10-17-2003

Evaluation of an animal-activated scarecrow and a monofilament fence for reducing deer use of soybean fields

Jeff Beringer
Missouri Department of Conservation

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

Joshua J. Millspaugh
University of Missouri, joshua.millspaugh@umontana.edu

Evaluation of an animal-activated scarecrow and a monofilament fence for reducing deer use of soybean fields

Jeff Beringer, Kurt C. VerCauteren, and Joshua J. Millspaugh

Abstract We measured the efficacy of an animal-activated scarecrow (AAS) and a 5-strand monofilament fence (MF) at reducing white-tailed deer (*Odocoileus virginianus*) use of 0.4-ha soybean plots in Missouri, USA. Our study design consisted of 9 soybean plots; 3 served as controls, 3 were surrounded by an MF, and 3 were surrounded by an AAS. Data collected for each protected plot included soybean height and weight taken from within and immediately adjacent to 10 unprotected, equally spaced 1-m^2 exclosures. A measure of deer use for each plot was collected with video cameras. A mixed-effects analysis of variance (ANOVA) indicated that heights of protected and unprotected soybean plants were significantly different for MF plots (F_2=93.6, P=0.01) and controls (F_2=47.6, P=0.02) but not different for AAS plots (F_2=2.16, P=0.272). Soybean plants in AAS plots were heavier than those from MF or control plots (F_2=10.2, P=0.01). Plant weight differences in protected and unprotected areas for AAS plots were less than those from MF plots (t_6=2.55, P=0.04) or control plots (t_6=4.46, P=0.004). Plant weight differences between MF and control plots were marginally significant (t_6=1.192, P=0.10). Deer spent less time in AAS plots than MF (t_6=2.55, P=0.04) or control plots (t_6=2.55, P=0.01). Scarecrow activations increased over time in all 3 AAS plots (all 95% confidence intervals >0), suggesting that deer were habituating to the devices. We suggest that AAS may be useful for short-term deterrence of deer from small areas.

Key words animal damage, crop depredation, fencing, frightening device, *Odocoileus virginianus*, white-tailed deer

The need to develop effective, practical, nonlethal tools to manage crop damage by white-tailed deer (*Odocoileus virginianus*) has increased with prevalence of locally abundant deer populations and societal demands for nonlethal wildlife management (VerCauteren et al. 2003*a*). The number of deer–human conflicts has increased along with populations of deer and humans. High populations of deer can cause economic loss, human health and safety concerns, and adverse impacts on agricultural and natural resources (Conover 1997).

Farmers, orchardists, landscapers, and gardeners need site- and time-specific methods to deter deer damage in urban and rural areas. Urban areas provide high-quality foods in the form of gardens, ornamental plantings, and fertilized lawns (Swihart et al. 1995). In contrast, in some rural areas ungulate diets may be dominated by agricultural crops (Austin and Urness 1993). Most agricultural producers (67%) reported that they experienced deer crop damage and that deer caused more damage than other wildlife species (Conover and Decker 1991, Conover 1994, Wywialowski 1994). Conover (1997) conservatively estimated annual damage to

Address for Jeff Beringer: Missouri Department of Conservation, 1110 South College Avenue, Columbia, MO 65201, USA; e-mail: Berinj@mdc.state.mo.us. Address for Kurt C. VerCauteren: United States Department of Agriculture, National Wildlife Research Center, Fort Collins, CO 80521, USA. Address for Joshua J. Millspaugh: Department of Fisheries and Wildlife Sciences, University of Missouri, 302 Anheuser-Busch Natural Resources Building, Columbia, MO 65211, USA.

agriculture in the United States at $100 million.

Damage-reduction strategies must be easy to implement when damage is occurring or just prior to this time, and should be part of an overall integrated deer management program. Several methods effectively reduce deer damage (Craven and Hygnstrom 1994) but may be cost-prohibitive. Hunting can effectively manage populations in rural (VerCauteren and Hygnstrom 1998, Woolf and Roseberry 1998) and urban (Hansen and Beringer 1997, VerCauteren and Hygnstrom 2002) areas and in some cases can be acceptable as the primary tool of deer population management (Brown et al. 2000). Farmers, orchardists, landscapers, and gardeners, however, need methods that can be applied during the growing season and in localized situations where hunting might not be socially acceptable or practical.

