Electronic Aversive Conditioning for Managing Wolf Predation

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Abstract: Electronic training collars have previously been used to condition captive predators not to attack livestock and other prey, but the use of aversive collars in actual management situations involving wild predators has not been scientifically evaluated and published. We adapted and tested commercially available dog training collars in an actual management situation involving wild wolves. Because we temporarily held wolves in captivity, we also discuss the use of pens as a tool that provides management flexibility. Three packs that had been implicated in killing livestock were held at a pen facility at the Flying D Ranch near Bozeman, Montana. Wolves from 2 packs were used in training collar experiments. We ran trials using bison calves, domestic cow calves, and hides to test equipment and the behavioral conditioning paradigm. In our program, we were unable to condition wolves not to attack livestock because of a variety of logistical and behavioral reasons. We concluded that temporarily holding wolves at a small, moderately accessible facility is of limited use for determining the utility of aversive conditioning as a wolf predation management technique. More research is necessary to effectively apply electronic training collars to wolf management. However, we determined that maintaining holding pens for wolves provides flexibility to managers in translocation efforts. Because wolves in our studies survived to reproduce, our collaborative efforts have made a significant contribution to wolf recovery.

Key Words: aversive conditioning, *Canis lupus*, non-lethal, shock, gray wolf, livestock predation

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INTRODUCTION

Researchers at the USDA APHIS Wildlife Services' National Wildlife Research Center (NWRC) have long been involved with testing and developing new and improved methods for managing conflicts between predators and humans (USDA 1994). As yet, however, there have still been no unqualified successes using non-lethal tools (Clark et al. 1996). Human population and land use continues to grow concurrently with predator introductions and expansions, and managers require a wider variety of thoroughly tested alternative methods to solve the growing number of conflicts between humans and wildlife. Private organizations, such as the Turner Endangered Species Fund (TESF), are similarly concerned with the need for developing tools that will assist in efforts to further expand wolf and other endangered species populations. They have dedicated a tremendous amount of time and resources toward this end. The objective of this paper is to describe the results of a collaborative research effort between government agencies (U.S. Fish and Wildlife Service and USDA APHIS WS NWRC) and personnel from a private conservation organization (TESF) to attempt to apply aversive conditioning methods in a wolf management situation.

Gray wolves (*Canis lupus*) in Idaho, Montana, and Wyoming frequently impact livestock. Lethal control is one method commonly used to end wolf predation on cattle, dogs, sheep, and other domestic animals. However, the goal of wolf management programs in the western United States is to reestablish viable populations of these predators. Lethal management actions slow the process of building populations of wolves, and therefore non-lethal but effective predation management techniques are required.

We examined the use of aversive conditioning for wolf management. As defined, aversive stimuli are stimuli that cause discomfort, pain, or an otherwise negative experience and are paired with specific behaviors to achieve conditioning against these behaviors (Shivik and Martin 2001). Gustavson et al. (1976) suggested that aversive conditioning using lithium chloride may be an effective management tool, although it is more useful for reducing consumptive behaviors of particular foods rather than for limiting killing behavior by predators (Conover and Kessler 1994). The concept and theory of using electric shock as an aversive stimulus to alter animal behavior has been studied intensively (Krane and Wagner 1975, Linhart et al. 1976, Quigley et al. 1990, Tiedeman et al. 1999). Andelt et al. (1999) recently demonstrated the effectiveness of domestic dog training collars for conditioning coyotes, and we expanded this concept to wolves, applying it in an actual management situation.

METHODS

A containment facility was constructed at the Flying D Ranch near Bozeman, Montana during May-June 2000, using a 0.2-ha pen that previously was employed for holding wolves in Yellowstone National Park. Wild wolves that were likely to have killed cattle were captured as part of normal operational control actions and transported to the facility for experimental conditioning.

Each wolf was fitted with an electronic training collar (CT 400A Contain and Train Collar, Innotek Inc.) designed to deliver an electric shock to the wolf when the collar was activated. Unmodified collars were used initially, but for the second pack, collars were modified to transmit radio frequency pulses simultaneously with activation to allow personnel to remotely monitor collar activation. The collar probes used were designed for dogs with long hair (2.5 cm), and fur was trimmed to ensure proper contact of the collar with the neck of each wolf. Domestic cow calves were fitted with a battery operated "Room-free" (Innotek, Inc.) that caused aversive collars to activate if a wolf approached system within approximately 1.0 m of the calf.

During daily maintenance, wolves were provided water *ad libitum* and fed a diet of game carcasses and canine food as directed by the resident veterinarian. Carcasses and food were dropped in an area observable by biologists, who attempted to minimize contact with wolves. Wolves were fed twice per week but fasted $\geq$5 days before a trial.

