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Testing fladry as a nonlethal management tool for wolves and coyotes in Michigan

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Abstract: Several forms of nonlethal management exist, but field testing is problematic, and few such techniques have been tested on free-ranging wolves (*Canis lupus*) or other predators. We tested fladry in the eastern Upper Peninsula of Michigan during the summers of 2004 and 2005 on treatment farms and control farms. Wolf visitation inside pastures, compared to those outside pastures, was less on fladry-protected farms ($U = 45$, $n = 7$, $P = 0.004$); whereas, we found no difference in wolf visitation inside and outside of pastures on control farms ($U = 30$, $n = 7$, $P = 0.24$). We found no difference in coyote (*Canis latrans*) visitation inside and outside of pastures on both treatment ($U = 29.5$, $n = 7$, $P = 0.26$) and control farms ($U = 31.5$, $n = 7$, $P = 0.19$). In our study, fladry deterred wolves from using livestock areas. Fladry was not effective for coyotes. Fladry may provide livestock owners and management agencies a temporarily effective, nonlethal management tool for reducing wolf-caused depredation of livestock; however, labor and equipment costs can be substantial.

Key words: *Canis latrans*, *Canis lupus*, coyote, fladry, human–wildlife conflicts, livestock depredation, nonlethal control, Upper Peninsula of Michigan

As gray wolves (*Canis lupus*) recolonize agricultural landscapes, wolf–human conflicts, such as livestock depredations, may increase (Mech 1995, Harper et al. 2005). Livestock depredations can lead to greater animosity toward wolves among farmers and other rural stakeholder groups (Fritts et al. 2003). If public social tolerance for wolf depredations decreases, the number of wolves killed illegally may increase (Mech 1995). Thus, it is important that management practices be developed and tested to reduce depredations and mitigate the risk of public attitudes toward wolves shifting from favorable to unfavorable (Mech 1995). The goals of all control tools are to provide safe, economically feasible, species-specific, and efficient methods that reduce the depredation problem for the longest period of time possible (Berryman 1972).

Managers have largely resorted to killing predators in the hopes of eliminating problem animals and reducing future conflicts between management agencies and livestock producers (Musiani et al. 2005). Public opinion favors the use of nonlethal management tools over lethal control (Reiter et al. 1999). Although nonlethal management options exist, few have been the subject of a controlled experiment involving free-ranging wolves or other predators. Partly, this has been due to the difficulty in conducting large-scale experiments while controlling for confounding variables (Breck 2004).

One possible nonlethal management tool is fladry. Fladry consists of flags that hang from a rope line. Fladry has been used for centuries in Eastern Europe and Russia as a method for hunting wolves (Okarma and Jedrzejewski 1997). Musiani and Visalberghi (2001) tested fladry on captive wolves and indicated that it confined wolf movements for short periods of time (i.e., 30 minutes). Musiani et al. (2003) conducted the first field trials of fladry on livestock operations and indicated its effectiveness for preventing wolf use of areas for at least 60 days.

Our objective was to use a controlled experiment to determine whether fladry could successfully reduce visitations by free-ranging wolves and coyotes (*Canis latrans*) into livestock pastures and, thereby, reduce livestock depredations throughout a growing season. We hypothesized that fladry would act as a visual barrier that wolves and coyotes would not cross. We predicted that visitation

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into pastures and depredations by wolves and coyotes on farms containing fladry would be lower than on the adjacent control farms (i.e., farms without fladry).

Methods

Study area

We conducted research in the eastern Upper Peninsula of Michigan, near Rudyard and Pickford in Mackinaw and Chippewa counties, during the summers of 2004 and 2005. The study area consisted of a mixture of northern hardwoods, lowland conifers, streams, grasslands, agricultural areas, and rivers. Agriculture included sheep, cattle, and horse operations, as well as crops (primarily oat, alfalfa, and wheat). During this study, the Upper Peninsula contained approximately 425 wolves within an estimated total of 87 wolf packs, as well as coyotes interspersed within the landscape (D. E. Beyer, Michigan Department of Natural Resources [MDNR], personal communication).

We selected cattle and sheep farms within the study area based on their location within the study area, habitat, livestock in pasture, past depredation history, and the willingness of farmers to participate in the study. We initially used MDNR winter track and radio telemetry data to identify likely study locations where wolves and farms overlapped. These areas were locations where MDNR had monitored radio-collared wolf packs within 2 years of this study. We also conducted track and scat surveys along dirt roads, 2-tracks, and on farms within these areas during late winter to early summer to confirm the presence of wolves within 5 km of potential study farms. We conducted track surveys a minimum of 3 times to confirm wolf presence (Wydeven et al. 1995). Of the 8 farms selected, 4 sheep farms ($\bar{x}$ = number of sheep = 625, SE = 75) were located in Chippewa County and 4 cattle farms ($\bar{x}$ = number of cattle = 64, SE = 2) were located in Mackinaw County. Average size of farms was 169 ha (SE = 19 ha). During 2003, approximately equal numbers of sheep (1,800 head) and cattle (2,200 head) occurred in the study area (Michigan Department of Agriculture 2003). We assumed that both farm types were equally accessible to wolves and coyotes. Further, all farm pastures were confirmed to be used by coyotes and wolves, based on track surveys we conducted before the experimentation began.

