Evaluation of ElectroBraide Fencing as a White-Tailed Deer Barrier

Thomas W. Seamans
USDA/APHIS/WS National Wildlife Research Center, thomas.w.seamans@aphis.usda.gov

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

Peer Reviewed

Evaluation of ElectroBraid™ Fencing as a White-Tailed Deer Barrier

THOMAS W. SEAMANS,[1] *United States Department of Agriculture/Wildlife Services, National Wildlife Research Center, Ohio Field Station, Sandusky, OH 44870-9660, USA*

KURT C. VERCAUTEREN, *United States Department of Agriculture/Wildlife Services, National Wildlife Research Center, Fort Collins, CO 80521-2154, USA*

Abstract

White-tailed deer (Odocoileus virginianus) *populations continue to increase, resulting in direct threats to public safety and increased agricultural losses. A variety of fencing methods are used to reduce deer presence at airports and agricultural areas. Electric fences may offer a less expensive alternative to expensive woven-wire fences. We tested an electric fence product, ElectroBraid™ (Yarmouth, N.S., Canada), on free-ranging deer in northern Ohio. We conducted both 1- and 2-choice tests, measuring deer intrusions and corn consumption at 10 sites encompassed with charged, noncharged or no fence. Mean daily deer intrusions decreased in each test when the fence was powered. When power was immediately applied to the fence, intrusions decreased 88–99%. When power was delayed for 10 weeks, intrusions were reduced 90%. When power was turned on and off within a 4-week period, intrusions decreased 57%. Mean corn consumption differed between treated (< 2–6.4 kg/day) and control sites (15–32 kg/day). Under the conditions and time duration of this test, the fence was an effective deer barrier.*
(WILDLIFE SOCIETY BULLETIN 34(1):8–15; 2006)

Key words

deer, electric fence, Odocoileus virginianus*, white-tailed deer, wildlife damage management.*

The number of white-tailed deer (*Odocoileus virginianus*) in the United States have increased from about 350,000 in 1900 to >26 million in the 1990s (Jacobson and Kroll 1994). Locally overabundant deer populations can increase human-wildlife conflicts. These conflicts include damage to agricultural crops and increased public safety risks because of collisions.

Aircraft collisions with deer pose a direct threat to human welfare (Dolbeer et al. 2000) and result in significant economic loss to the aviation industry (Wright 2001). Airports may serve as refuges for deer because human and animal predators have restricted access while foraging opportunities exist for deer. Deer on airports have become a concern as the number of reported deer–aircraft collisions continues to increase (Bashore and Bellis 1982, Wright 1996, Dolbeer et al. 2000). From 1990–2002, there were 570 civil aircraft collisions with deer reported in the United States, with damage occurring in 81% of the collisions (Cleary et al. 2003). Thirteen of these strikes have resulted in 18 people suffering injuries, including 1 fatality (Cleary et al. 2003).

Due to the high probability of strikes resulting in damage or injury when deer–aircraft collisions occur, it is imperative that airports be kept free of deer (Wright 1996, Wright et al. 1998, Dolbeer et al. 2000). Lethal control of deer on airports often is controversial but, because of the risk to human safety, it is often justifiable. However, killing deer alone may not serve as a long-term solution if the airport remains attractive and accessible to deer.

Fences of various designs can be effective at excluding deer (McAninch et al. 1983). Woven-wire or chain-link fences can be a highly effective barrier to deer (Craven and Hygnstrom 1994). However, because these fences cost $30–$50/m (U.S.) when installed (Sandusky Fence and Guard Rail Company, Fremont Fence and Guard Rail Company, personal communication), less expensive alternatives are needed. Electrified, high-tensile wire fences may not be as effective but are less expensive (costs range from $4–$13/m installed) than woven-wire fences (Brenneman 1983, McAninch et al. 1983, Craven and Hygnstrom 1994). Some of the various electric fence designs include slanted, offset, and vertical. Some deer may penetrate electric fences and in agricultural situations this reduced number of deer may be allowable as fewer deer result in an acceptable crop loss level (Brenneman 1983, Palmer et al. 1983). However, airports should strive to have no deer on the airfield (Cleary and Dolbeer 1999).

There are several electric fence products on the market. We tested a product called ElectroBraid™ (Yarmouth, Nova Scotia, Canada). The fence, carried on frangible, fiberglass posts at 15-m intervals, is comprised of 0.6-cm polyester rope with copper wire woven into the rope. ElectroBraid fence material has a 25-year warranty against rust, rot, and weathering. Four or 5 strands of the rope at 25-cm horizontal spacing, carrying 5 kilovolts, is recommended by the manufacturer to deter deer. The fence and accessories cost about $9/m, including installation. ElectroBraid is being used on some airports for deer control. We found no studies in the peer-reviewed literature that evaluated ElectroBraid. Our goal was to test the efficacy of ElectroBraid for preventing deer from entering and feeding at sites surrounded by ElectroBraid. Also, it is our experience that fences often are not well maintained and power to a fence is intermittent. Therefore, we also hoped to determine if deer continually test the fence to detect if it is powered or, if once they begin to penetrate, they continue to do so even when power is restored to the fence.