Initial equipment tests involved placing a calf hide in the pen that was protected with the conditioning system. After a successful demonstration of the system (i.e. wolves were repelled from the hide), conditioning trials were attempted. A conditioning trial involved introducing one domestic calf into the wolf pen. The system was designed to automatically deliver a conditioning stimulus when a wolf approached the calf. Wolves were able to freely and immediately remove themselves from conditioning stimuli by retreating away from the calf. Trials were monitored with video cameras and by technicians using a spotting scope from a blind. As an experimental control, bison and domestic rabbits were also released into the pen, and wolves were allowed to kill and consume these animals.

Calves were removed from the pen at the conclusion of a conditioning trial. Initial trials were designed to end after 3 hours of observation, or immediately if a wolf attack was not prevented by the conditioning stimulus, but trial duration was increased up to 24 hours dependent upon the effectiveness of the collar and the behavior of wolves. If an attack on a calf was not prevented with the conditioning stimuli, the attack was immediately interrupted by observers.

After participation in the project, wolves were released and monitored for depredations as part of regular management programs. Survival, reproduction and the occurrence of livestock kills was monitored (as part of regular management operations) to measure residual effects of conditioning and captivity.

Table 1. Chronology of aversive conditioning tests on Sheep Mountain wolves.

Date	Action/trial	Comment
6/8/00	Wolves released into pen	
7/12/00	Capture to fit collars	
7/18/00	Wolf 16 lethargic	
7/19/00	Wolf 16 dead	
7/21/00	Bison calf placed in pen	Calf charged wolf
7/31/00	Euthanized bison calf	
8/2/00	Bison calf consumed	
8/4/00	Beef hide placed in pen	195 repelled by collar
8/4/00	2 live rabbits put in pen	
8/12/00	4 live rabbits put in pen	
8/15/00	Neck irritation on 195M	
8/17/00	Scat analysis	Wolves consumed rabbits
8/21/00	Trial #1 – tethered Angus calf in pen	No approach to calf in 6 hr trial
8/22/00	Trial #2 – Tethered Hereford calf in pen	No approach in 6 hr trial
8/23/00	Trial #3 – Angus calf put in pen; not tethered	No approach in 3.5 hr trial; calf left in pen
8/24/00	Calf retrieved from pen	Calf unharmed.
8/24/00	Capture	Removed collar from 189M and 195M due to irritation; 196M showed no irritation; left collar on
10/17/00	Capture	Put collars on with short probes; necks healed completely; no irritation on 196M
10/18/00	Trial #4 - Angus calf put in pen to free-roam	2 hr observation. 195M attempts to bite calf; no aversive stimulus observed or wolf ignored shock; removed calf with small puncture on foot.
10/20/00	Capture – 196M and 189M	Re-fit collars using long probes; re-shaved necks
10/26/00	Capture – 195M	Re-fit collar using long probes; re-shaved neck
11/08/00	Trial #5 - Hereford calf put in pen; not tethered	No approach during 3.5 hr trial
12/05/00	Removed from pen	Released

RESULTS

Sheep Mountain Pack

Wolves from the Sheep Mountain Pack were released into the pen on 8 June, 2000 (Table 1). One adult female and 3 yearling males were fitted with electronic collars, but the female died after chemical immobilization. Trials were conducted with the 3 young males only. An initial test of the system on 4 August, 2000 indicated that the system repelled wolves from a hide. That is, one wolf (196M) approached the hide and then jumped away when the collar activated. Neither this wolf nor any of the other wolves observing the event approached the hide again during the duration of the 5-hr trial. A bison calf was introduced into the pen on 21 July; however, its first interaction with wolves involved the bison calf butting a wolf, and the calf was not molested for the duration of time it remained in the pen (until it was euthanized on 31 July after which it was consumed by the wolves). The bison calf was left in the pen continuously and wolves were not fed while it remained in their pen. Next, unprotected domestic calves were introduced into the pen on 3 separate occasions, but wolves did not approach them. A protected calf was left in the pen overnight on 23 August and was removed from the pen unharmed the next morning. Rabbits were introduced into the pen on 2 occasions, but they were consumed by the wolves.

Wolves were examined on 24 August and evidence of tissue damage from the collar probes was moderate on one wolf, minor on the second, and non-existent on the third. The collars were removed to allow healing of abraded areas and associated contact dermatitis. Wolves were fully healed by 17 October and the collars were refitted using the manufacturer's short probes. On 18 October, a protected calf was put in the pen at 0930 hrs. Wolves slowly milled around the calf, but when the calf stood up, the wolves trotted away. At 1125 hrs, wolf 195M slowly walked up to the inactive calf. The calf jumped up quickly and kicked at the wolf, which apparently did not receive the aversive stimulus. The wolf made a second attempt and held on to the calf's rear leg. The calf was bawling, but the wolf showed no sign of receiving a shock. Observers immediately shouted and ran down to the pen, ending the possibility of a predation event. The calf was examined and no injuries were found. We were not able to determine if the electronic collars malfunctioned or if the wolf ignored the conditioning stimuli, but collars were operating when they were removed on 20 October and refitted with probes designed for dogs with long hair. Wolves did not approach the calf in a final test on 8 November.