All farms had existing electrified livestock fencing used to maintain sheep or cattle within pastures (i.e., no farms had predator-proof fencing). Sheep farms had 5-strand, high-tensile fencing with 2 electrified wires (located 30 cm and 65 cm above ground level). Cattle farms had 3-strand high-tensile fencing with 2 electrified strands (located 40 cm and 65 cm from ground level). Fences were 115 cm high at the top wire, which was not electrified. The bottom wire (not electrified) on fences was 22 cm and 30 cm above ground level for sheep and cattle farms, respectively. Two of the 4 cattle farms also had a mid-level, nonelectrified barbed wire. All farms had open, grass pastures that were surrounded at least on 1 side by forest. All the farms had active livestock disposal sites. These carcass dumps were created in spring and early summer (primarily during lambing or calving) and were all located outside the livestock pastures within 50 m of the perimeter of the livestock fencing. Further, 5 of the 8 farms (i.e., 2 cattle and 3 sheep) had MDNR-documented coyote or wolf depredations, and 1 cattle farm had documented attacks within 2 years of this study. Farmers of the 2 remaining farms without

Figure 1. Fladry (foreground in photo) was hung outside of existing livestock fencing at the study site in the eastern Upper Peninsula of Michigan. Livestock fencing was present at both fladry and control farms during 2004 to 2005.

past verified depredations claimed to have lost livestock (i.e., livestock were missing) to coyotes or wolves within the previous 2 years; however, none of those losses was confirmed by MDNR.

Blocking by livestock type, we randomly assigned 2 sheep and 2 cattle farms as treatment (fladry) sites and 2 sheep and 2 cattle farms as control sites. Fladry and control farms were located within 3 km of each other to ensure that wolves and coyotes within the area had equal access to both farm types.

Fladry

We placed fladry on the farms at the beginning of May and monitored the farms mid-May through mid-August (75 days). These months were the period of greatest predation risk, due to the onset of the lambing and calving season when young livestock were most vulnerable (Fritts et al. 1992). We used fladry with 8-cm-wide red flags made of rip-stop nylon. The flags were 46 cm long and spaced every 46 cm on the line. Fladry lines were always placed outside the livestock fencing (Figure 1). To install the fladry material, we first installed electric rebar posts (6.35 mm in diameter) on the outside of the existing livestock fence. Rebar posts were spaced 7 to 9 m apart and approximately 0.5 m away from the existing fence. This spacing and placement of the rebar posts ensured that the fladry line remained consistent and taut; it also prevented the fladry line from entangling itself around the existing fencing material. This configuration of the fladry line allowed the voltage of the livestock electric fence to remain constant and prevented damage to the fladry and injury to the livestock (i.e., livestock could not chew or consume the flags). The rebar posts ran the length of the entire perimeter of the fence and were equipped with plastic fencing insulators for attaching fladry line to rebar posts. Fladry was then strung through the insulators and positioned so that the bottom of the individual flags was approximately 0.1 m above ground level. We monitored fladry lines every 3 or 4 days to ensure that flags were present and not damaged. We replaced missing or damaged flags with new ones. During each day of our scent station survey (see below), we checked the fladry lines to ensure that they were still hanging intact. During October, the fladry was removed and stored for the winter. The rebar posts and insulators stayed intact to be used the following summer.

Predator visitation

We used scent stations to monitor the use of each farm by wolves and coyotes. We constructed scent stations (1.5-m diameter) by using a line trimmer to remove vegetation and then added sifted sand (Roughton and Sweeney 1982). We baited stations in the center with sheep or cattle feces from the farm to act as a mild attractant. This type of bait was not considered to be a food-based lure due to the scent of the feces being continuously around the farm and surrounding area. We chose to use feces because a stronger lure could attract a wolf or coyote from great distances, and we did not want the animal to be attracted to the smell of the lure, but to the area itself. We placed scent stations around the inside and outside perimeter of the pastures as pairs on both the control and fladry farms and then monitored concurrently. We positioned pairs of scent stations directly across from one another, with the livestock fence and fladry line in the middle. One station was directly inside the livestock fencing, and the other station was positioned outside, 0.55 m from the livestock fence (i.e., directly outside the fladry line on treatment farms). We placed paired scent stations approximately every 200 m from each other around the perimeter of the farm.