Methods

We evaluated the effectiveness of ElectroBraid as a deer barrier from January–March 2002, December 2002–February 2003, and January–February 2004 at the National Aeronautic and Space Administration's Plum Brook Station (PBS), Erie County, Ohio, USA. We did not work at airports because of the compounding effects of control efforts that are implemented to keep deer off airports. Additionally, because we attracted deer to test sites it was

[1] *E-mail: thomas.w.seamans@usda.gov*

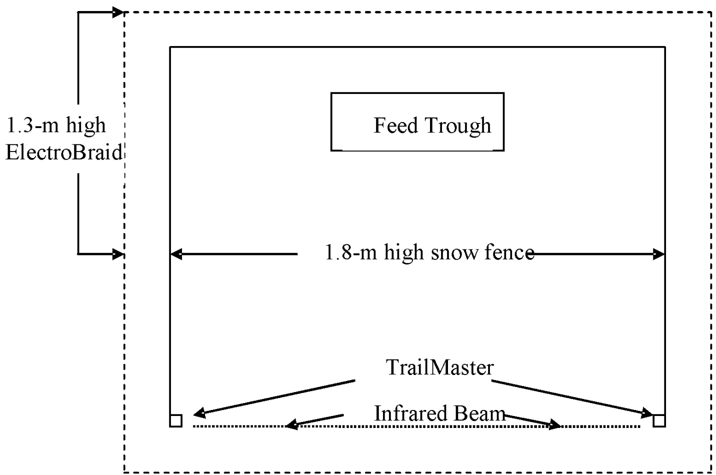

Figure 1. Deer feed station used from 2002–2004 to evaluate efficacy of ElectroBraid as a deer barrier, Erie County, Ohio, USA. In 2002 and 2003, ElectroBraid was 1 m from the snow fence and 6 m from the leading edge of the feed trough. In 2004, ElectroBraid was 20 m from the snow fence.

not safe to conduct this type of test at airports. We ended tests each year as the weather warmed and alternative foods became available.

The 2,200-ha facility was surrounded by a 2.4-m-high chain-link fence with barbed-wire outriggers. Habitat within PBS differed from the surrounding agricultural and urban area and consisted of canopy-dogwood (*Cornus* spp.), (39%), grass–forb fields (31%), open woodlands (15%), mixed hardwood forests (11%), and roads and buildings (4%), (Rose and Harder 1985). The deer population was estimated by the Ohio Department of Natural Resources (DNR). A helicopter survey was conducted by DNR and USDA biologists along established transects when at least 8 cm of snow covered the ground. The estimated minimum size of the deer population was 422 (19/km^2) during winter 2002 (A. E. Barras, USDA, unpublished data) and 1,200 (54/km^2) during winter 2003 (J. D. Cepek, USDA, unpublished data). Poor survey conditions in 2002 likely resulted in a low population estimate (A. E. Barras, USDA, unpublished data). Regardless, both estimates reflect high deer densities when compared to common target winter densities in the Midwest and Great Lakes states of 6–13 deer/km^2 (Gladfelter 1984, Menzel 1984).

We established 10 deer feeding sites at locations where deer sign was prevalent and where deer were observed during December 2001, with $\geq$1 km between sites. At each site we erected 2, 5 $\times$ 5-m stations (left and right), 9 m apart. At each station we erected a plastic snow fence (1.8 m high) on 3 sides and placed a 1.2-m-long feed trough about 1 m from the rear of the enclosure (Fig. 1). Each trough was supplied with whole-kernel corn. Corn consumption was monitored by fitting each feed trough with 2 metal indicator plates at each end of the trough that had been calibrated for corn and inscribed at 4.5-kg intervals (Belant et al. 1997). We estimated corn consumption to the nearest 2.3 kg by interpolating the distance between the 4.5-kg intervals. We added corn to feed troughs as necessary to maintain a constant food supply ($\approx$25 kg). We did not attempt to differentiate between corn consumed by deer and that consumed by raccoons (*Procyon lotor*) or fox squirrels (*Sciurus niger*). Based on a raccoon survey conducted on PBS in 2002 (Blackwell et al. 2004) that showed high raccoon density and presence in the area of all test sites we believed all sites were subject to comparable wildlife pressure. We used an active-infrared trail-monitoring device (TrailMaster®, Goodson and Associates, Incorporated, Lenexa, Kansas) to count deer visits to the trough. The device was installed 60 cm above ground at each opening to continually monitor the number of deer intrusions and avoid recording nontarget species (e.g., raccoon, fox squirrel). The National Wildlife Research Center Animal Care and Use Committee approved the procedures used prior to study initiation

Two-Choice Test

We conducted the two-choice test from 15 February to 1 March 2002. We began by monitoring corn consumption and deer intrusions daily until left and right stations were used equally based on a paired *t*-test for both corn consumption and intrusions within each site for 7 days. At each site we randomly selected 1 station to receive the electric fence while the other station served as a control with no fence around the station. We installed the 1.3-m-high fence with 5 strands of ElectroBraid at 25-cm intervals around the station so that the electric fence was 1 m from the snow fence on 3 sides and 6 m from any other fencing when viewed from the front of the station (Fig. 1). The ElectroBraid was powered by a Viper™ 1500 solar-powered energizer (Tru-Test Incorporated, San Antonio, Texas) which had a maximum pulse output of 1.5 joules and was powered by a 12-volt deep-cycle battery. We recorded daily corn consumption, deer intrusions, and voltage for 7 days. After 7 days we switched the stations; the control stations became treated and treated stations became controls. We again monitored daily corn consumption, deer intrusions, and voltage for 7 days. We compared data between treated and control stations for each week using Wilcoxon Signed Rank test. We conducted regression analyses on consumption and intrusions over days.

One-Choice Test

We conducted the one-choice test from 2–22 March 2002. At the conclusion of the two-choice test, we randomly removed 1 feed trough from each site such that 5 sites were treated with a trough surrounded by electric fence and the remaining 5 sites were controls without electric fence. We monitored daily corn consumption, intrusions, and voltage in the same manner as in the two-choice test. In addition, we used 5 motion-activated video cameras to view deer behavior at treated stations. Due to technical difficulties with the cameras, we did not analyze behavioral data from camera footage. We compared corn consumption and intrusions between treated and control sites using Kruskal–Wallis analysis of variance. We conducted regression analyses on consumption and intrusions over days.