The 3 wolves from the Sheep Mountain Pack were released into Paradise Valley (Daily Lake), Montana, on 5 December 2000. Two spent the breeding season with a dispersing female from Yellowstone Park, who whelped 4 pups. The third wolf found an uncollared female and produced 6 pups before being removed in a control action 314 days after release. In total, of these 3 wolves, 1 died of natural causes and 2 died in control actions.

Boulder Pack

The second pack contained 5 wolves (4 pups and 1 yearling), and was brought into the pen on 16 January 2001, after being captured near Avon, MT (Table 2). They were not subjects in aversive collar conditioning, but were kept in the Flying D pen for 10 weeks to aid in deterring homing behaviors before being relocated approximately 200 air miles from their natal territory to Northwest Montana (Cabinet Mountains) on 28 March, 2001. To date, 4 of the wolves remain together and have moved about 80 miles south from the release site. One pup slipped its collar approximately 10 miles from its natal territory and is presumed to have made it back to its original pack. Now called the Parsnip Pack, this pack is expected to contribute to recovery in the next year.

Gravelly Pack

On 27 April, the Flying D received one black yearling retrieved by Wildlife Services after evidence showed its pack was killing sheep in the Gravelly Range

Table 2. Chronology of captivity and aversive conditioning tests on Boulder and Gravelly wolves.

Date	Action/trial	Comment
1/16/01	Boulder wolves in pen	No collars fitted
3/28/01	Relocated to NW MT	
4/27/01	One Gravelly yearling in pen	
6/6/01	Six 7-week old Gravelly pups in pen	
6/7/01	Alpha female in pen	
7/30/01	Collars on adults	Collars with radio-monitor
8/20/01	Test range of collars from observation ridge	System malfunction, corrected
9/10/01	Tested collars using beef hide	No approach to hide in 8-hr trial
9/11/01	Tested collars using beef hide	No approach to hide in 3-hr trial
9/14/01	Tested collars using scent post	No approach to scent post
12/19/01	Released into NW MT	

(Table 2). The Gravelly Pack had continued to kill sheep and a control action was initiated, but lethal control was delayed after finding six 7-week-old pups following the adults. The pups were dug out of the den and brought to the Flying D pen on 6 June 2001. On 7 June, the alpha female was caught and reunited with the pups and the yearling.

The pack was allowed to acclimate for 2 weeks before scheduling a capture to fit electronic training collars on the 2 adults. Improvements were made to the training collars by incorporating a sensor that alerted biologists if the collar was activated.

The refurbished collars were placed on the 2 adult wolves on 30 July 2001. During the next few weeks attempts to find 2 beef calves were unsuccessful due to missing the early local calving season. On 20 August, collars were tested and a problem was found in the radio transmission equipment. This problem was corrected, and on 10 September a protected beef hide was placed in the pen. The test was conducted from 1100 to 1900 hrs. No wolves approached the hide. The same test was repeated on 11 September from 1000 to 1300 hrs, but again no wolves approached the hide. On 14 September, a meat-based scent post was placed in the pen and the triggering mechanism buried. No wolves approached the scent post. The Gravelly wolves were released into northwest Montana on 19 December 2001. The wolves from the Gravelly Pack were renamed the Caribou Pack, and they are all currently alive at this writing. Most notable is the adult female, who has dispersed into Washington State and British Columbia.

DISCUSSION

Based on previous reports using penned animals, we believe that it is possible to condition predators to not attack certain species (Linhart et al. 1976, Andelt et al. 1999). However, applying aversive conditioning methods to penned wild wolves is extremely difficult, and a number of difficulties were encountered. For example, we were unable to effectively monitor collar stimulation remotely. For the Gravelly Pack, no attempts to approach the beef hide or the meat-based scent post were observed, and we believe that the wolves were not acting as they would if not held in a pen. That is, the wild wolves remained wary throughout their captivity. Because they were not inclined to attack prey, it was not possible to adequately test aversive stimuli equipment, much less to effectively condition wolves. Acquiring small beef calves for use in trials was similarly difficult and calf availability was not synchronized with wolf testing. Similarly, regulations regarding the transport of wildlife prohibited us from using deer fawns or elk calves for comparison of wolf predation behaviors on livestock versus wild prey. In summary, we concluded that future use of electronic collars to modify wolf behavior will require refining equipment, increasing the number of wolves that are tested, solving problems with pen access, beef calf availability, and wild prey availability so that a rigorous scientific protocol can be followed. In actual management situations, however, these logistical difficulties will be difficult to overcome.

The most promising outcome of the study, however, was the side benefit of pens for temporarily holding wolves until a suitable area for release was found. Although we acquired no evidence that the wolves we held were conditioned, and many of the wolves eventually died after release, the pen facilities at the Flying D Ranch made a significant contribution to wolf recovery efforts, and intensive management of individual wolves continues to advance recovery (Phillips et al. *In Review*). In our work, 2 of the 3 Sheep Mountain Pack members contributed to recovery by siring a minimum of 10 pups, and wolves from the Parsnip Pack are expected to produce pups in 2002.

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