PVC Curtains to Prevent Deer Access to Stored Feed: A Pilot Study

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ABSTRACT: Bovine tuberculosis is endemic in white-tailed deer in Michigan's Northeastern Lower Peninsula (NELP), and evidence suggests transmission to domestic cattle. One source of transmission is through feed shared between deer and cattle as a result of deer access to stored cattle feed. Fences (2-3 m in height) have been erected to surround stored feed on at least 50 cattle farms in the NELP in order to prevent deer access. However, gate closure by landowners remains a problem. We investigated the use of polyvinyl chloride (PVC) curtains installed at gate openings as a tool to deter deer from entering stored feed areas. Deer activity was monitored through the use of infrared digital cameras and by recording deer tracks inside and outside stored feed facilities. Two treatment and two control sites were established. On the first treatment site, deer tracks inside the fenced feed area decreased post-treatment from 9 to 0. Tracks within 5 m outside the fence decreased from 28 to 13. Photographs of deer entering or exiting the gate decreased from 23 to 0. Photographs of deer near stored hay decreased from 2 to 0. No deer activity was observed on either control site or the second treatment site during the study period. While sample sizes are too small for statistical analysis, we believe the use of PVC curtains to deter deer from stored feed areas has merit and deserves additional intensive research.

KEY WORDS: barrier, bovine tuberculosis, Michigan, *Mycobacterium bovis*, *Odocoileus virginianus*, PVC curtain, white-tailed deer

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INTRODUCTION

In 1994, a hunter-killed deer in Michigan's Northeastern Lower Peninsula (NELP) tested positive for *Mycobacterium bovis*, the causative agent of bovine tuberculosis (bTB). In 1995, testing of 354 hunter-killed deer taken within a 16-km radius of the 1994 case revealed bTB was being maintained in Michigan's deer population with no apparent livestock involvement (Schmitt 1997). However, in 1998 bTB was detected in domestic cattle herds in the NELP, resulting in the United States Department of Agriculture (USDA) revoking Michigan's bTB-free status (Schmitt et al. 2002).

From 1998 - 2005, bTB was documented in white-tailed deer (*Odocoileus virginianus*) with an apparent prevalence ranging from 0.19 - 4.47% (Schmitt 2005), and evidence suggests deer are capable of transmitting the disease to domestic cattle (Palmer et al. 2001, 2004; Milian-Suazo et al. 2008). To protect shared feed resources, many landowners in the NELP participated in the USDA Wildlife Services' fencing program where high (2 - 3 m) fences were erected to exclude deer from cattle feed storage areas. A survey of 50 farms who participated in the fencing program found 30 fences were complete and actively used to store feed. Of these 30, 15 gates were found open at least once (T. Wilson, USDA Wildlife Services, unpubl. data). Six of the 30 farms were bTB positive prior to fence installation. Five of the 6 previously bTB-positive farms left their gates open. Such activities may allow deer access to stored feed resources and may increase the potential for bTB transmission to cattle.

Research suggests that deer enter feed storage areas during the winter months when natural food resources are scarce, and that much of the activity occurs during nighttime hours leaving landowners unaware of deer activity (Berentsen et al., unpubl. data). Although most landowners comply with gate closure around stored feed, some prefer to leave gates open to allow easy vehicle access when feeding cattle.

While capturing free-ranging ungulates, opaque, rather than transparent, barrier material is used to reduce the potential of captured animals physically challenging the barrier material (Vincent 1973, Ebedes 1993). Our objective was to evaluate whether opaque polyvinyl chloride (PVC) curtains erected at entrances to stored feed areas where gates are intentionally left open would inhibit or prevent deer from entering the facility while allowing unfettered access by landowners.

METHODS

Participating farms were selected using a list of landowners in the NELP who participated in the USDA Wildlife Services fencing program. Only landowners who actively used fences for all hay storage, had fences at least 3 m high, and regularly left gates open were considered for participation in the study. Feed sources within the fenced area were round hay bales regularly placed and used by the landowner(s) as cattle feed. No additional food resources were placed in the feed storage areas to attract deer.

Each study site had one or two gates that provided access to stored feed areas. Treatment Site 1 had two gates that were left open: one for tractor access to stored cattle feed, and the other at the opposite side of the enclosure to allow cattle to enter a wired-off section of the enclosure to feed. This section was separated from the stored feed area by a single strand of barbed wire approximately 0.5 m above the ground. Treatment Site 2 had one gate that was regularly left open for easy tractor access. Control Site 1 had one open gate and Control Site 2 had two open gates.

From January 7-9, 2009, wooden support beams to hold the PVC curtains were erected at open gate entrances on all four study sites. On February 4-5, 2009,

opaque PVC curtains (Chase Industries, Cincinnati, OH) were attached to the wooden support beams on 2 of the 4 study sites. PVC strips were 30.5 cm wide with an approximate 50% overlap, hanging 3.0 - 3.6 m from the mounting beam to reach 0 - 15 cm from the ground (Figure 1). At Treatment Site 1, a PVC curtain was not hung over the open cattle access gate due to landowner concerns that cattle would avoid the gate and not enter the feeding area. This cattle access gate was not included in the study. On February 10, 2009, the single strand of barbed wire separating the cattle feeding area from the feed storage area was reinforced by adding 3 strands above the barbed wire. This created a fence height of ≥2 m in an attempt to prevent deer crossing from the cattle feeding area into the stored feed. Two farms had no curtains erected and served as control sites. Post-treatment data collection began February 11, 2009.

