DOGS FOR REDUCING WILDLIFE DAMAGE TO ORGANIC CROPS: A CASE STUDY

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Abstract: Deer (*Odocoileus* spp.) damage millions of dollars in agricultural crops each year in the United States. A variety of frightening devices and repellants have been developed to reduce crop depredation, however most are effective temporarily (<6 months). Several types of fences are available, but the most effective are expensive, time consuming to install, and may be considered aesthetically displeasing. Additional means to control wildlife damage to agriculture are needed. We evaluated the efficacy of dogs (*Canis familiaris*) over a several year period for preventing crop damage caused by white-tailed deer (*O. virginianus*) and other wildlife at an organic fruit and vegetable farm in south-central Wisconsin. Annual losses at the farm before the introduction of dogs were estimated at $3,177 in 1997 and $4,391 in 1999. One field was protected with 2 crop protection dogs confined by an invisible electronic fence containment system and 2 fields were protected with a double-strand electric polytape fence. In 2001 and 2002, no damage occurred in the fields protected with dogs, but $3,797 and $638 was estimated to be lost in the fields protected with electric polytape. Crop protection dogs have great potential to be an effective long-term tool for reducing crop damage caused by deer and other wildlife. Further rigorous testing is warranted to determine their effectiveness in a variety of agricultural and environmental settings.

Key words: *Canis familiaris*, crop depredation, dog, electronic containment fence, *Odocoileus virginianus*, polytape fence, white-tailed deer, wildlife damage management

Proceedings of the 11th Wildlife Damage Management Conference (D.L. Nolte, K.A. Fagerstone, Eds). 2005

INTRODUCTION

Deer (*Odocoileus* spp.) cause an estimated annual loss of $100 million in United States agricultural production (Conover 1997). In Wisconsin, a survey conducted by the Department of Agriculture, Trade, and Consumer Protection (DATCP) estimated white-tailed deer (*O. virginianus*) annually cause > $36 million in damage (Wisconsin Department of Agriculture, Trade, and Consumer Protection 1984). Most landowners are typically willing to accept some degree of damage to enjoy the aesthetics and recreation that deer provide (VerCauteren et al. 2003). Agricultural producers' tolerance appears to be influenced by the amount of crop damage (Brown et al. 1978), typically accepting ≤ 10% of the crop's value (Craven et al. 1992). Deer damage management and abatement claims are further convoluted by sociological and ecological factors (Campa et al. 1997) with no apparent panacea to satisfy all interest groups.

Several methods exist to reduce deer damage (Craven and Hygnstrom 1994). The most common and cost-effective option is hunting (Conover 2001), but is typically limited by seasonality. Culling, the act of selectively removing animals by professionally trained sharp-shooters, may be more economical compared to translocation or administration of contraceptives (Peck and Stahl 1997), but may not be practical or economical in some areas. Additionally, the public may prefer non-lethal measures (Peck and Stahl 1997, DeNicola et al. 2000).

Agricultural producers need aversive measures early in the growing season when immature crops are most vulnerable. Some intensive producers, who yield ≥ 2 crops per growing season, need means to alleviate damage throughout the growing season. Non-lethal aversive measures such as repellents and frightening devices exist (Harris et al. 1983, Palmer 1983, Conover 1984, Wagner and Nolte 2001, Gilsdorf et al. 2002), but success is variable and usually short-term due to wildlife habituation (Beringer et al. 2003). Thus, repellents and frightening devices are largely inadequate for protecting crops throughout the growing season.

A variety of fence types are available for alleviating wildlife damage (K. C. VerCauteren and M. J. Lavelle, Wildlife Services, submitted). Eight foot tall or higher interwoven wire fence is a common solution, however it is expensive and requires effort to install and maintain, can restrict the movements of non-target wildlife, and may be considered unattractive. A durable, easy to work with, economical alternative may be an electric polytape fence. Electric polytape is a highly visible ribbon-like material constructed of polypropylene and interwoven conductive wires. Electric polytape has been shown to reduce deer damage in small fields (< 6 ha) by as much as 90% (Hygnstrom and Craven 1988), with greater efficacy as the height and number of strands is increased. Some benefits include comparable cost to traditional electric fences and easy application of repellents due to the larger surface area.

In Wisconsin, agricultural producers that meet the eligibility requirements established by the Wisconsin Department of Natural Resources (WDNR) - Wildlife Damage Abatement and Claims Program (WDACP) may be compensated for crop damage. Personnel from the United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services (WS) assess damage for the WDACP (Horton and Craven 1997). In 2000, the WDACP awarded over $1.5 million in damage assessments (Carter et al. 2001). Producers that sustain annual losses > $5000 for > 5 years are eligible for installation of an 8-foot tall interwoven wire perimeter fence. Although, an 8-foot tall fence is an effective tool for reducing crop depredation, it may not be an acceptable solution to all agricultural producers.