On–Off Test

Based on the results of the previous tests, we wanted to evaluate the efficacy of ElectroBraid after deer had been initially exposed to the fence to determine if they had been conditioned to avoid the fence. Therefore we conducted an experiment where power to the fence was turned on and off.

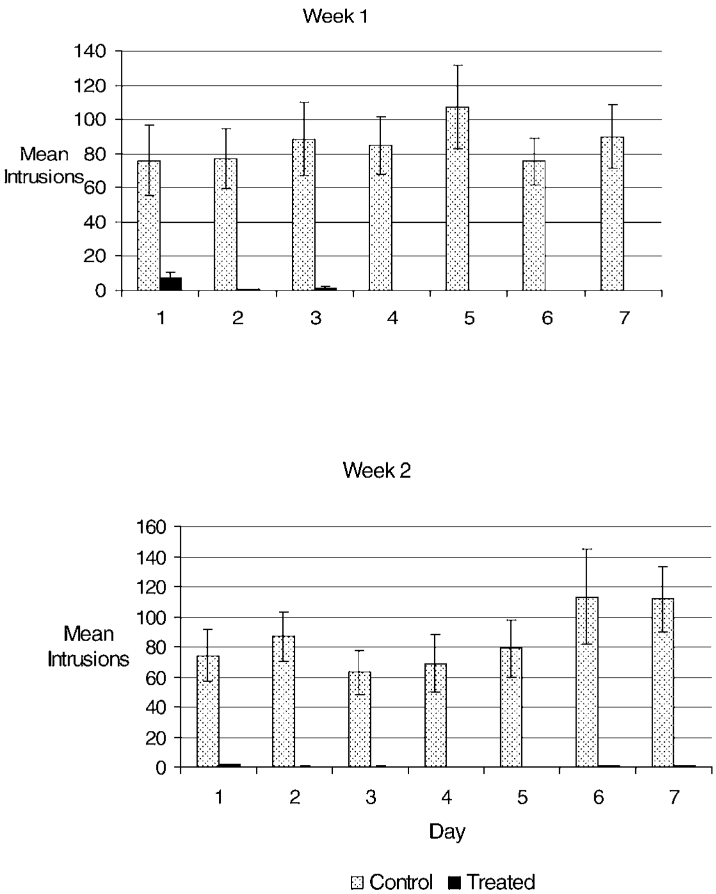

Figure 2. Mean daily deer intrusions in week 1 and 2 into sites treated with ElectroBraid and control sites without ElectroBraid during a 2-choice test, February, 2002, Erie County, Ohio.

Trial 1.—At the conclusion of the one-choice test, we removed all ElectroBraid and food troughs. In December 2002 we re-established all sites with 1 trough at each site. When deer were using each site daily for 7 consecutive days (pretreatment), we erected ElectroBraid around each site. We divided the 10 sites geographically into 2 groups of 5 such that eastern sites were ≥2 km from western sites. We randomly chose to power the western sites first (treated sites) while eastern fences were not powered (control sites). We supplied power for 1 week to the western sites; we then turned power off for 2 weeks. We recorded intrusions and corn consumption as in the previous tests.

Trial 2.—On the western sites, after having power off for 2 weeks, were turned it back on for 1 week. After the week of power being on, we again turned the power off for 2 weeks. The power to the fences on eastern sites remained off throughout this round of testing.

Trial 3.—Ten weeks after initially setting up the eastern sites (this includes 4 weeks of pretreatment and 3 weeks each for Trials 1 and 2), we supplied power to them for 3 weeks and left the power off on the western sites. We monitored all sites for corn consumption and intrusions. We summarized data by week and compared within trials and treatment groups using Kruskal-Wallis analysis of variance.

Large Enclosure Tests

In January 2004 we re-established 9 sites at the same locations as the previous 2 years and moved 1 site 0.5 km due to construction. We measured intrusions and corn consumption as previously stated. When deer were using each site daily for 7 consecutive days (pretreatment), we placed and powered ElectroBraid around 5 randomly selected sites so that the electric fence enclosed 0.2 ha around the feed trough. Each side of the enclosure was a minimum of 45 m and centered on the trough. Control sites had no ElectroBraid surrounding the sites. We measured deer activity at all sites for 6 weeks following fence installation. We compared pretreatment data between treated and control sites using the Wilcoxon rank sum test. We summarized data by week and compared within treatment groups using Kruskal-Wallis analysis of variance.

Results

Prior to installing ElectroBraid in 2002, the mean number of daily intrusions (±SE) between left (46.3 ± 4.2) and right (52.6 ± 5.9) sites was similar ($T = 1.4$; $P = 0.16$). Likewise, daily corn consumption between left (7.4 ± 0.5 kg) and right (7.2 ± 0.6 kg) sites was similar ($T = 0.45$; $P = 0.66$).

Two-Choice Test

In week 1 the mean number (±SE) of daily intrusions at treated sites (1.3 ± 0.5) differed ($T = 7.27$; $P < 0.01$) from control sites (85.5 ± 7.0). In week 2 the mean number of daily intrusions in treated sites (0.5 ± 0.1) again differed ($T = 7.06$; $P < 0.01$) from control sites (85.2 ± 7.8; Fig. 2). In week 1 mean daily corn consumption differed ($T = 7.17$; $P < 0.01$) between treated (1.4 ± 0.2 kg) and control (15.5 ± 0.9 kg) sites. In week 2 mean daily corn consumption again differed ($T = 7.06$; $P < 0.01$) between treated (0.9 ± 0.3 kg) and control (14.1 ± 1.0 kg) sites (Fig. 3).