Figure 1. Installing the PVC curtain at a treatment site in Michigan, 2009.

From January 7-9 2009, remote infrared cameras (Reconyx™, Holmen, WI) were erected within 1 m of the inside and outside of all gate entrances to stored feed areas (Figure 2). An additional camera was set near the center of each site to monitor the hay piles within each high fence. Cameras were programmed to take one photograph per second for a total of 5 photographs, with a 5-minute period of inactivity before the cameras could be triggered again. Each burst of 5 photos was counted as a single photographic event. Both treatment sites and one control site each had 3 cameras installed. Because there were 2 gate entrances at the remaining control site, 5 cameras were installed at this site.

Cameras were checked daily (Monday - Friday) at all sites to monitor deer activity inside and outside the stored feed facility on each farm for a period of approximately 4 weeks pre and post treatment. Photographs of deer were categorized as follows:

1. Deer Entering: photographs of deer entering the feed storage area
2. Deer Exiting: photographs of deer exiting the feed storage area
3. Deer Inside: deer photographed near or at hay bales inside the feed storage area.

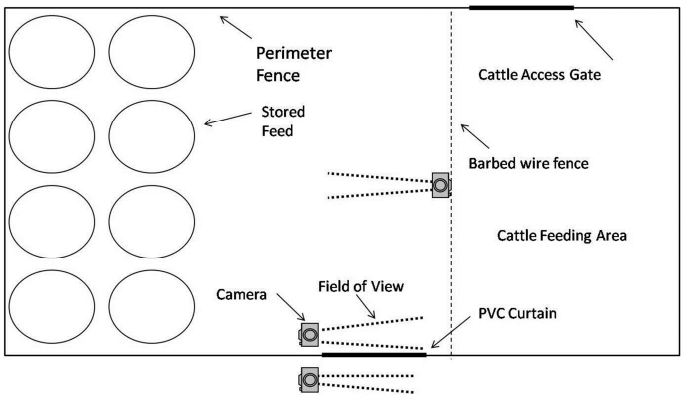

Figure 2. Schematic depicting camera placement at Treatment Site 1.

Fenced areas were monitored for deer sign (tracks) inside the feed storage area and within 5 m of the outside perimeter of the fence. Tracks found exclusively within 5 m of the outside of the high fence, but never entering the gate, were classified as "outside the fence." Deer tracks that entered the gate at any time, regardless of where they moved before entering the gate, were classified only as "inside the fence."

Curtains were inspected during camera checks and PVC strips were replaced if damaged or missing. After the conclusion of the study landowners from the treatment sites were given an informal survey to gauge their opinions of the curtain. Questions included perceptions of efficacy of the curtain in deterring deer, ease of driving through the curtain, whether any vehicle damage occurred as a result of driving through the curtain, and whether the landowner would be interested in using the PVC curtain permanently.

RESULTS

Camera Photos

A total of 9,458 photographic events were recorded by the cameras at all sites (Table 1). Most events (97.9%) were of cattle, farmers, the researcher checking the camera, or weather related-photographs, such as the curtain moving in the wind. The remaining photographs (2.1%) included white-tailed deer, coyotes (*Canis latrans*), skunks (*Mephitis mephitis*), squirrels (*Sciuris* spp.), rabbits (*Sylvilagus* spp.), crows (*Corvus* spp.), domestic dogs (*Canis familiaris*), and cats (*Felis domesticus*).

Twenty-three photographic events of deer entering or exiting the stored feed area were recorded pre treatment, 0 events were recorded post treatment. Two photographs of deer inside the fence near stored feed were recorded pre-treatment. Zero events were recorded post treatment (Table 2). No photographs of deer breaching the PVC curtain were obtained. No photographic events of deer inside or outside the fence were obtained at Treatment Site 2 or either control site during this study.

Deer Tracks at Study Sites

At Treatment Site 1, deer tracks classified as "inside the fence" decreased post-treatment (Table 3). We documented 10 sets of deer tracks inside the fence before the curtain was installed and 28 deer tracks outside the

Table 1. Number of pooled photographic events by category for treatment and control farms in Michigan, 2009.

Site	Treatment 1		Treatment 2		Control 1	Control 2	Row Total
	Pre	Post	Pre	Post			
Deer entering/exiting	23	0	0	0	0	0	23
Deer near feed	2	0	0	0	0	0	2
Cattle	0	0	0	0	2	744	746
Researcher	64	107	57	67	126	193	614
Farmer	43	119	65	131	322	255	935
Weather	40	3,702	19	2,185	42	981	6,969
Other	8	35	2	1	90	33	169
Column total	**180**	**3,963**	**143**	**2,384**	**582**	**2,206**	**9,458**

Table 2. Number of photographic events of white-tailed deer entering, exiting, and inside high fences in Michigan, 2009.

