

LETTER FROM THE CONSERVATION FRONT LINE

When strange bedfellows go all in: a template for implementing non-lethal strategies aimed at reducing carnivore predation of livestock

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In the Rocky Mountains of the USA, abundances and distributions of grizzly bear *Ursus arctos* and gray wolf *Canis lupus* have increased (Bangs *et al.*, 2001; Nicholson & Hendricks, 2018). This has led to increased predation of livestock in areas where livestock producers have not needed to implement conflict prevention methods in recent history. Lethal removal of carnivores that kill livestock remains a common source of carnivore mortalities (Woodroffe, 2001; Broekhuis, Cushman & Elliot, 2017). In the USA, the U.S. Department of Agriculture's Wildlife Services (USDA-WS) is often asked by the U.S. Fish and Wildlife Service or a State's wildlife management agency to lethally remove large carnivores that depredate livestock. Where possible, conservation practitioners favor increased use of non-lethal tools to replace lethal methods aimed at preventing depredation of livestock. Conservation groups often dispute management actions for large carnivores, sometimes resulting in lawsuits. It is often challenging to look beyond these differences and note that the ultimate goal of these diverse groups is typically some variation on the same theme: to increase coexistence by reducing conflicts between humans and carnivores.

Non-lethal tools that reduce livestock depredation could facilitate coexistence; however, scientists note a distinct lack of experimental studies that adequately evaluate the efficacy of non-lethal tools (Eklund *et al.*, 2017; van Eeden *et al.*, 2018). A call for more research is warranted, but the time and resource requirements associated with research are often mismatched to the immediate needs of protecting livestock, large carnivores, and the livelihoods of livestock producers.

One non-lethal tool available to reduce depredation of livestock by wolves is fladry. Fladry consists of strands of flags, measuring approximately 50-cm long by 10-cm wide, sewn onto nylon rope at 45-cm intervals. Fladry acts as a primary repellent by taking advantage of the fact that wolves are neophobic and relies on producing a flight response to deter them (Shivik, 2006). When the flags are hung just

above the ground, their motion in the wind creates a novel, visually frightening stimulus and can exclude canids from the protected area for 60–75 days (Musiani & Visalberghi, 2001; Musiani *et al.*, 2003; Mettler & Shivik, 2007; Davidson-Nelson & Gehring, 2010). Modifications to fladry have prolonged its effectiveness by incorporating an aversive stimulus, electricity; often referred to as turbo fladry. For turbo fladry, the nylon twine that supports the flagging is replaced by an electrified polywire that emits a non-harmful, but painful, shock when an animal touches it (Lance *et al.*, 2010). Because of its reported efficacy for up to ~75 days, it is best used during periods when livestock would be most vulnerable to depredation, such as the calving and lambing seasons.

Although research has been conducted on fladry, there remain limitations on our understanding of its efficacy and whether it can be useful on a working landscape. Without this knowledge, livestock producers remain hesitant to invest in purchasing turbo fladry supplies, which cost several thousand US dollars per pasture, and the time needed to install and maintain turbo fladry. Therefore, Wildlife Service (WS)-Montana formed a partnership with a non-profit conservation organization (i.e. Natural Resources Defense Council, NRDC) to identify livestock producers willing to use turbo fladry. This partnership allowed all of us on their properties to assist with the installation and monitoring during birthing season. The National Wildlife Research Center, the research branch of USDA-WS, was brought into the collaboration after the first year to bolster protocols and ensure relevant data were collected along the way.

Similar to many agricultural communities in other parts of the USA, USDA-WS has a good relationship with most livestock producers in Montana. Most hesitation by producers to implement non-lethal tools is typically a result of skepticism about their efficacy or a reluctance to partner with non-profit organizations. Thus, we focused on our shared goal of reducing conflicts between humans and carnivores and collaborated to

implement a non-lethal tool program. First, we identified livestock producers willing to participate, often called early adopters, in the diffusion of innovations (Rogers, 1962). USDA-WS Field Specialists approached livestock producers within their local service area that were potential early adopters and had recurrent wolf depredations spanning several years on calving pastures that were 0.16–0.28 km². These producers were asked whether they would be willing to participate in a collaborative USDA-WS project with NRDC to prevent wolf depredations. If they were, a participant agreement was created and signed that presented the project as a cost-share with in-kind donations of labor expected from the livestock producers. We felt this step was important to ensure the participants bore a sense of ownership in the project.

