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Are Viable Non-Lethal Management Tools Available for Reducing Wolf-Human Conflict? Preliminary Results from Field Experiments

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ABSTRACT: Wolf-caused depredation results in substantial economic loss to individual farmers and can lead to greater public animosity towards wolves (i.e., reduction in social tolerance) and the agencies that manage depredations. Using an experimental design in field trials, we are testing shock collars, fladry, and livestock guarding dogs to determine if they are effective in reducing wolf use of areas in Wisconsin and Michigan. During 2003-2004, we equipped 5 wolves with shock collars and found that a 14-day shock period resulted in a decline in wolf use of baited sites by 50% compared to control wolves that increased visitation to baited sites by 18%. During 2005, we found that all pack members in shock-collared wolf packs (n = 5) avoided shock sites for over 60 days after being exposed to a 40-day shock period. During 2004-2005, we found that fladry offered farms at least 90 days of protection from wolves. During 2006-2008, we are conducting field trials with livestock guarding dogs on Michigan farms using an experimental design protocol and additional field trials of shock collars in Wisconsin. Our preliminary data suggest that shock collars and fladry may reduce wolf use of areas within their pack territories. Results of this research will provide important guidelines for implementing potential non-lethal management measures in areas wolves have recolonized or will likely recolonize in the near future and/or where wolves are being reintroduced.

KEY WORDS: adaptive management, *Canis lupus*, empowering farmers, fladry, gray wolf, livestock depredation, livestock guarding dog, non-lethal management, shock collar, spatial scale, wildlife damage management

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INTRODUCTION

Livestock depredation caused by wolves (*Canis lupus*) can result in a substantial economic loss for individual livestock growers. From a conservation perspective, increases in wolf-caused livestock depredations can erode public social tolerance for wolves and make long-term management difficult. Livestock depredations can lead to greater animosity towards wolves among farmers and other rural user groups that may be directly and indirectly affected both economically and personally (Kellert 1999). Also, negative attitudes towards wolves can become entrenched if it is perceived that government agencies are ineffective in preventing livestock depredations. Unfortunately, these negative attitudes often translate to increased illegal killing of wolves and may endanger the long-term recovery of wolves in the northern Great Lakes Region. Thus, it is important that management prescriptions be developed and tested that curb depredations and reduce the risk of public attitudes shifting from favorable to unfavorable towards wolves and other carnivores (i.e., reduce the risk of a declining social tolerance, Decker *et al*. 2001).

Lethal control is the primary tool used for managing wolf-caused livestock depredations. Although lethal control has some merit in controlling wolf-caused depredations, it is expensive (Mech 1998), and it is a highly simplified approach that alone does not effectively reduce or prevent future livestock depredations by resident or new wolves that move into the area (Gehring *et al*. 2003, Musiani *et al*. 2005). Lethal control is typically only temporarily effective since depredations commonly recur on the same farms within 1 year (Fritts *et al*. 1992, Gehring *et al*. 1999, Bradley 2004). Another important issue is the scale at which lethal and other management tools are applied in order to effectively reduce livestock depredations (Gehring and Potter 2005, Musiani *et al*. 2005). An integrated management approach of using non-lethal management tools in concert with lethal control might offer a more effective management approach. In the U.S., the general public tends to support non-lethal management tools as more humane (Reiter *et al*. 1999). Further, non-lethal tools would be particularly important for small and recovering wolf populations (Gehring and Potter 2005).

Farmers have been largely passive and reactive in the management of wolf-caused livestock depredations in the northern Great Lakes Region. For example, when a depredation occurs, farmers contact governmental representatives to attempt to prevent future losses. However, farmers likely do not actively develop depredation management plans or implement depredation-reduction practices. Rather, we suggest that farmers should be more engaged and active in the management of their own property to prevent and reduce wolf-caused livestock depredations. One way that farmers might reduce or prevent depredations would be to reduce or prevent the use of pastures by wolves via non-lethal means, allowing resident wolves to defend their territory from other wolves and predators (Gehring and Potter 2005). Such an approach might also reduce the chance of increased depredations resulting from the removal of wolves (Bjorge and Gunson 1985) and the disruption of pack social structure and stability (Gehring *et al*. 2003). If successful, this approach would maintain wolves in areas, but preclude them from areas that contain livestock, thereby preventing depredations. This strategy would also lead to significant economic savings, reductions in the number of wolves killed, and incorporate farmers as a franchise in the management process.

