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Cattle guards reduce white-tailed deer crossings through fence openings

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Abstract. In response to increased white-tailed deer (*Odocoileus virginianus*) encroachment on airports, we evaluated the effectiveness of cattle guards as deer exclusion devices. We conducted three experiments in a 2200 ha fenced facility in northern Ohio with high (91/km^2) deer densities during 1994–1995. In each experiment, we monitored deer crossings at two or three cattle guards (4.6[L] $\times$ 3[W] $\times$ 0.5 or 1.0[D] m) constructed at fence openings for 2 weeks pre- and post-installation. For each experiment, the mean daily number of deer crossings after installation of cattle guards was reduced ($P < 0.01$) by $\geqslant$88% compared with respective crossing rates during pretreatment. Reduction in deer crossings using cattle guards with 0.5 or 1.0 m deep excavations were similar (95–96% vs 98%) overall. Cattle guards at permanent openings used for vehicular traffic appear a viable technique to reduce deer movements into fenced airports and other facilities where reductions in deer intrusions are desired.

1. Introduction

Deer at airports are a threat to aviation safety, as they are involved in 65% of aircraft–mammal strikes (Frankenfield *et al.*, 1994). Increasing deer populations in many urban areas have resulted in the increased encroachment by deer on airports (Bashore and Bellis, 1982). Airports frequently contain large expanses of grasses and forbs (dicotyledonous herbaceous plants) that can provide high-quality forage for deer. Many airports have installed perimeter fences to exclude deer, but deer often continue to enter these facilities through access points that remain open for emergency or service vehicles.

Cattle guards are widely used to prevent hoofed livestock from traversing between fenced areas through permanent openings maintained for vehicular access (Hoy, 1982). However, there has been little consideration of, or research on, their use at airports to exclude deer (but see Bashore and Bellis, 1982). If deer can be excluded by cattle guards, these devices could provide a safe and humane method for solving deer problems at some airports. Therefore, our objective was to evaluate the effectiveness of cattle guards in preventing white-tailed deer (*Odocoileus virginianus*) from entering exclosures through permanent openings.

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2. Materials and methods

The study was conducted during 1994–1995 at the 2200 ha National Aeronautic and Space Administration Plum Brook Station (PBS), Erie County, Ohio, which is enclosed by a 2.4 m high chain-link fence with barbed-wire outriggers. During this study, PBS contained an estimated 2000 white-tailed deer (91/km^2) (E. Cleary, United States Department of Agriculture, personal communication). An airport with runways is maintained in a 700 ha area of PBS that is separated from the remainder of PBS by a 1.7 km long chain-link fence (2.4 m high). This fence served as the test site for evaluating cattle guards.

Three 3.1 m wide openings spaced 0.6 km apart along the 1.7 km fence were created during summer 1994. An infrared monitoring device (TrailMaster®, Goodson and Assoc., Inc., Lenexa, Kans.) was used to count the number of deer crossings at each site. Infrared monitors were checked at least twice weekly. We limited the number of intrusions recorded by the infrared monitor to observations $\geqslant$2 min apart. This interval was selected because multiple events; attributed to activation of the monitoring units by environmental factors (e.g. insolation, precipitation) or the same animal attempting to cross cattle guards, were infrequently recorded over short (< 2 min) time periods.

An excavation (4.6[L] $\times$ 3[W] $\times$ 0.5[D] m) was then created at each opening; deer were allowed to use these excavations for $\geqslant$1 month prior to each experiment. Because deer were probably able to contact the bottom of these 0.5 m deep excavations when cattle guards were installed, we increased the depth of excavations to 1.0 m during the final experiment to determine if this greater depth would further reduce the number of crossings.

Simulated cattle guards were constructed following United States Department of Agriculture (1960) guidelines by building 4.6 $\times$ 3 m wooden frames using 5 $\times$ 15 cm lumber (figure 1). Twenty-two 7.6 cm diameter $\times$ 3 m PVC pipes were spaced evenly at 12.7 cm intervals across each wood frame, parallel to the fence opening and level with the ground surface. To prevent entanglement and potential injuries to deer while attempting to cross cattle guards, pipes were not secured to the wood frame. The existing 2.4 m high chain-link fence was extended along each side of the cattle guard to prevent deer from crossing along the side. Track plots of soil were established in excavated and approach areas as a second means to monitor deer use of cattle guards.

Table 1. Mean daily number of deer crossings through 3.1 m wide fence openings before and after simulated cattle guards were installed at National Aeronautic and Space Administration Plum Brook Station, Erie County, Ohio, 1994 – 1995

		Number of deer crossings/day				
Experiment (dates)	Cattle guard	Pretreatment (n=14 days)		Treatment (n=14 days)		% reduction
1 (22 Oct – 18 Nov 1994)	A	14.2	7.8	0.4	0.5	98
	B	15.1	5.4	0.8	1.8	95
		14.6	6.6	0.6	1.3	96
2 (25 June – 10 July 1995)	A	7.4	4.1	0.9	1.0	88
	B	11.6	8.0	0.4	0.6	96
	C	10.7	7.4	0.1	0.4	99
		9.9	6.8	0.5	0.8	95
3 (22 Sep – 20 Oct 1995)	B	4.4	3.1	0.2	0.4	95
	C	4.5	3.1	0.0	0.0	100
		4.4	3.0	0.1	0.3	98

