraska. Proceedings of the National Bowhunting Conference 1:51-57.

Welty, J. C. 1982. The life of birds, 3rd edition. Saunders College Publishing, Philadelphia, Pennyslvania, USA.

Kurt VerCauteren (right) is a research wildlife biologist in the Product Development Program of the National Wildlife Research Center (NWRC). He received his B.S. from the University of Wisconsin (UW)-Stevens Point, M.S. and Ph.D. from the University of Nebraska-Lincoln. Kurt is a Certified Wildlife Biologist and has served as Secretary of the Colorado Chapter of The Wildlife Society (TWS) and President of the Nebraska Chapter. He is currently on the Board of the Society's Wildlife Damage Management Working Group. Kurt's current research involves devising tools and techniques to reduce wildlife damage associated with ungulates, waterfowl, and rodents. ***Scott Hygnstrom*** is a professor and wildlife damage specialist with the University of Nebraska-Lincoln. He received his Ph.D. in wildlife ecology from UW-Madison. Scott has been a member of The Wildlife Society since 1982. His primary interests include wildlife–agricultural interactions, human-wildlife conflicts, hunting, and volleyball. ***Mike Pipas*** is a biological technician with the NWRC and a Certified Wildlife Biologist. Mike received his B.S. from Indiana University of Pennsylvania and M.S. from Washington State University. ***Paul Fioranelli*** (left) received his B.S. from Mississippi State University. He is currently working with bird–aquaculture research at the NWRC's Mississippi Field Station. Paul enjoys spending time with family and friends, fishing at his home on the Tennessee-Tombigbee Waterway, hunting, raising white fan-tail pigeons, and landscape gardening. ***Scott Werner*** received his B.S. from the Pennsylvania State University and his M.S. and Ph.D. from Utah State University. Scott is a research wildlife biologist with

NWRC, and current research interests involve non-lethal repellents to reduce blackbird damage to rice. ***Brad Blackwell*** received his M.S. from North Carolina State University and Ph.D. from the University of Maine. He is a Certified Wildlife Biologist and a research wildlife biologist with the NWRC. Brad's current research focus includes the integration of demographic modeling into evaluation of wildlife management plans and the use of ecologically significant visual cues in the development of products to reduce bird strikes to aircraft and as treatments to enhance the effect of avian foraging repellents.

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