Deer often habituate quickly to novel "frightening" sounds, sights, or smells (Bomford and O'Brien 1990, Craven and Hygnstrom 1994, Curtis et al. 1995). As a result, traditional frightening devices (e.g., cracker shells, gunfire, propane cannons, scarecrows) generally have been ineffective for even short time periods (Koehler et al. 1990, Belant et al. 1996, Gilsdorf 2002). A motion-activated acoustic deterrent also has been shown to be ineffective for deer (Belant et al. 1998).

Several fence designs are recommended for excluding deer from agricultural crops. Their effectiveness generally improves with cost and durability (Craven and Hygnstrom 1994). Fencing options range from high-tensile woven-wire fences that act as long-term barriers to single-strand electric polytape fences intended to prevent or reduce deer damage for a limited time (Craven and Hygnstrom 1994). Rosenberry et al. (2001) successfully protected small plots (6 × 6 m and 12 × 12 m) with a 2.4-m-tall plastic-mesh fence. Monofilament fences (MF) are used with some success (J. Braithwait, Missouri Department of Conservation, personal communication) by gardeners throughout rural Missouri. The MF could act as both a physical and a psychological barrier to deer. We tested 2 methods of reducing deer damage to 0.4-ha soybean fields: an animal-activated scarecrow (AAS) and MF. Both were visually unobtrusive. Our study objective was to measure the utility and effectiveness of these damage-mitigation techniques by measuring deer-browse damage (e.g., height and weight of soybean plants) and the amount of time deer spent in treatment and control plots.

Study area

We conducted our study at the Woods Farms Study Area (WFSA), located in the Ozark Natural Division (Thom and Wilson 1980) in Crawford and Phelps counties, Missouri, USA. WFSA encompassed 91 km^2. The area was mostly oak-hickory (*Quercus* spp. and *Carya* spp.) forest with steep to nearly level topography. Forest soils were mostly thin and stony but contained a series of broad fertile bottomland fields. Access to WFSA was controlled, and the area was managed for a variety of wildlife species. Agricultural food plots for deer and eastern wild turkeys (*Meleagris gallopavo*) were present but comprised <1% of the area. Deer densities on WFSA were high, approaching 25/km^2 (Haroldson 1999).

Methods

Study design

We conducted our study from 11 July–23 August 2001. Our study plots consisted of 9 widely dispersed (>550 m apart) 0.4-ha fields drilled to soybeans and, prior to germination, randomly assigned a treatment of either an AAS (n=3), MF (n=3), or control (n=3). Study plots formerly were wildlife food plots (winter wheat or clover) and were surrounded by warm- and cool-season grasses. Prior to planting (3 July 2001), we fertilized plots according to soil-test requirements and controlled weeds with herbicide applications. Deer regularly used all sites (R. Houf, Missouri Department of Conservation, personal observation) prior to their use as study plots. We separated plots by forests or topographic features (e.g., ridges) to ensure that treatments, especially the AAS, did not affect deer use of other plots. Within each plot we placed 10 protected, uniformly spaced 1-m^2 exclosures to aid in measuring deer utilization of plots. We measured height (cm) and green weight (gm) of protected soybean plants within each exclosure and in 1-m^2 field plots (unprotected) adjacent to the exclosures at the conclusion of the study. The 1-m^2 unprotected field plots were placed <1 m from exclosures, and we attempted to avoid areas with poor soybean germination. We measured deer utilization of each plot through real-time observations from elevated towers (12 m) and by videotaping each plot from approximately 2 hr before sundown until dark. When reviewing tapes we recorded the number of deer that entered a plot and the length of time they remained in each plot to quantify deer use of plots (deer use minutes=# deer × total minutes in plot).

Along the MF plots, we placed posts at 4-m intervals around the perimeter, with 5 strands of 27-kg monofilament fishing line strung tight between the posts at 30-cm intervals; fence height was 1.5 m. Each AAS plot had 1 pop-up scarecrow (Cummings et al. 1986) wired to a compact disc (CD) player in the center of each plot (Figure 1). When activated, the normally prone AAS would rise to a height of 1.2 m for 30 seconds and then slowly return to a prone position as air was released through a porthole. We placed infrared laser detection systems (IR) with activation counters (Pulnix Sensors Incorporated, Sunnyvale, Calif.) around the perimeter of each AAS plot. Each IR cast 2 parallel beams from 65 and 90 cm in height. An activation occurred when both beams were broken. We hardwired the IR units to the compact-disc player and a solenoid switch that, when activated, released air from a compressed-air storage can and caused the scarecrow to rise. Upon activation, the AAS sprang up and the CD player randomly played recordings of deer distress vocalizations, barking dogs, humans yelling, and other sounds. A strobe light flashed to illuminate the AAS during nighttime hours. The entire frightening session lasted about 30 sec. We wired all AAS plots separately and independently from other AAS plots. We used 2 deep-cycle 12-volt batteries to power the AAS systems.