Few studies have used a rigorous experimental approach in studying the depredation ecology of wolves in semi-agricultural landscapes (Fritts *et al*. 1992). We conducted field tests of 3 non-lethal management tools (fladry, livestock guarding dogs, shock collars) relative to their effectiveness for altering wolf movements away from baited and livestock areas. We also included farmers as active participants in our depredation research.

METHODS

Shock-Collar Study

During 2003-2005, we captured gray wolves in Wisconsin using standard trapping procedures outlined by Hawley (2005). Captured adult wolves were instrumented with a radio collar. At least 1 wolf from each study pack was collared. We randomly assigned treatment type (shock collar or control) to each study pack. For treatment packs, we also placed a shock collar on the adult wolf using procedures outlined by Hawley (2005). In both pack types, we established baited sites at a forest road intersection used by wolves. Baited sites were created by placing road-killed deer at the site every 2-3 days. We also placed a shock box (with transmitter, battery and reed-switch timer) and a data logger (Osprey, H.A.B.I.T., Vancouver, B.C.) at the baited site. The shock box was automated to continuously scan for the shock-collar receiver within a pre-defined range. During 2003 and 2004, we established a shocking range of 30 m from the shock box. During 2005, we expanded the range to 70 m from the shock box. When a wolf was within this range, it would receive a 13-s shock during each 60-s interval. During trials for treatments and controls, we recorded the number of wolf visits and time spent at the site using the data loggers. We also relocated wolves using a mobile telemetry tracking vehicle to determine the distance that wolves traveled from the baited sites.

Fladry Study

We selected 4 sheep and 4 cattle farms in the eastern Upper Peninsula of Michigan that were within wolf-occupied areas. We randomly assigned 2 sheep and 2 cattle farms to be treatment farms that would receive fladry. We identified the other 2 sheep and 2 cattle farms as control farms, without fladry. Treatment and control farms were located within 3 km of each other within the same wolf-occupied areas. Both farm types had existing multi-strand electric fencing and were similar in number of livestock and size of area. During May 2004 and 2005, we placed fladry 1 m from the outside of pasture fencing. Prior to hanging the fladry, we cleared the pasture perimeter of vegetation via mechanical means. The fladry line was hung on plastic insulators attached to rebar posts spaced at approximately 7-m intervals. We hung the fladry so that the bottom of the flags was at ground level. Once established, the fladry was checked every 3-4 days to ensure that no flags were missing or were not hanging vertically. We repaired the fladry fencing as needed.

To record wolf visitations on the outside and inside of the fladry fence, we established paired, 1-m^2 sand scent stations spaced every 200 m around the pasture. The stations were paired so that 1 station was immediately outside the fence and the other was immediately on the inside of the fence. We baited the stations with a small clump of livestock feces found at the farm site. Stations were checked daily for 5 days during June through August and wolf tracks were recorded. We conducted similar scent-station sampling concurrently at control farms.

Livestock Guarding Dog Study

During March 2005, we purchased 12 Great Pyrenees pups (6 female and 6 male, ages 7-9 weeks) of the same pedigree from a breeder in Illinois. These pups were delivered to 6 cattle farms in the western Upper Peninsula of Michigan. These farms had been previously selected during January and February based on their 1) location within wolf-occupied areas, 2) interest in joining the study, and 3) similarities relative to the number of cattle, husbandry, and fence quality. We also selected 3 matching control farms within proximity to 3 of these treatment farms. We housed dogs with calves in the same pen during March through August. During that time, we constructed additional strands of electric wire fencing around the pastures that cattle were using to ensure that dogs would remain within pastures and not roam. During September, livestock guarding dogs (LGDs) were moved into temporary pens within the pastures and slowly integrated into cattle herds. After September, LGDs were allowed to roam freely with cattle within the pastures.