The next step was to determine an installation date that complemented the birthing season of livestock on the property, and the logistics of the personnel engaged in installation. On the set date, 3–8 people installed fladry and the supplies for the monitoring program in a single day. The monitoring program was designed to be extremely simple: four trail cameras were evenly distributed around the perimeter of the pasture being protected with fladry. The cameras were set along game trails and angled parallel to the fladry line to record any interactions between wildlife and the fladry. We maintained the fladry by conducting weekly maintenance checks, although in some instances, the checks were only conducted every 2–3 weeks. At least one person would walk the entire fladry perimeter to check voltage, ensure no short circuits had occurred, and make any necessary repairs. That person also noted any signs of carnivore presence. Finally, we removed the fladry and the camera traps after approximately 120 days. The exact date of removal was dependent on several factors including weather, availability of staff, and coordination with the livestock producer.

In each year, all fladry was in place between early January and the end of April, with variation in specific start and end dates among livestock operations to match the birthing schedules of their livestock. During that time period in 2016, there were seven turbo fladry projects in Montana and one in Wyoming. No monitoring occurred in 2016, but none of the livestock operations reported livestock depredation within the fladry protected paddock during the time it was hung.

Between January and April of 2017, there were eight turbo fladry projects. These included six of the livestock operations from year one and two additional livestock operations. One of the new turbo fladry projects was aimed at protecting sheep, with the other projects protecting cattle. Once again, there were no depredation events in any pastures during the time they were encircled with fladry, and wolves were detected on at least two livestock operations via camera traps.

In 2018, four livestock operations from 2017 participated again, along with six additional livestock operations. Of those that did not participate again, one livestock operation ran the fladry project on their own and another installed a permanent protective fence to protect the sheep. Two livestock producers were unable to be contacted. Of the new participants, two were in Montana, two in Idaho near the Montana state border, and two in Oregon. The additional livestock producers and State WS personnel agreed to participate because of the evidence-based

results of the preceding year. Wolves were detected outside of the pastures protected by fladry via camera traps at two projects in Montana and one project in Oregon. Wolves were also detected by a livestock producer in person at the same project in Oregon and via back-tracking in snow at one livestock operation in Idaho. Wolves were also heard howling from another livestock operation in Montana while fladry was installed, suggesting wolves were likely to have encountered the fladry-protected area. Thus, we could confirm wolf presence in the area near all but one livestock operation per state during the time when fladry was installed. Importantly, no depredation events occurred at any participating livestock operations while fladry was installed.

In both years that monitoring occurred, several other mammalian species were also detected via camera traps, including grizzly bears, black bears *Ursus americanus*, coyotes *Canis latrans*, foxes *Vulpes* sp. and *Urocyon* sp., raccoons *Procyon lotor*, deer *Odocoileus* sp., elk *Cervus canadensis*, and moose *Alces alces*. While no depredation events occurred at project sites in the final year, depredation events did occur in the absence of fladry: one livestock operation in Oregon suffered the loss of two calves the day after fladry was taken down; depredation occurred in a field immediately adjacent to where fladry was located once fladry was removed at one livestock operation in Montana; and a livestock operation in Idaho, that neighbored an operation where fladry was installed, had a calf attacked by wolves and the calf had to be euthanized. The fladry was re-installed at the livestock operation where the two calves were killed in Oregon and no further losses occurred for the additional 6 weeks the fladry was up, although wolves were again detected on camera traps. The spatiotemporal coincidence of these depredation events further suggests turbo fladry was an effective deterrent for the livestock pastures it protected.

We learned three important lessons about successful methods to implement and run the program. These include:

- 1 Working collaboratively across several types of agencies and organizations allowed doors to open that may not have opened for any one particular group;
- 2 The collaboration allowed several sources of financial and personnel resources to be available to livestock producers; and
- 3 Monitoring provided an evidence-based approach to encourage participation by more livestock producers and convince producers of its efficacy.

The program continues to expand as more livestock producers, in a growing number of States, have begun to install fladry, or agreed to install fladry in future seasons. The current program requires little investment from the livestock producer. Supplies are purchased by USDA-WS, NRDC, and State and other non-governmental organizations, with installation and monitoring primarily conducted by their employees. Some livestock producers and their staff were active participants in the installation, maintenance, and removal of the fladry. To encourage producer participation, we modified the participant agreement after the first year. Livestock producers only had to assist with maintenance once every 3 weeks during the first 2 years, with NRDC and USDA-WS responsible for the other 2 weeks. In the final year, the

contract stated that the livestock producers had to conduct the maintenance every other week.

In circumstances such as those described above, limited time and resources make resolving problems difficult for any single group. The continued expansion of cooperative programs, such as this, allows for conservation practitioners and wildlife managers to work towards the same goals while overcoming similar obstacles. We contend that being creative and receptive to partnering with a variety of agencies and groups, even those that may seem at opposition with another, can open doors and better solve conservation problems. Finally, having animal conservation scientists involved in the establishment of a monitoring or research program can help quantify impacts, be useful to determine if the solutions are effective, and provide evidence to encourage more people to adopt proven solutions. Even so, we encourage animal conservation scientists to conduct further research on the efficacy of fladry and other such non-lethal tools to ensure the best solutions are used.

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