Figure 1. An animal-activated scarecrow frightening device (right) used to deter deer-browse damage to soybean plots from 11 July–23 August 2001, on Woods Farm Study Area, Missouri, USA.

Data analysis

We measured treatment effects by comparing differences in plant heights in the 1-m^2 protected (exclosures) and unprotected areas of each plot for each treatment. We analyzed data separately for each deterrence method where the experimental units were nested within both plots (i.e., random blocking factor) and the protected or unprotected field treatments (i.e., fixed factor). We treated the study as a one-factor, unbalanced, randomized block design with subsampling. We used a mixed-effects ANOVA based on Type III sums of squares (Neter et al. 1990) to determine whether plant height differences between protected and unprotected plots were similar among treatments. The model took the form:

$$Y_{ijk} = \mu_{..} + t_i + p_j + \varepsilon_{(ij)} + n_{k(ij)}$$

where t=fixed treatment effects, p=random plot effects, e=experimental error (i.e., interaction between treatment and plot), and n=sampling error.

To measure the treatment effect on end weight of plants and deer-use minutes by treatment, we treated the study as an unbalanced 2-factor design with plot nested within treatments (Neter et al. 1990). For weight data we treated repeated observations as subsamples, not repeated measures, because deer-use minutes were not made on all plots on all days (n=29–35). We used a mixed-effects ANOVA based on Type III sum of squares to determine whether differences in plant weight and deer-use minutes were similar among treatments. The model took the form:

$$Y_{ijk} = \mu_{..} + t_i + p_{j(i)} + n_{ijk}$$

where t=fixed treatment effects, p=random plot effects, and n=sampling error.

We used linear regression to assess the trend in the number of activations for each AAS plot over time. We transformed the number of activations using a natural log. We fit the full model ($Y_{ijk}=\mu_{....} + day_i + plot_j + day{*}plot_{ij} + n_{ijk}$) and compared it to a reduced model without the interaction term. We analyzed data from each plot separately because the interaction term was significant (F_{52}=6.904, P=0.015).

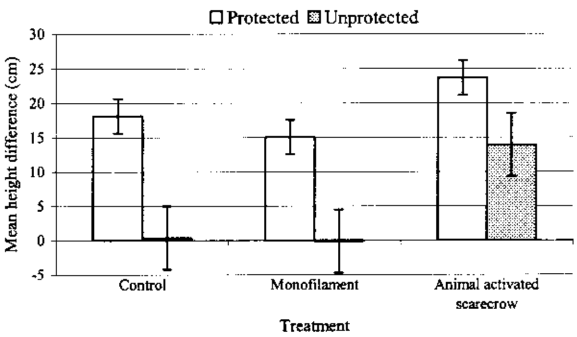

Figure 2. Mean differences in soybean plant height (cm) calculated from 89 protected and 89 unprotected subplots sampled on 30 July and 23 August 2001, on Woods Farm Study Area, Missouri, USA. Differences in growth were computed from these data, by treatment (0 ± 1 SE), for 0.4-ha soybean plots (n = 9) browsed by white-tailed deer.

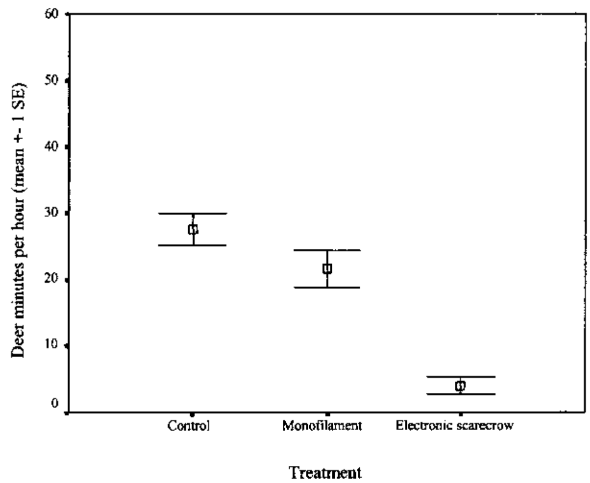

Figure 4. Deer use of soybean plots in deer minutes per hour (0 ± 1 SE from the data) by treatment for 0.4-ha soybean plots (n = 9) from 11 July–23 August 2001, Woods Farm Study Area, Missouri, USA.