We monitored wolf, coyote, and deer movement into pasture systems using sand tracking swaths (1.5×4 m) placed every 200 m around the pasture perimeter. We checked these swaths every day for a total of 15 days during July through August and recorded the number of each species that crossed under fences and entered pastures. These data were collected before the LGDs were placed into the pastures and thus represent pre-treatment data. We collected similar data on control farms to assess any changes in use of pastures independent of the presence of LGDs.

RESULTS

Shock-Collar Study

Shock-collar equipped wolves demonstrated a 50% reduction in use of baited sites after the 14-day shocking trial, whereas control wolves increased visitation to baited sites by approximately 18% ($n = 5$ shock-collared wolves, $n = 5$ control wolves). During the 40-day shock period, we recorded a mean visitation rate of 2.6 days (SE = 0.600) for shock-collared wolves ($n = 5$), whereas control wolves ($n = 2$) averaged 14.5 days (SE = 3.50) during the same period. During the 40-day post-shock period, we recorded a mean visitation rate of 2.2 days (SE = 0.374) for shock-collared wolves, whereas control wolves spent a mean of 17.5 days (SE = 4.50) at the bait sites. Mean distance shock-collared wolves were found away from baited sites during the 40-day shock period was 4,099 m (SE = 342), and mean distance for control wolves during the same period was 1,954 m (SE = 193). Mean distance shock-collared wolves were found away from baited sites during the 40-day post shock period was 5,179 m (SE = 262), and mean distance for control wolves was 2,594 m (SE = 464).

Fladry Study

We recorded no wolf visits inside fladry pastures when the integrity of fladry was present, whereas more wolves were detected outside the fladry fencing ($\chi^2 = 10.1$, P = 0.001). Conversely, wolves did not discriminate between the pasture fencing on control farms where they were found equally inside or outside pastures ($\chi^2 = 0.286$, P = 0.593). On 2 occasions, wolves trespassed into fladry-protected farms, but both cases were when the fladry fencing was not standing. One case was where calves had escaped the pasture and pulled the fladry fence down. The second case was at a livestock gate that the farmer failed to reattach the fladry line to, subsequently a wolf walked through the gate.

Livestock Guarding Dog Study

LGDs were successfully integrated on all 6 farms during March through September 2005. During October, the dogs were allowed to range free within cattle pastures. To date, the dogs conduct regular patrolling of pastures. Currently, we have only anecdotal observations from participating farmers, including that wolves frequent the boundaries of farms and howl while LGDs alert bark until the wolves leave. One farmer observed a single wolf trespass into the corner of a pasture, at which point the dogs pursued it and chased it out of the pasture. We also have farmer observations of no coyote activity on the farm, whereas coyotes were regularly sighted before the dogs were deployed. Our post-treatment monitoring for predator activity will begin in summer 2006. These data will allow a determination of the relative effectiveness of LGDs for preventing or reducing predator activity on farms.

DISCUSSION

Shock Collars

Relatively few investigators have studied the use of shock collars as a non-lethal management tool. Linhart *et al*. (1976) appears to be the first reference of using shock collars as a wildlife-related application. Andelt *et al*. (1999) found that captive coyotes could be aversively conditioned to sheep in the pen after receiving corrective shocks when they attempted to attack sheep. In a captive wolf trial, Shivik *et al*. (2003) found no evidence supporting the effectiveness of shock collars preventing the post-treatment consumption of artificial food piles.