Producers and agencies responsible for compensation need additional effective, economical, and unobtrusive means to deter crop depredation. Trained dogs maintained within electronic containment fence may be a viable option. Dogs have demonstrated to reduce deer damage in Eastern white pine (*Pinus strobus*) plantations (Beringer et al. 1994) and have also been used effectively to prevent interaction between potentially disease infected deer and cattle (K.C. VerCauteren, Wildlife Services, unpublished data).

Our objective was to assess the efficacy of dogs for reducing crop depredation by comparing damage estimates between baseline and treatment years. The study was approved by Wildlife Services, National Wildlife Research Center's Institutional Animal Care and Use Committee. Reference to trade names does not imply USDA endorsement of commercial products or exclusion of similar products.

STUDY AREA

The primary land use in south-central Wisconsin is agricultural production. The landscape is a mosaic of farmland, wetlands, and oak-hickory (*Quercus* spp., *Carya* spp.) and maple-beech (*Acer* spp., *Fagus* spp.) hardwood forests. White-tailed deer density in Unit 70A (Dane county) was estimated at 32.6 deer/km^2 prior to the 2000 hunting season, well above the WDNR management goal of 1.9 deer/km^2 (R. Rolley, Wisconsin Department of Natural Resources, personal communication). Deer-vehicle collisions and agricultural crop damage were the highest on record during our study (Wisconsin Department of Natural Resources 2001).

Our study was conducted on a 22 ha community-supported farm in Dane County, Wisconsin, with a history of crop depredation. Approximately 50 different organic crops were cultivated including several types of fruits (i.e., tomatoes, strawberries, watermelons, muskmelons, and pumpkins) and vegetables (i.e., corn, soybeans, lettuce, snap peas, golden beets, peppers, potatoes, and broccoli). Crops damaged typically included sweet corn, soybeans, carrots, snap peas, spinach, celery, broccoli, celeriac, Kalura lettuce, and various ornamental flowers. Well established deer trails trodden in to the ground were noticeable entering the agricultural fields.

Wildlife Services personnel estimated deer and raccoons (*Procyon lotor*) damaged $3,177 in 1997 and $4,391 in 1999 at the farm when no control measures were practiced. The producers enrolled in the WDACP and wanted to work with WS biologists to prevent further economic loss. Installation of an 8-foot tall interwoven wire fence was proposed by WDNR, but was not an acceptable option to the farm manager because it would negatively affect the pastoral and recreational characteristics of the community-supported farm. Several damage mitigation measures were considered, but the producers were most favorable to the idea of conducting an experimental trial using crop protection dogs (CPDs).

MATERIALS AND METHODS

The study was conducted from 2000 to 2002 on three adjacent fields of 1.2, 1.4, and 3.7 ha in size. Fields were planted and managed similarly for a variety of crops. Crops were rotated throughout the growing season with one crop being planted immediately after another was harvested. We randomly assigned a treatment to each field. The 1.4 ha field was treated with an invisible electronic containment system (Off Limits Crop Protection System, Green Bay, WI, USA) that confined 2 CPDs. This system contained dogs in the field through the use of a shock collar activated by radio waves transmitted along a 14-gauge insulated copper wire buried approximately 5 inches below the ground surface around the perimeter of the field. Dogs were fitted with electronic collars that activated within 2–3 m of the buried wire with an audible signal or an electric shock if the dogs continued to approach. Dogs were formally trained to the boundary of the containment system, but not professionally trained to dissuade wildlife (see Beringer et al. 1994, for further details on dog training and containment system start-up).

We selected dogs of mixed and pure breeds with natural herding instincts (i.e., Border collie) or of blood lines for strenuous work (e.g., Siberian husky) that we felt would confront wildlife and deter crop damage. All dogs were spayed or neutered by a veterinarian and vaccinated for diseases and parasites. We speculate neutering helped decrease the chances of male dogs leaving the confinement area in search of estrous bitches. We used 2 CPDs because it appears to be more difficult to confine 1 dog without a companion (Coppinger and Coppinger 1987). Food, water, and shelter were provided in disparate locations within the 1.4 ha field to encourage canine use of the entire area. These resources were placed near deer trails entering the field to facilitate the likelihood of deer and canine interaction. Dogs were confined occasionally to 1.8 x 3.6 m kennels during periods of high human activity. Unsuitable dogs (i.e., fearful of loud noises, perceived to not confront wildlife) were replaced as needed.