Results

There was no difference between the height of vegetation in protected and unprotected field plots in the AAS treatment (F_2=2.16, P=0.28). In both the monofilament (F_2=93.60, P=0.01) and control plots (F_2=47.65, P=0.02), growth of vegetation was less in unprotected than protected plots (Figure 2).

Plant weight differences by treatment were significant (F_6=10.02, P=0.01). Differences in plant weight in AAS plots were less than differences in control (t_6=4.46, P<0.01) and monofilament (t_6= 2.55, P=0.04) plots (Figure 3). Differences in plant weight between monofilament and control plots were marginally significant (t_6=1.92, P=0.10).

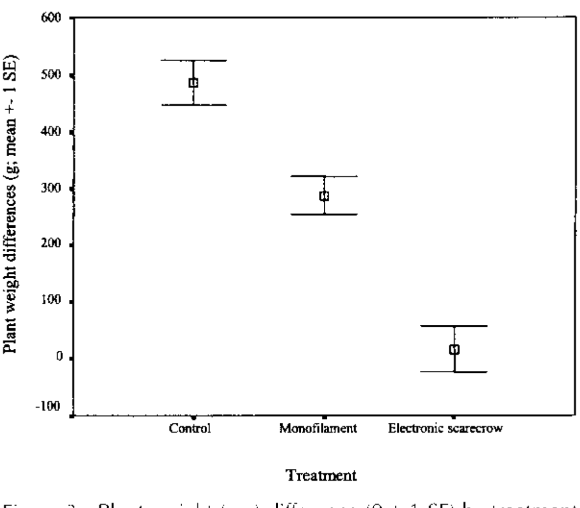

Figure 3. Plant weight (gm) difference (0 ± 1 SE) by treatment for 0.4-ha soybean plots (n = 9) browsed by white-tailed deer from 11 July –23 August 2001, Woods Farm Study Area, Missouri, USA.

The number of deer-use minutes differed among treatments (F_6=6.23, P=0.0343). The control plots (t_6 =3.39, P=0.0147) and MF plots (t_6=2.55, P=0.0437) had significantly greater deer minutes than AAS treatment plots (Figure 4). Deer minutes on control and MF treatments were similar (t_6=0.84, P=0.4344).

In all 3 AAS plots, there was a positive correlation between date and number of activations (AAS [Plot 2]: slope = 0.105, SE = 0.022, 95% CI = 0.0577–0.1517, R^2=0.5338, F=21.76, P_{19}<0.001; AAS [Plot 5]: slope = 0.146, SE = 0.016, 95% CI = 0.1130–0.17898, R^2 =0.8276, F=86.40, P_{18}<0.001; AAS [Plot 9]: slope=0.181, SE=0.023, 95% CI=0.1315–0.2304, R^2=0.8277, F=62.46, P_{13}<0.001). That is, the number of activations increased in all 3 plots throughout the duration of our study (Figure 5).

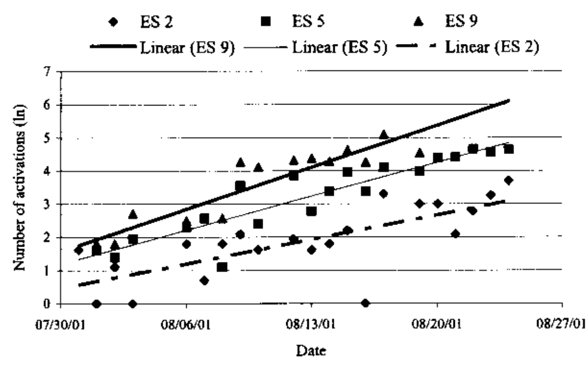

Figure 5. Linear trend lines depicting number of activations (ln) from 11 July–23 August 2001, for 3 plots protected with animal-activated scarecrows designed to deter deer browsing of 0.4-ha soybean plots (n = 3), from 11 July–23 August 2001, Woods Valley Farm Study Area, Missouri, USA.