One-Choice Test

The mean number of daily intrusions at treated sites (0.4 ± 0.1) differed ($T = 4.00$; $P < 0.01$) from control sites (71.6 ± 3.3). Intrusions did not increase at treated ($r_{1,96} = 0.01$; $P = 0.39$) or control ($r_{1,93} = 0.01$; $P = 0.58$) sites during the 3-week treatment period (Fig. 4). Mean daily corn consumption by wildlife differed ($T = 8.82$; $P < 0.01$) between treated (1.9 ± 0.2 kg) and control sites (15.5 ± 0.8 kg). Consumption did not increase at treated ($r_{1,103} = 0.00$; $P = 0.90$) or control sites ($r_{1,103} = 0.01$; $P = 0.70$) during the 3-week treatment period (Fig. 4).

In the video of the treated sites, we observed ≥2 individual deer at 1 site penetrate the functioning ElectroBraid fence on 18 occasions. It was apparent that the fence was powered at the time of these intrusions as other deer were observed being shocked immediately after the deer penetrated the fence. We observed no other deer penetrating any other fence. The voltage in 2002 at each electric fence ranged from 5.9–9.1 kilovolts with a mean of 7.1 kilovolts. Power was not lost at any site during the test.

On–Off Trials

Trial 1.—Mean daily intrusions at treated sites which had the fence turned on as soon as it was erected decreased ($H = 111.9$, $P < 0.01$) ≥99% from 185.8 ± 18.9 during pretreatment to 0.6 ± 0.4 during the treatment week and remained low through the 2 weeks of post-treatment. Mean daily intrusions at control sites

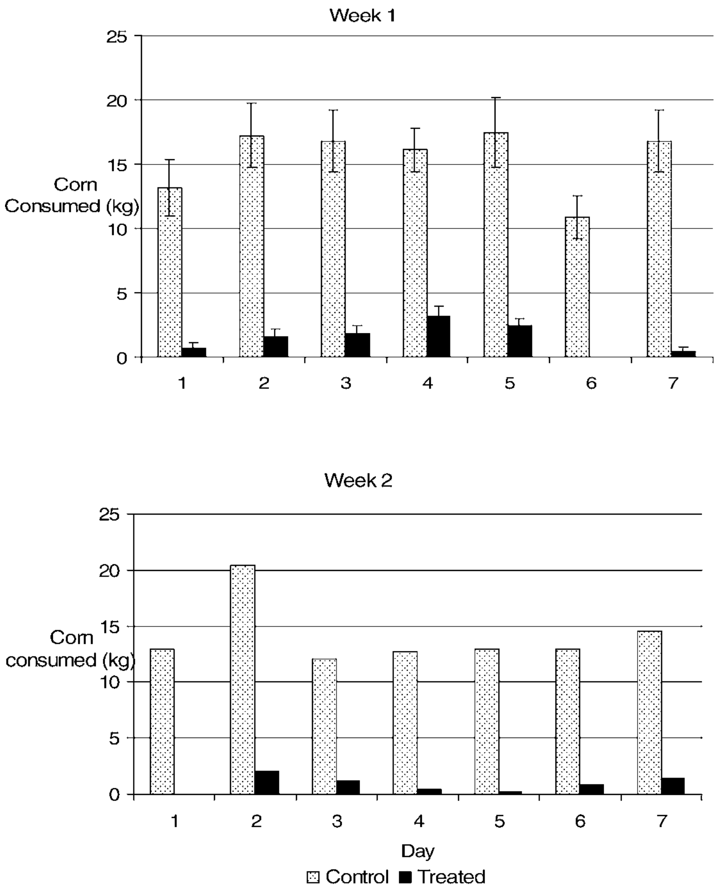

Figure 3. Mean daily corn consumption (kg) by wildlife at sites treated with ElectroBraid and control sites without ElectroBraid during a 2-choice test, February 2002, Erie County, Ohio.

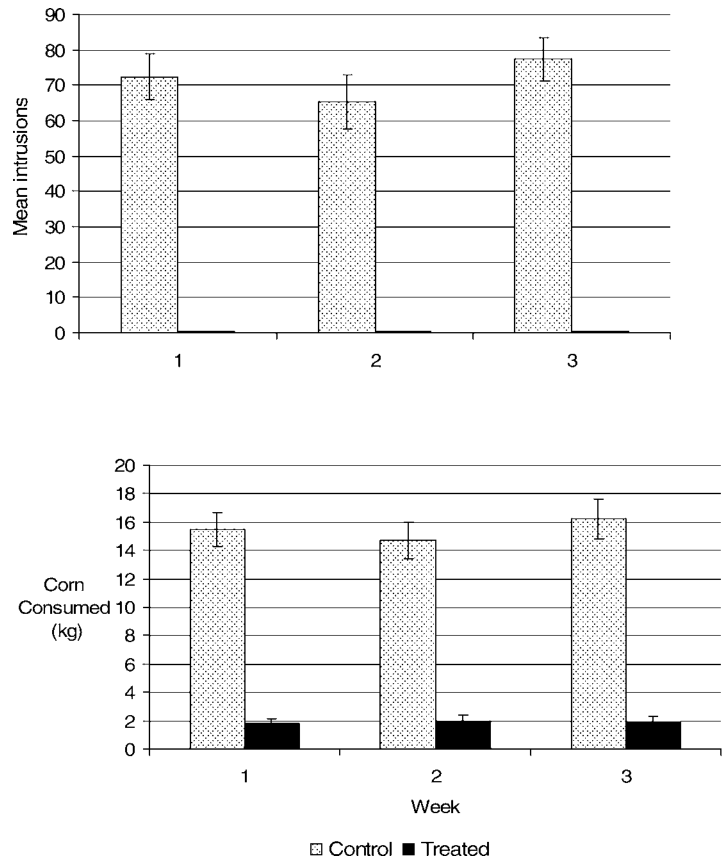

Figure 4. Mean daily deer intrusions (top) and corn consumption (kg; bottom) at sites with powered ElectroBraid and without any ElectroBraid during a 1-choice test, March 2002, Erie County, Ohio.

changed (H = 22.1, $P < 0.01$) from 102.0 ± 8.4 during pretreatment to 61.3 ± 2.8 during treatment and remained low during post-treatment (Fig. 5).