Deer photos	Treatment Site 1		Treatment Site 2		Control Site 1	Control Site 2
	Pre	Post	Pre	Post		
Deer entering	8	0	0	0	0	0
Deer exiting	15	0	0	0	0	0
Deer inside	2	0	0	0	0	0

Table 3. Number of white-tailed deer inside and outside the high fence, based on deer tracks recorded at treatment and control farms in Michigan, 2009.

Site/Deer activity	Treatment Site 1		Treatment Site 2		Control Site 1	Control Site 2
	Pre	Post	Pre	Post		
Tracks inside fence	9	0	0	0	0	0
Tracks ≤5 m outside fence	28	13	0	0	0	0

fence. Post treatment we documented 0 tracks inside the fence and 13 tracks outside the fence. No deer tracks were found inside or outside the fences at Treatment Site 2 or either control site during this study.

Survey Results

Participants in the survey indicated they believed the curtain was effective at deterring deer from entering stored feed areas. Landowners found the curtains easy to drive through with minimal or no vehicle damage. Participants indicated they would like to use the curtain permanently, but opinions differed on who should pay for and maintain the curtains.

DISCUSSION

Numerous problems arose while selecting suitable study sites. While informal surveys and personal observation by multiple researchers showed that approximately 50% of landowners who actively use the high fence leave their gates open, few were willing to admit it. Several landowners who did close their gates regularly offered to leave the gates open for us to conduct our research. These offers were declined as we were unwilling for landowners who were complying with gate closure to put their livestock at risk of contracting bTB as a result of participating in the study. Thus, we had to rely on landowners who admitted to leaving gates open, which restricted the number of study sites available.

One photographic event of deer investigating the curtain from inside the fenced feed storage area at Treatment Site 1 was recorded (Figure 3). This occurred after the curtain had been installed but before the fence separating the cattle feeding area from the feed storage area was heightened. It is unclear whether the deer penetrated the PVC curtain barrier or crossed over the single barbed wire strand from the cattle feeding area. The photographic evidence showed the deer approaching the PVC curtain but not penetrating it. If the deer had breached the curtain, we expected photographs to be taken on both sides of the curtain within a minute of each other. It is likely the deer entered the fenced feed area through the second gate on the opposite side of the feed storage area. No deer tracks were recorded that provided information on where the deer entered, but it is possible

Figure 3. Deer investigating PVC curtain from inside the enclosure, prior to fence reinforcement.

any tracks had been covered by blowing snow. However, it is possible that cameras were tripped by other factors, such as weather or blowing curtains, and that deer crossed the curtain without being photographed. After the single strand of barbed wire separating the cattle feeding area from the stored feed was reinforced, there were no recorded events of deer inside the stored feed area.

We encountered several challenges installing the curtains. Although the curtains were designed to withstand temperatures well below freezing, curling of the curtains in cold weather and a shape "memory" made them somewhat difficult to install, as they would retain the shape in which they were stored. Storing the curtains flat may help reduce this phenomenon but could make transporting the curtains difficult. In one case, the curtains were severely damaged at a single site by low temperatures combined with high winds. Similar curtains with interlocking ridges are available and may help reduce curtain movement in windy conditions, while still allowing access by landowners.

We documented one incident where a tractor caused a minor tear in a single curtain strip. One landowner reported that the curtain loosened the exhaust pipe of a tractor. However, the landowner indicated that the exhaust pipe simply needed to be tightened and did not consider it a problem. Overall, landowners indicated no problems with driving through the curtains in small trucks, tractors, or all-terrain vehicles. Curtain durability was a concern with one landowner, who indicated that the lower portions of the curtain tore off very quickly. This could possibly be addressed by raising the curtains slightly higher above the ground to minimized potential damage from being run over by tractor tires. It is interesting to note that one landowner believed the curtain was effective in deterring deer from entering the stored feed area, when no deer were photographed or spotted nearby by either the researcher or the cameras during the study period. This discrepancy highlights the notion that stakeholder perceptions and research results may not always correlate. Landowners were asked whether they would be interested in using the curtain permanently if they were to become commercially available. While all landowners surveyed expressed interest in using the PVC curtain permanently, opinions differed on who should pay for and maintain them.

We believe this concept has merit and warrants further research. Ideally, follow up research should be conducted in areas that have no history of bTB infection in deer or cattle. In such study sites, gates could be left open without the potential of bTB transmission. However, finding study sites in which high fences have been erected around stored feed outside the bTB core area of Michigan's NELP could be problematic. Most of the high fences were erected by USDA Wildlife Services in the bTB core area, and not in surrounding communities who were not considered at risk. Alternately, experiments with captive deer could provide much needed information on the utility of PVC curtains as barriers to white-tailed deer. And, while the intention behind installing high fences around stored feed was not to provide a place for landowners to feed cattle, some landowners are using them for that purpose. This begs the question of whether cattle would penetrate the curtain in order to feed, which could be an additional topic of future research.

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