Discussion

Our study site had high deer densities, and soybean plots were the only agricultural planting available. As a result, deer were attracted to the soybean plots, thus providing a rigorous test of the effectiveness of these damage-mitigation techniques. During our 6-week study, the AAS was an effective short-term deterrent to deer browsing of soybeans, although it became less effective over time. The MF was only marginally effective at reducing deer use of soybean plots.

The MF met our goals of being unobtrusive, portable, inexpensive, and low-maintenance. Some monofilament lines were occasionally broken by deer or tree limbs. Overall, the design was not an effective browse deterrent in our setting. Real-time and video observations suggest that the MF deterred deer initially (1–2 weeks) but was ineffective during the last 4 weeks of our study. Our fence design was less effective than single-strand electrified fencing (Hygnstrom and Craven 1988) or recently described portable fencing (Rosenberry et al. 2001). Spacing of the monofilament at 30-cm intervals may have allowed deer to easily walk through the fence. During initial encounters, fawns were able to slip under or through monofilament lines but adults remained outside the fence. In subsequent encounters, adult deer entered the plots by going between the second and third lines, again after fawns had already entered the plots. It is possible that a different fence design might have prevented deer penetration. We do not recommend use of our MF design for a period longer than 2 weeks to deter deer from browsing soybean or other crops.

Our results suggested that the AAS was an effective 6-week deterrent to summer deer browsing on planted soybean fields. Light browsing and minimal deer use of these plots did not affect plant height or weight. Overall differences in soybean plant heights between protected and unprotected subplots were mostly attributable to plant height differences among the 3 AAS plots; 2 plots were in fertile bottom fields and 1 on an upland site. Plant height differences related to site were not apparent among other treatments because unprotected soybeans were heavily browsed.

While comparisons with different deer deterrents and crops are problematic, they may give clues to the effectiveness of this technique relative to others. The level of protection afforded by the AAS was better than that reported for propane exploders (Belant et al. 1996) and repellents (Palmer 1983, Conover 1994) and similar to protection afforded by single-strand electric fences (Porter 1983, Hyngstrom and Craven 1988) or crop-protection dogs (Beringer et al. 1994). However, the AAS was not as effective as multi-strand electric fences or 3-m woven- wire barrier fences (Caslick and Decker 1979).

The AAS was visually unobtrusive and portable. Maintenance included biweekly charging of batteries and recharging the air-storage can weekly during weeks 1–3 and daily during the final 5 days at 2 of the sites. A larger air container would have reduced the effort required to maintain air pressure sufficient to erect the AAS. Our devices were experimental and portable and thus required more attention during early phases of the study. Problems often resulted from power supply, and a constant 110-volt current would likely alleviate this. Costs to set up our experimental AAS system were $1,600, but could be reduced by using less expensive IR sensors.

On 2 AAS sites the IR beams were set up too close to the soybean plots, and by week 5 soybean plants were tall enough to break both beams and activate the AAS. These activations depleted the air supply and might have facilitated deer habituation to the frightening device. Belant et al. (1996) speculated that increased detonation rates of propane exploders might have reduced their effectiveness at frightening deer from feeding sites in Ohio.

Real-time and video observations and deer tracks around the plots suggested that deer attempted to enter soybean plots almost immediately after the AASs were installed. Subsequent attempts to enter the fields did not occur for several days. In most instances deer fled from our field of view when the AAS was activated. During observation periods we witnessed up to 30 deer feeding around, but not entering, the AAS plots. After 2–3 weeks, deer had created trails just outside the IR beams surrounding each AAS plot. It appeared that deer were cognizant of IR beam locations and attempted to avoid activating the AAS. Our activation counters indicated that deer triggered the AAS from 0–6 times in a 24-hr period. By week 6, however, activations on 2 plots increased to as high as 100 in a 24-hr period. We believe the AAS for these plots lost some effectiveness because deer were able to feed undisturbed in the plots for up to 4 days during mechanical malfunctions. Also, video from both plots revealed that a deer (we believe a single deer in each case) found a swale on the perimeter that allowed it to enter the plot without activating the AAS. Once this deer was in the plot, others attempted to enter, activated the AAS, and all deer left; subsequently, the first deer re-entered at the same location and started the process again. We saw a similar situation when a fawn entered an AAS plot but the AAS was not activated until an adult doe attempted to enter. The third AAS plot did not have mechanical problems or topographical features that allowed deer to enter without AAS activation. Thus, activations remained low throughout the study. Browse damage remained low and deer spent little time inside plots, despite some apparent habituation to the AAS in 2 of 3 plots.