Mean daily corn consumption at treated sites decreased (H = 98.2, $P < 0.01$) from 32.7 ± 1.5 kg during pretreatment to 1.2 ± 0.6 kg during treatment and remained significantly lower (Fig. 5). Mean daily corn consumption at control sites also decreased (H = 23.9, $P < 0.01$) from pretreatment (23.3 ± 1.6 kg) through treatment (15.1 ± 0.9 kg) and post-treatment weeks (Fig. 5).

Trial 2.—We initiated trial 2 even though intrusions and corn consumption were not back to pretreatment levels. Mean daily intrusions at treated sites decreased (H = 19.1, $P < 0.01$) about 57% from pretreatment to treatment and then increased through post-treatment (Fig. 6). Mean daily intrusions at control sites decreased (H = 19.2, $P < 0.01$) from pretreatment to treatment and then increased in post treatment weeks (Fig. 6).

Mean daily corn consumption at treated sites decreased (H = 31.7, $P < 0.01$) from pretreatment to treatment and then increased through post-treatment weeks (Fig. 6). Mean daily corn consumption at control sites increased (H = 12.2, $P < 0.01$) from pretreatment during the post-treatment weeks (Fig. 6).

Trial 3.—A trail-monitoring device at a treated site malfunctioned and we did not use data from that site for intrusion analysis. Mean daily intrusions at treated sites decreased (H = 60.5, $P <$ 0.01) an average of 91% from pretreatment levels during the 3 weeks of treatment. Mean daily intrusions at control sites did not differ (H = 1.01, P = 0.80) throughout trial 3 (Fig. 7).

Mean daily corn consumption at treated sites decreased (H = 67.0, $P < 0.01$) from pretreatment through treatment weeks. Mean daily corn consumption at control sites did not differ (H = 3.3, P = 0.35) throughout the trial (Fig. 7).

The voltage in 2003 at each electric fence ranged from 6.1–7.8 kilovolts with a mean of 7.0 kilovolts. Power was not lost at any site during the test.

Large Enclosure Tests

Mean daily intrusions between treated (124.0 ± 13.1) and control (135.9 ± 14.8) sites were similar (U = 0.35; P = 0.72) during pretreatment. Mean daily intrusions at treated sites decreased (H = 85.6; $P < 0.01$) an average of 88% from pretreatment through all treatment weeks. Mean daily intrusions at control sites increased (H = 15.1; P = 0.02) from pretreatment through all treatment weeks (Fig. 8).

Mean daily corn consumption between treated (19.7 ± 1.8 kg) and control (24.0 ± 2.1 kg) sites was similar (U = 1.32; P = 0.18) during pretreatment. Mean daily corn consumption at treated sites decreased (H = 65.3; $P < 0.01$) from pretreatment through all treatment weeks. Mean daily corn consumption at control sites did

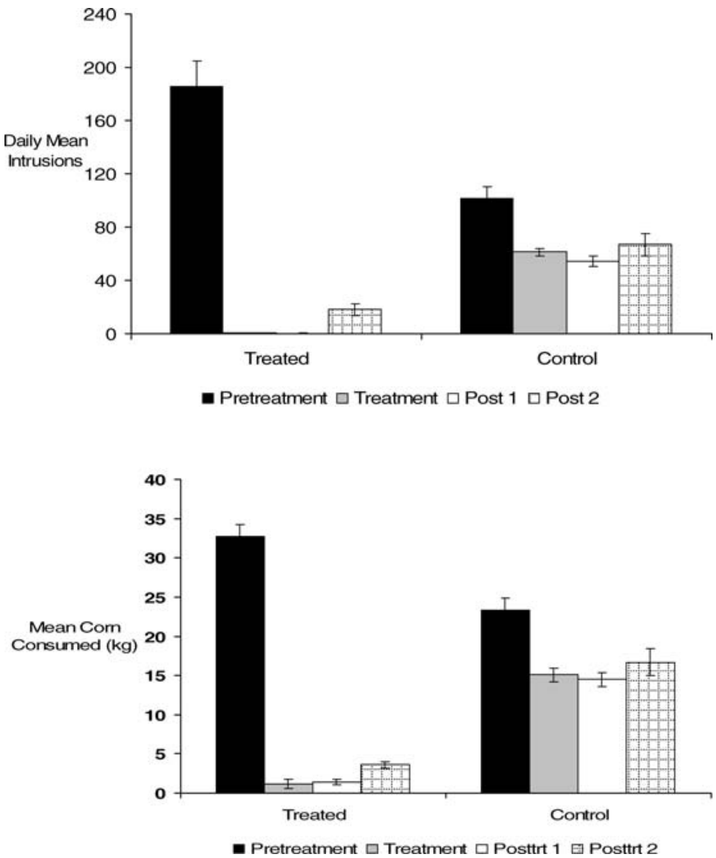

Figure 5. Mean daily deer intrusions (top) and corn consumption (kg; bottom) at sites with ElectroBraid. Treated sites had power on for 1 week (Treatment) and then off for 2 weeks (Posttreatment 1 and Posttreatment 2) during December 2002 in Erie County, Ohio.