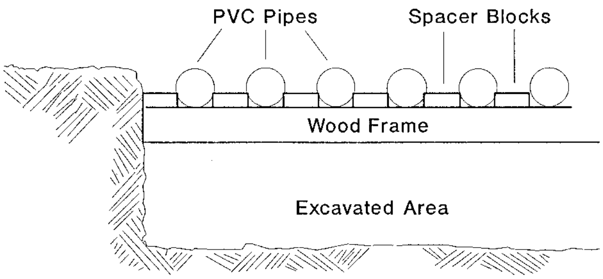

Figure 1. Profile of simulated cattle guard showing 7.6 cm diameter PVC pipes placed parallel between spacer blocks on wood frame over excavation.

We conducted Experiments 1 and 2 with cattle guards installed over 0.5 m excavations (22 Oct. – 18 Nov. 1994 and 25 June – 10 July 1995, respectively) and Experiment 3 (22 Sept. – 20 Oct. 1995) with cattle guards installed over 1.0 m excavations. Because of equipment failure at one site, only two cattle guards were evaluated during Experiment 1. We also evaluated only two cattle guards during Experiment 3 because standing water (about 0.5 m depth) in the excavation at one site precluded deer use of the opening during pretreatment.

We determined the effectiveness of cattle guards by comparing the mean daily number of deer crossings during pretreatment and treatment. Differences in deer movements during pretreatment and treatment for each cattle guard during each experiment were analysed using Wilcoxon Rank Sum tests (Zar, 1984; SAS Inst., Inc., 1988). To assess whether the number of deer crossings increased during the treatment period, we similarly compared the number of crossings between week 1 and week 2 post-installation.

3. Results

During Experiment 1, the overall mean daily number of deer crossings ($\pm$SD) was reduced 96% (14.6 ± 6.6 pretreatment; 0.6 ± 1.3 treatment) after installation of cattle guards over the 0.5 m excavations (table 1). Reductions (Sites A and B: $Z = 4.15$ and 4.57, respectively, $P < 0.01$) in the number of crossings (95 and 98%) were comparable between sites. Similarly, for Experiment 2, the overall mean daily number of deer crossings was reduced 95% (9.9 ± 6.8 pretreatment; 0.5 ± 0.8 treatment). Reductions (Sites A – C: $Z = 4.33$, 4.54, and 4.67, respectively, $P < 0.01$) in the number of crossings among sites ranged from 88 to 99%. During Experiment 3, the mean daily number of deer crossings after cattle guards were installed over the 1.0 m excavations was reduced 98% (4.4 ± 3.0 pretreatment; 0.1 ± 0.3 treatment) overall relative to pretreatment mean daily crossing rates. Reductions (Sites B and C: $Z = 1.88$ and 4.57, respectively, $P < 0.01$) of 95% and 100% were recorded at individual sites. Overall, the mean daily number of crossings recorded during pretreatment for Experiment 3 was $\geqslant$59% less than the number of crossings recorded during pretreatment for Experiments 1 and 2.

During each of the three experiments, numerous tracks in approach areas indicated that deer often approached cattle guards but did not cross. Tracks and displaced pipes centrally located in cattle guards indicated that deer occasionally had attempted to leap across cattle guards.

There was a decrease ($Z = 2.18$, $P = 0.03$) in the number of deer crossings from week 1 to week 2 treatment at one cattle guard during Experiment 3. There were no differences ($Z = 0.11 – 1.79$, $P \geqslant 0.07$) in the number of crossings between week 1 and week 2 treatment for remaining cattle guards during the experiments.

4. Discussion

Cattle guards appear to be an effective method of reducing deer crossings through fence openings. Although the number of deer travelling through openings was reduced $\geqslant$95% overall, deer apparently remained able to occasionally cross. However, it is possible that single events recorded by the infrared monitors could have been caused by environmental factors other than deer. Thus, the reductions in the number of deer crossings reported here may be conservative.

The number of deer crossings during pretreatment was similar for Experiments 1 and 2, suggesting that deer were excluded by cattle guards and not the excavations. However, increasing the depth of the excavations under the cattle guards from 0.5 to 1.0 may have influenced deer use of these sites and caused the reduction of deer crossings recorded before installation of cattle guards during Experiment 3. Also, rainfall prior to the pretreatment period of Experiment 3 which resulted in 2–5 cm of water in the excavations may have influenced deer use of the sites.

Although increasing the depth of excavations under cattle guards did not appear to enhance exclusion of deer, it may simplify maintenance. For example, cattle guards placed in areas with moderate to high snowfall may become filled with compacted snow, allowing deer to cross unencumbered. Increasing the depth of excavations or constructing cattle guards in removable sections to facilitate snow removal could reduce this potential problem. In addition, we recommend installing fences or other suitable barriers adjacent to ($\leqslant$0.1 m) and along the entire length of cattle guards to maximize their effectiveness.

We emphasize that cattle guards used in this study were simulated; actual cattle guards should be constructed following United States Department of Agriculture (1960) guidelines. Cattle guards at permanent openings used for vehicular traffic appear to be a viable technique to exclude deer from fenced airports and other facilities where deer exclusion is desired.

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