We recommend the use of an AAS or similar animal-activated frightening devices after evaluating topographic features when setting up IR sensors. We orientated IR sensors in a vertical plane, with sensor heights at 65 and 95 cm. While this setup minimized nontarget activations (e.g., birds, blowing leaves), it might have facilitated entry by fawns and adult deer in low places. A single IR beam or orientation of IR beams in a horizontal plane would reduce the chance of deer penetration without activation. We concur with Belant et al. (1996) that animal-activated frightening devices offer longer-term protection to crops than systematic devices because habituation to the frightening devices is slower. We believe the AAS would be more effective in areas with lower deer densities than on our study area and in habitats with alternative food sources. Those considering the use of the AAS technique should attempt to install the device prior to initiation of crop feeding by deer. Once deer have developed a feeding pattern, frightening devices may be less effective. While our study evaluated AASs only on small (0.4-ha) plots, the IR sensors can project up to 200 m. Protecting larger fields will require attention to topographic features to ensure appropriate above-ground spacing of IR beams. Knowledge of the juxtaposition of deer habitat and crop fields and where deer enter fields may reduce the need to completely encircle a field with IR beams. Our study suggested that AASs may be most useful for short-term protection of high-dollar crops or gardens where damage is seasonal or crop rotation is frequent (e.g., strawberries). They also may be useful for protecting stored crops (VerCauteren et al. 2003*b*). In these settings, permanent fencing may not be practical, visually appealing, or cost-effective. We suggest that AASs may be useful for short-term deterrence of white-tailed deer and other wildlife species.

Acknowledgments. We thank the Woods Foundation for monetary support and J. R. and J. H. Woods for graciously allowing us to work on their farm. M. Larson provided assistance with data analysis and SAS programming. R. Houf and R. Woeck were technicians on our study and were integral in data collection. G. Mihalevich and J. Krumm were instrumental in the design and development phases of our study. L. Hansen provided useful editorial comments on our manuscript.

Literature cited

Austin, D. D., and P. J. Urness. 1993. Evaluating production losses due to depredating big game. Wildlife Society Bulletin 21: 397–401.

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. Vertebrate Pest Conference 18: 107–110.

Beringer, J., L. P. Hansen, R. A. Heinen, and N. F. Giessman. 1994. Use of dogs to reduce damage by deer to a white pine plantation. Wildlife Society Bulletin 22: 627–632.

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.

Brown, T. L., D. J. Decker, S. J. Riley, J. W. Enck, T. B. Lauber, P. D. Curtis, and G. F. Mattfeld. 2000. The future of hunting as a mechanism to control white-tailed deer populations. Wildlife Society Bulletin 28: 797–807.

Caslick, J. W., and D. J. Decker. 1979. Economic feasibility of a deer-proof fence for apple orchards. Wildlife Society Bulletin 7: 173–175.

Conover, M. R. 1994. Perceptions of grass-roots leaders of the agricultural community about wildlife damage on their farms and ranches. Wildlife Society Bulletin 22: 94–100.

Conover, M. R. 1997. Monetary and intangible valuation of deer in the United States. Wildlife Society Bulletin 25: 298–305.

Conover, M. R., and D. J. Decker. 1991. Wildlife damage to crops: perceptions of agricultural and wildlife professionals in 1957 and 1987. Wildlife Society Bulletin 19: 6–52.

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.

Cummings, J. L., C. E. Knittle, and J. L. Guarino. 1986. Evaluating a pop-up scarecrow coupled a propane exploder for reducing blackbird damage to ripening sunflower. Pages 286–291 *in* T. P. Salmon, editor. Proceedings Twelfth Vertebrate Pest Conference. University of California, Davis, USA.

Curtis, P. D., C. Fitzgerald, and M. E. Richmond. 1995. Evaluation of the Yard Gard ultrasonic yard protector for repelling white-tailed deer. Eastern Wildlife Damage Control Conference 7: 172–176.

GILSDORF, J. 2002. Effectiveness frightening devices for reducing deer damage to corn fields. Thesis, University of Nebraska. Lincoln, USA.