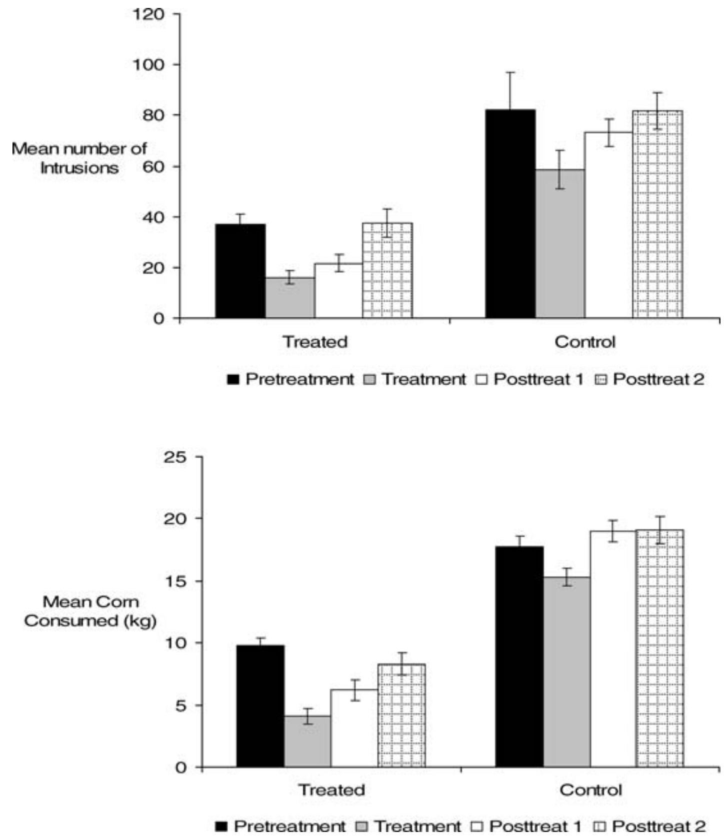

Figure 6. Mean daily deer intrusions (top) and corn consumption (kg; bottom) at sites with ElectroBraid. Treated sites had been through an earlier round of power on and off prior to power being re-supplied for 1 week (Treatment) and then off for 2 weeks (Posttreatment) during January 2003 in Erie County, Ohio. The Pretreatment period was 1 week without power prior to the Treatment period.

not change ($H = 10.4$; $P = 0.11$) from pretreatment through all treatment weeks (Fig. 8).

The voltage in 2004 at each electric fence ranged from 5.0–9.8 kilovolts with a mean of 7.9 kilovolts. Power was present at each site on every daily check.

Discussion

When presented with an electrified fence surrounding a desired food source in an area of high deer density, there was about a 90% reduction in the number of deer passing through, under, or over the fence during a seasonally stressful period. The reduction was evident in both small (5- × 5-m) and large (0.2 ha) exclosure experiments. The experiments took place over 3 years and likely included deer that had experienced the powered fence at least 9 months prior to the second and third test. However, after we turned the power off, allowing deer to contact the fence without getting shocked, and then returned power, deer penetrations were reduced by 57%. When presented for the first time with a non-powered fence deer continued to penetrate the fence at a rate similar to or up to 40% less than that of when no fence was present. After 7 weeks of penetrating the non-powered fence, intrusions decreased 90% when we supplied power to the fence.

The number of intrusions decreased, both when the fence was electrified initially and after a delay in powering the fence. Why intrusions were almost eliminated in the first instance and then reduced by 57–90% instead of 99% is unknown. Gallagher and Prince (2003) found that foraging deer were not conditioned to associate a sound with an electric shock. Based on video footage, deer that penetrated the fence when power was on did so without touching their nose or ears to the fence. Generally, they stepped through the fence while contacting the fence along their back, belly, or legs. Based on these observations, in February 2004, we obtained a deer hide from a freshly euthanized deer. Within 1 hour of removing the hide we laid the hide, hair side down, on the lower fence strands with the flesh side touching the ground and applied the voltmeter to the hide while grounding the meter into the soil. We took this measurement only at 1 treated site with 1 deer hide. We found a decrease in measured voltage from 9.0 kilovolts in the fence to a maximum of 0.7 kilovolts (range was 0.2–0.7 kilovolts) through the hide. If our deer hide test was representative of living deer, then it is possible that deer do not receive a significant shock when only thick parts of their hair make contact. It is apparent that when presented with a device that caused some pain when investigated, the effect was greater than when deer were given time to adjust to the device in the absence of a painful stimulus.

Although deer are able to jump 2.4-m fences, they generally crawl under or through barriers (Sauer 1984). Most airport fences that are expected to exclude deer are ≥3 m tall (Cleary and Dolbeer 1999). The fence used in this experiment was 1.3 m tall and, despite the ability of deer to jump the fence, no evidence was