Shivik *et al*. (2003) also cited individual-based responses of the captive wolves to the corrective shock. Schultz *et al*. (2005) used an adaptive management approach by using shock collars on 2 wolves from a pack associated with depredations on a farm. They found shock collars to have the potential to help reduce wolf depredation on domestic animals, but the long-term effects of the treatment were unknown. Hawley (2005) conducted field experiments on wild wolves using shock collars. He found that shock-collared wolves spent less time at baited sites and were located farther from baited sites compared to non-shock-collared wolves (Hawley 2005). Relatedly, Nolte *et al*. (2004) found shock collars on deer to have the potential to keep them from damaging resources. The results from most past studies have supported the promising potential for the application of shock collars in certain management situations and revealed potential limitations.

Fladry

Fladry has been used for centuries as a tool for capturing and killing wolves in Eastern Europe and Russia because it serves as a virtual barrier that wolves avoid crossing (Musiani and Visalberghi 2001, Musiani *et al*. 2003). Past research has suggested that fladry is effective for ≤60 days (Musiani *et al*. 2003). However, we documented wolf avoidance of fladry-protected farms for ≤90 days. Because fladry is a neophobic device, wolves may eventually become habituated to it (Musiani and Visalberghi 2001, Musiani *et al*. 2003). The length of time to habituation is likely related to the frequency at which wolves visit farms protected with fladry. We predict that greater wolf use of livestock areas with fladry will likely shorten the time to habituation. Turbo fladry (electrified fladry) may offer a unique, new non-lethal management tool that reduces or prevents habituation, although this material is costly (Williamson 2006).

Livestock Guarding Dogs

LGDs have been used for over 2,000 years to prevent predation on sheep and other livestock in Europe (Coppinger and Coppinger 2001) but have only recently been used in other capacities such as protecting forest plantations (Beringer *et al*. 1994), golf courses (Woodruff and Green 1995), orchards (Curtis and Rieckenberg 2005), organic vegetable farms (VerCauteren *et al*. 2005), and protecting cattle from deer potentially infected bovine tuberculosis (VerCauteren, unpubl. data). However, their use by agricultural producers appears to be limited (Gehring and VerCauteren, unpubl. data). LGDs can be an effective management tool for reducing livestock losses to predators (Coppinger *et al*. 1983, Andelt 1992, Andelt and Hopper 2000). However, most work has focused on sheep-coyote conflicts. Andelt and Hopper (2000) documented that Colorado sheep producers with LGDs lost smaller proportions of lambs to predators. In fact, shepherds without LGDs lost up to nearly 6 times more lambs than producers with LGDs. Of 160 producers surveyed, 84% reported that their LGDs were excellent or good at reducing sheep predation. Few studies exist on LGDs' ability to bond with cattle (VerCauteren and Gehring, unpubl. data) and reduce predation by wolves. Proper training is best accomplished by raising the dog with the livestock it will be guarding in order to establish a bond between dog and livestock (Green and Woodruff 1999, Lorenz and Coppinger 1996, Dawydiak and Sims 2004). Our preliminary data suggests that LGDs can be relatively easily integrated into cattle operations, thus expanding the possible role of these dogs in the agricultural community.

SUMMARY

Our preliminary field experiments provide rigorous tests of non-lethal management tools with potential application to depredation management. Surprisingly, few studies have conducted similar large scale field experiments on these tools. However, this information is essential in order to determine if these tools have general application across the landscape. Our research program is testing individual non-lethal management tools relative to their efficacy. Integrated tests in which these tools are combined onto 1 farm site would be interesting.

In some cases, the current use of lethal control to reduce livestock depredations at the regional scale has been ineffective (Musiani *et al*. 2005). A more cost-effective management strategy might be to incorporate more non-lethal management tools at the landscape scale in order to reduce livestock depredations. This application would require the active participation of farmers because many of these tools (e.g., fladry and LGDs; Gehring and Potter 2005) are relatively easy for farmers to integrate into their normal husbandry practices. We not only see a cost savings benefit of this active land management, but also we predict that this proactive management will increase the social tolerance of wolves and other predators among farmers because they will become active stakeholders in the management process.

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All protocols used in these studies were approved by the CMU Institutional Animal Care and Use Committee.

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