HANSEN, L. P., AND J. BERINGER. 1997. Managed hunts to control white-tailed deer populations on urban public areas in Missouri. Wildlife Society Bulletin 25:484–487.

HAROLDSON, B. S. 1999. Evaluation of thermal infrared imaging for detection of white-tailed deer. Thesis, University of Missouri, Columbia, USA.

HYGNSTROM S. E., AND S. R. CRAVEN. 1988. Electric fences and commercial repellents for reducing deer damage to cornfields. Wildlife Society Bulletin 16:291–296.

KOEHLER, A. E., R. E. MARSH, AND T. P. SALMON. 1990. Frightening methods and devices/stimuli to prevent mammal damage–a review. Pages 168–173 *in* L. R. Davis and R. E. Marsh, editors. Proceedings Fourteenth Vertebrate Pest Conference, Sacramento, California, USA

NETER, J., M. H. KUTNER, C. J. NACHTSHEIM, AND W. WASSERMAN. 1990. Applied linear statistical models. Fourth edition. Irwin, Chicago, Illinois, USA.

PALMER, W. L. 1983. Evaluation of white-tailed deer repellents. Wildlife Society Bulletin 11:164–166.

PORTER, W. F. 1983. A baited electric fence to reduce deer damage to orchard seedlings. Wildlife Society Bulletin 11: 325–327.

ROSENBERRY, C. S., L. I. MULLER, AND M. C. CONNER. 2001. Movable, deer-proof fencing. Wildlife Society Bulletin 29:754–757.

SWIHART, R. K., P. M. PICONE, A. J. DENICOLA, AND L. CORNICELLI. 1995. Ecology of urban and suburban white-tailed deer. Pages 35–44 *in* J. B. McAnich, editor. Urban deer: a manageable resource? Proceedings of the 1993 Symposium of the North Central Section,The Wildlife Society, St. Louis, Missouri, USA

THOM, R. H., AND J. H. WILSON. 1980. The natural divisions of Missouri. Transactions of the Missouri Academy of Science 14:9–23.

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. Pages 51–57 *in* R. J. Warren, editor. Proceedings of the 1st National Bowhunting Conference. Archery Manufacturers and Merchants Organization, Comfrey, Minnesota, USA.

VERCAUTEREN, K. C., S. E. HYGNSTROM, M. J. PIPAS, P. FIORANELLI, S. WERNER, AND B. BLACKWELL. 2003*a*. Red lasers are ineffective for dispersing deer at night. Wildlife Society Bulletin 31:247–252.

VERCAUTEREN, K. C., M. J. PIPAS, P. PETERSON, AND S. BECKERMAN. 2003*b*. Stored crop loss due to deer consumption. Wildlife Society Bulletin 31: in press.

WOOLF, A., AND J. L. ROSEBERRY. 1998. Deer management: our profession' symbol of success or failure? Wildlife Society Bulletin 26:515–521.

WYWIALOWSKI, A. 1994. Agricultural producers' perceptions of wildlife-caused losses. Wildlife Society Bulletin 22:370–382.

Jeff Beringer (photo) is a resource scientist with the Missouri Department of Conservation (MDC) and was formerly a wildlife damage biologist with MDC. He received a B.S. in wildlife management from the University of Wisconsin–Stevens Point and an M.S. in wildlife and fisheries science from the University of Tennessee. His primary interest is deer and wild turkey research and management. He and his 2 young boys enjoy hunting and fishing whenever possible. **Kurt VerCauteren** is a research wildlife biologist in the Product Development Program at the National Wildlife Research Center. He received his B.S. from the University of Wisconsin–Stevens Point, and 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 and as president and secretary of the Nebraska Chapter. His current research involves devising tools and techniques to reduce wildlife damage associated with ungulates, rodents, and waterfowl. ***Joshua J. (Josh) Millspaugh*** is an assistant professor of wildlife conservation at the University of Missouri (MU). Prior to joining the MU faculty, Josh was a postdoctoral researcher in the School of Fisheries at the University of Washington (UW). Josh received his Ph.D. in wildlife science from the UW, his M.S. from South Dakota State University, and his B.S. from the SUNY College of Environmental Science and Forestry (SUNY-ESF). Josh's research currently focuses on design and analysis of radiotracking studies, large-mammal ecology and management, and the refinement and use of hormone assays in wildlife conservation.

Associate editor: *Grado*