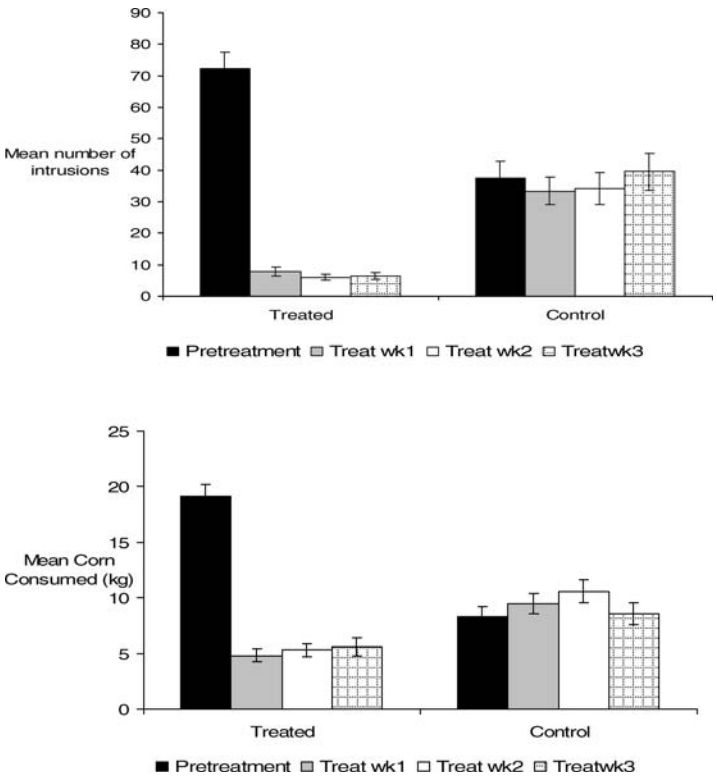

Figure 7. Mean daily deer intrusions (top) and corn consumption (kg; bottom) at sites with ElectroBraid that was powered and not powered. Five treated sites had no power to the fence for 10 weeks prior to being powered. Five control sites had been powered for 1 week in December and 1 week in January in Erie County, Ohio. The Pretreatment period was the week preceding power being supplied during the 3 week treatment period.

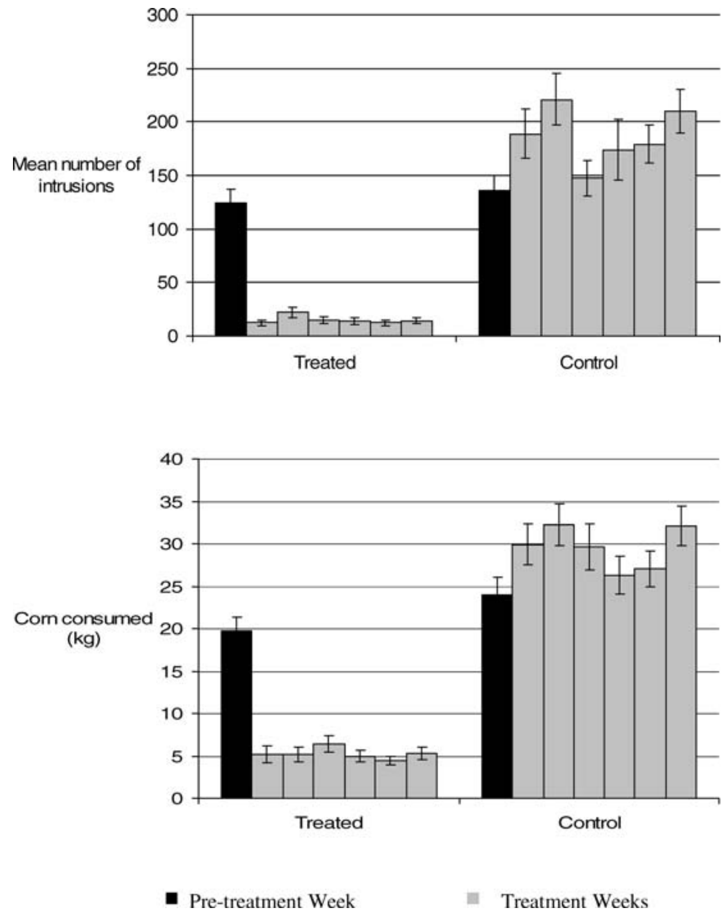

Figure 8. Mean daily deer intrusions (top) and corn consumption (kg; bottom) at 5 sites enclosed within 0.2 ha of powered ElectroBraid and 5 control sites without ElectroBraid January–February 2004, Erie County, Ohio, USA.

found of deer jumping the fence in any test to reach the corn. The lack of intrusions via jumping are notable because the test occurred in an area with high deer densities (19–54/km^2) during an energetically stressful period with a desirable food source (Wywialowski 1996) as an attractant. Based on video footage and deer tracks at the sites, it was apparent that deer generally approached to within 1 m of the fence where they would bob and extend their heads towards the fence and then back away. It is possible that these deer had been shocked earlier in the test and were cautious of the fence. The perceived danger represented by the fence may explain why deer chose not to jump the fence. However, when penned deer were presented with a similar ElectroBraid barrier and pressured toward the fence they did go through and, in 2 cases, over the fence (D. Nolte, USDA, unpublished data). Based on activity at all control sites, deer were not deterred by the orange snow fence we erected on 3 sides of the feeding station. Therefore, we conclude that the electric fence was the barrier to which the deer responded.

Video footage recorded raccoons feeding in the troughs. Tracks indicated that raccoons were feeding at all sites. The bottom ElectroBraid strand at each site was high enough ($\geq$25 cm) that raccoons could go under the fence without touching it. As raccoons were present at all sites, we considered their impact on corn consumption to be uniform. Their presence explains the corn consumption values noted for treated sites even when deer were not recorded entering the sites.

Management Implications

Because deer, motivated by hunger or fear, can overcome an electric fence or a 3-m-high chain-link fence, we conclude that 88–99% reductions in deer penetrations in our experiments show ElectroBraid fence, under the conditions and time frame of this test, to be a relatively effective deer barrier. When compared to woven fence, this electric fence is more economical to install and the manufacturer warranties the fence for 25 years. In addition, the fence may be set up, taken down, and moved relatively easily. We did not achieve complete elimination of deer penetrations.

Airports should not have attractive forage present within or near the active runways. The motivation for deer to penetrate perimeter fences should be minimized, which will enhance the efficacy of a fence. Also, increased power to the fence will make contact with the fence more painful and possibly increase the effectiveness of the fence. Totally deer-proof fence may be too expensive for some airports; thus, airport managers must accept some level of risk from deer being chased into the airport movement area. ElectroBraid, being lower in cost than woven fence yet effective in reducing the number of deer from desired areas, can provide an alternative fence for airport managers who also use some other form of deer management on their airport.