The 1.2 and 3.7 ha fields were treated with a double-strand electric polytape fence charged with 6,000 volts. The bottom strand of the electric fence was elevated 46 cm above ground level (AGL) and the top wire was 86 cm AGL.

A WS employee assessed crop damage in the fields every 2–3 weeks. The economic loss was determined for each crop damaged by using the New Farm Organic Price Index (OPX; New Farm 2004). If the crop was not listed in the OPX, we used the USDA – Agricultural Marketing Service – Fruit and Vegetable Program market value as reported at the terminal market in Chicago, IL, USA (USDA, Agricultural Marketing Service 2004).

RESULTS AND DISCUSSION

Crop Protection Dogs

On 13 July 2000, the fence containment system was installed and two female border collies were deployed within the 1.4 ha field. One of the border collies was extremely fearful of loud noises (i.e., thunder, gunshots) and was replaced after 45 days with a male Labrador retriever mix. The Labrador retriever mix caused damage (i.e., digging holes and urinating on plants) and was a nuisance by barking incessantly and demanding human attention. The Labrador retriever mix and the remaining border collie did not roam the containment area and failed to keep deer out of the field. These dogs were replaced by a third female border collie and a male hound mix in September 2000. The new dogs also failed to patrol the containment area and confront wildlife. Therefore, they were removed in January 2001. Dogs that were not directly observed to confront and chase wildlife were perceived to be ineffective and were replaced. None of the dogs in 2000 were acceptable by our expectations. However, crop damage was reduced to only $116, taking place in soybeans specifically planted to test the efficacy of the dogs (Table 1). Most of this damage (97%) occurred before 13 July, the start of the study and the deployment of dogs.

At the beginning of the 2001 growing season, a male purebred Siberian husky and a male German shepherd mix were deployed. The shepherd ran wildly, jumped on people, and was removed immediately. Conversely, the Siberian husky actively patrolled the containment area and was observed chasing deer from the field. On 20 July 2001, a female Siberian husky, Malamute mix was deployed. She also actively patrolled the area and chased deer. After the two Siberian huskies were established, no damage occurred in the 1.4 ha field for the remainder of the study. Both of these dogs continued to work the farm until June 2004 when the male Siberian husky died of natural causes. The female Siberian husky, Malamute mix continues to roam the field and it has not been determined if the managers will replace the lost CPD.

Table 1. Organic crop damage from 1997–2002 in fields.

Year	Field[A]	Treatment	Crops Damaged	New Farm OPX[B]
1997	A	No protection	Celery	$166
	A	No protection	Broccoli	$1,755
	A	No protection	Celeriac	$230
	A	No protection	Kalura lettuce	$1,026
	B	No protection	N/A	N/A
	C	No protection	N/A	N/A
				$3,177
1998	Not Enrolled in WDACP – No Damage Assessment			
1999	A	No protection	Various flowers	$702[C]
	A	No protection	Sweet corn	$1,183
	A	No protection	Carrots	$591
	A	No protection	Snap peas	$1,251
	A	No protection	Spinach	$150
	A	No protection	Broccoli	$514
	B	No protection	N/A	N/A
	C	No protection	N/A	N/A
				$4,391[D]
2000	A	Dogs	Romaine lettuce	$125*
	A	Dogs	Snap peas	$1,390*
	A	Dogs	Golden beets	$396*
	A	Dogs	Broccoli	$464*
	A	Dogs	Peppers	$826*
	A	Dogs	Soybeans	$116
	B	No treatment	Field fallow	$0
	C	No treatment	Field fallow	$0
				$3,317
2001	A	Dogs	No damage	$0
	B	Electric fence	Green snap beans	$2,233
	B	Electric fence	Muskmelon	$313
	B	Electric fence	Watermelon	$362
	C	Electric fence	Green snap beans	$889
				$3,797
2002	A	Dogs	No damage	$0
	B	Electric fence	Lettuce mix	$265
	B	Electric fence	Soybeans	$135
	C	Electric fence	Sweet corn	$238
				$638

[A] A=1.4 ha, B=3.7 ha, C=1.2 ha [B] New Farm – Organic Price Index [C] USDA – Agricultural Marketing Service value [D] Estimate determined using the USDA-AMS value for flowers * Damage occurred prior to introduction of CPDs

Producers need dogs with amendable personalities that dissuade wildlife. The Siberian husky, Malamute mix that continues to work the farm fulfilled these requisites and was perceived to be effective by the farm managers. Even though, the presence of dogs regardless of their breed or perceived effectiveness reduced crop depredation. Siberian huskies worked well for our purpose and pure and mix Siberian huskies have been used to alleviate deer damage in New York apple orchards (P. Curtis, Cornell University, personal communication). Some of the common problems exemplified by other dogs that had to be removed include lack of interest in deer, barking, fear of loud noises, and demand for human attention. Therefore, producers should purchase dogs specifically raised and trained to dissuade wildlife to avoid the additive expenditure and trial and error of finding effective CPDs.