Successful wildlife damage management at airports requires trained biologists using an integrated approach that includes harassment, barriers, habitat management, and lethal control (Cleary and Dolbeer 1999). Based on the results of this test, ElectroBraid could be another tool in an airport white-tailed deer management program.

Acknowledgments

The study was supported by the Federal Aviation Administration (FAA). Opinions expressed in the study do not necessarily reflect current FAA policy decisions governing the control of wildlife on or near airports. Mention of companies or commercial products does not imply recommendation or endorsement by the United States Department of Agriculture (USDA) over others not mentioned. The USDA neither guarantees nor warrants the standard of any product mentioned. Product names are mentioned solely to report factually on available data and to provide specific information.. We thank ElectroBraid Fence Limited for supplying fencing equipment and R. Lampman and S. McTaggart for assistance in setting up fences. We thank S. Barras, R. Beason, B. Blackwell, R. Bush, J. Dierker, Z. Patton, C. Seamans, N. Seamans, and B. Washburn for field support.

Literature Cited

Bashore, T. L., and E. D. Bellis. 1982. Deer on Pennsylvania airfields: problems and means of control. Wildlife Society Bulletin 10:386–388.

Belant, J. L., S. K. Ickes, L. A. Tyson, and T. W. Seamans. 1997. Comparison of four particulate substances as wildlife feeding repellents. Crop Protection 16:439–447.

Blackwell, B. F., T. W. Seamans, R. J. White, Z. J. Patton, R. M. Bush, and J. D. Cepek. 2004. Exposure time of oral rabies vaccine baits relative to baiting density and raccoon population density. Journal of Wildlife Diseases 40:222–229.

Brenneman, R. 1983. Use of electric fencing to prevent deer browsing in Allegheny hardwood forests. Proceedings of the Eastern Wildlife Damage Control Conference 1:97–98.

Cleary, E. C., and R. A. Dolbeer. 1999. Wildlife hazard management at airports, a manual for airport personnel. United States Department of Transportation, Federal Aviation Administration, Office of Airport Safety and Standards, Washington, D.C., USA.

Cleary, E. C., R. A. Dolbeer, and S. E. Wright. 2003. Wildlife strikes to civil aircraft in the United States 1990–2002. Federal Aviation Administration, Wildlife Aircraft Strike Database Serial Report Number 9. Washington, D.C., USA.

Craven, S. R., and S. E. Hygnstrom. 1994. Deer. Pages D25–D40 *in* S. E. Hygnstrom, R. M. Timm, and G. E. Larson, editors. Prevention and control of wildlife damage. University of Nebraska Cooperative Extension Service, Lincoln, Nebraska, USA.

Dolbeer, R. A., S. E. Wright, and E. C. Cleary. 2000. Ranking the hazard level of wildlife species to aviation. Wildlife Society Bulletin 28:372–378.

Gallagher, G. R., and R. H. Prince. 2003. Negative operant conditioning fails to deter white-tailed deer foraging activity. Crop Protection 22:893–895.

Gladfelter, H. L. 1984. Midwest agricultural region. Pages 427–440 *in* L. K. Halls, editor. White-tailed deer ecology and management. Stackpole Books, Harrisburg, Pennsylvania, USA.

Jacobson, H. A., and J. C. Kroll. 1994. The white-tailed deer—the most managed and mismanaged species. Presented at Third International Congress on the Biology of Deer: Edinburgh, Scotland, 28 August–2 September, 1994.

McAninch, J. B., R. Winchombe, and M. Ellingwood. 1983. Fence designs for deer control: a review and the results of recent research in southeastern New York. Proceedings of the Eastern Wildlife Damage Control Conference 1:101.

Menzel, K. E. 1984. Central and southern plains. Pages 449–456 *in* L. K. Halls, editor. White-tailed deer ecology and management. Stackpole Books, Harrisburg, Pennsylvania, USA.

Palmer, W. L., R. G. Wingard, and J. L. George. 1983. Deer damage control in Pennsylvania agriculture. Proceedings of the Eastern Wildlife Damage Control Conference 1:75–76.

Rose, J., and J. D. Harder. 1985. Seasonal feeding habits of an enclosed high density white-tailed deer herd in northern Ohio. Ohio Journal of Science 85: 184–190.

Sauer, P. 1984. Physical characteristics. Pages 73–90 *in* L. K. Halls, editor. White-tailed deer ecology and management. Stackpole Books, Harrisburg, Pennsylvania, USA.

Wright, S. 1996. Watch out for Rudolph! FAA Aviation News 35:19–23.

Wright, S. E. 2001. An analysis of deer strikes with civil aircraft, USA 1982–2000. Proceedings of Bird Strike 2001:31–41.

Wright, S. E., R. A. Dolbeer, and A. J. Montoney. 1998. Deer on airports: an accident waiting to happen. Proceedings of the Vertebrate Pest Conference 18:90–95.

Wywialowski, A. P. 1996. Wildlife damage to field corn in 1993. Wildlife Society Bulletin 24:264–271.

Thomas W. Seamans is a Certified Wildlife Biologist for the USDA/Wildlife Services/National Wildlife Research Center field station in Sandusky, Ohio. Tom has spent the last 18 years conducting research focused on finding biologically sound solutions to conflicts between people and wildlife. He received a B.S. degree in wildlife science from Cornell University and an M.S. in wildlife management from the Ohio State University.

Kurt VerCauteren is the Chronic Wasting Disease Project Leader for the Wildlife Disease Research Program of the USDA Wildlife Services, 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, has been on the board of the Wildlife Damage Management Working Group, served as secretary of the Colorado Chapter of The Wildlife Society, and as president of the Nebraska Chapter. His current research involves devising means to reduce transmission and to manage CWD and bovine tuberculosis in wild and captive cervids.

Associate editor: Grado.