Installation of an 8-foot high perimeter fence around the 1.4 ha field would have cost approximately $12,000. The typical life-expectancy is approximately 25 years, costing the producer an estimated $480/year excluding additional maintenance costs. During the first year of the study, we invested $3,575 for the electronic containment fence, dogs, veterinary services, and additional supplies (food and shelter). Thereafter the maintenance cost was $650/yr for food, veterinary services, and replacement batteries for the containment collars for 2 CPDs. We estimated the cost of using CPDs over a 25 year period would be approximately $767/year including the initial investment ($3,575) and additional maintenance costs ($650/year). This is a greater annual expense than an 8-foot fence, but it gives the producer the flexibility of adaptive management and the ability to maintain the aesthetic and pastoral characteristics of the farm. Cost of CPDS are comparable to an 8-foot fence for the first 13 years, however afterwards they become an additive expense, costing > $12,000, the cost of an 8-foot fence. During the initial 13 years, deer density may change to a level where crop damage may no longer be problematic and producers would be inundated with a 25-year fence. Thus, CPDs can be a practical, economical, and long-term solution for producers considering alternative options to fencing to manage crop depredation.

Electric Polytape

Double-strand electric polytape fences were erected around the 1.2 and 3.7 ha fields in 2001. The combined damage estimate for both fields was $3,797 in 2001 and $638 in 2002. More plants were damaged in these fields than the field protected by CPDs. A double-strand electric polytape fence provides only limited protection for crops, which may or may not be effective under certain deer densities and browsing pressure. Polytape and other non-lethal measures are not as effective as lethal strategies, they do not resolve problems caused by high deer density; they only displace it. Therefore, an integrated approach may be the best solution for alleviating crop depredation.

Proven strategies to reduce deer densities include liberal hunting bag limits, issuance of depredation permits, and hunter access programs in cooperation with private landowners. After the discovery of chronic wasting disease (CWD) in south-central Wisconsin in February of 2002, WDNR implemented several lethal strategies to lower deer densities in an attempt to eradicate CWD. Between March 2002 and April 2004, 8,663 white-tailed deer were collected for CWD surveillance in Dane county with a management goal of $1.9/km^2$ (Wisconsin Department of Natural Resources 2004). The current estimated deer density in Dane county after the hunting season has decreased from 32.6

deer/km^2 in 2000 to 13.5 deer/km^2 in 2003 (R. Rolley, Wisconsin Department of Natural Resources, unpublished data). This reduction may have indirectly resolved agricultural damage caused by the previously high deer densities. Annual crop damage at the organic farm during 2002 was reduced to only $638 in the fields protected with electric fencing, a decrease of $3,159 from the previous year. This lower damage is likely a direct result of the reduction in the deer population. In fact, no damage assessment was needed in 2003 because crop damage was minimal.

Crop protection dogs successfully excluded deer from the 1.4 ha field during 2000 and 2001 when deer densities were high. Electric polytape was less effective than CPDs, but provided minimal protection under high deer density as indicated by damage estimates before and after control measures for 1999 (no protection = $4,391) and 2001 (polytape = $3,317). As deer density decreased between 2001 and 2002, the effectiveness of electric polytape appeared to increase. Although the discovery of CWD foiled our long-term study, the use of lethal control to reduce the deer population provided us the opportunity to document how lower density and browse pressure affected crop damage and the success of our non-lethal control measures.

Agricultural producers must use an integrated approach to resolve wildlife depredation. A combination of sport hunting, issuance of depredation permits, and the use of electric polytape fencing may adequately resolve damage during periods of lower deer densities. However, during periods of high deer density, agricultural producers considering alternative options to fencing may want to consider CPDs in conjunction with other lethal strategies because CPDs have demonstrated great potential at alleviating crop damage. We recommend that agricultural producers consult their local WS agent or state wildlife damage biologist to determine if CPDs may be an adequate solution for their needs or if any special permits may be required for CPD use. State regulations vary, so it may be illegal for dogs to pursue deer in "deer habitat." However, if private property is fenced, and invisible electronic containment fence typically qualifies as "fencing" then the area may no longer be considered deer habitat.

Our work, combined with the WDNR increased lethal harvest, are further evidence that deer density reduction achieves lower amounts of crop damage and that non-lethal management strategies are more efficient under lower population densities and feeding pressure.

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