We conducted the scent station surveys for 5 days each week during mid-May through mid-August for both field seasons, totaling 75 days of sampling. We checked stations daily to look for and recorded the presence of wolf and coyote tracks. We used track dimensions and shape characteristics to differentiate these species. We chose to determine the difference between species by both comparing the differences in track size and using a cut-off point of 9.0 cm in length and 7.0 cm in width (Halfpenny and Bruchac 2001). The presence of wolf or coyote track(s) in any of the scent stations at a farm constituted 1 visit, classified as inside or outside the pasture.

We used a Mann-Whitney U-test (1-tailed test) to compare wolf or coyote visitation inside the pasture and outside the pasture on fladry farms and control farms. Given our research design, we assumed farms were independent from each other across the 2 years of the study, and we treated farm-year as our experimental unit. For each farm-year, we averaged wolf and coyote visits inside and outside pastures during the monitoring period and conducted Mann-Whitney U-tests for fladry ($n = 7$) and control ($n = 7$) farms. We used a significance level of $\alpha = 0.05$.

Wolf and coyote depredations

We monitored depredations of livestock on fladry and control farms during the summer field seasons. The owners of the farms counted their animals to ensure that no livestock was missing and looked for dead livestock. If a depredation did occur, the livestock producer was asked to contact the MDNR and U.S. Department of Agriculture Animal and Plant Health Inspection Services Wildlife Division, hereafter WS. Investigators from WS determined the cause of livestock death.

Time requirement and cost of fladry

We calculated the process of installing fladry in person-hours for 1 individual. We broke down the process into 4 steps and quantified the installation time for each step, including (1) installation of rebar posts, (2) installation of insulators on the rebar posts, (3) installation of fladry on the insulators, and (4) monitoring the fladry. We calculated the amount of time for each step from the 2004 summer field season, which included a group of 8 individuals working to place a single fladry fence around the entire 4.8-km perimeter of an approximately 150-ha farm. Labor costs were calculated at a rate of $8 per hour. The 2004 field season was the first time anyone in the group had placed fladry on a farm. We chose to use the information from the 2004 field season because it would be a more accurate representation of the true time commitment for a livestock producer using fladry for the first time. Therefore, these values should be considered conservative. We purchased fladry from Carol's Custom Creations (Arco, Id.) in 400-m segments. We determined the cost of rebar posts and insulators throughout the study periods of 2004 and 2005. We used livestock market prices in Michigan (United Producer's Inc.) to estimate the number of depredations that farmers would need to experience to equal the costs of fladry. We estimated fall market weights of cattle ($\bar{x}$ = 284 kg) at an average price of $1.43 per kg. We estimated fall market weights of lambs ($\bar{x}$ = 57 kg) at an average price of $2.09 per kg.

Results

Predator visitation

We observed an average of 0.29 wolf visits inside pastures and 1.43 wolf visits outside pastures and an average of 0.43 coyote visits inside pastures and 0.71 visits outside pastures on fladry farms. We observed an average of 0.71 wolf visits inside pastures and 0.29 wolf visits outside pastures and an average of 0 coyote visits inside pastures and 0.29 visits outside pastures on control farms. We observed both of the wolf visits inside fladry-protected pastures when the fladry barrier was not properly installed or maintained. The first time this happened, calves had escaped the pasture and pulled the fladry fence down for approximately 200 m. Track evidence indicated that several wolves entered the pasture at this specific site. The second time it happened because a livestock producer failed to re-attach a 3-m-long fladry gate after he had been in the pasture. We found 1 set of wolf tracks entering this pasture at the gate. These 2 wolf trespasses occurred 21 and 26 days after fladry was established, respectively. We included the 2 wolf visits into pastures in our analysis, despite the compromised integrity of the fladry at those times.

Wolf visitations inside pastures compared to those outside pastures were less on fladry-protected farms (U = 45, n = 7, P = 0.004), whereas, we found no difference in wolf visitations both inside and outside pastures on control farms (U = 30, n = 7, P = 0.24). We found no difference in coyote visitations inside and outside pastures on treatment (U = 29.5, n = 7, P = 0.26) and control farms (U = 31.5, n = 7, P = 0.18). Coyotes first crossed the fladry an average of 47 days (SE = 4 days) after fladry establishment. We also received observations from the general public of 2 accounts, each on separate farms, of large canids investigating the fladry, walking parallel to it, and then returning in the direction they came from after they unsuccessfully attempted to cross the fladry.

Wolf and coyote depredation

During the 2004 field season, there were no wolf or coyote depredations on either fladry or control farms. During the 2005 field season, there were no wolf depredations on either fladry or control farms, but we did document 8 verified coyote depredations on 1 sheep farm with fladry.

Time requirement and cost of fladry

The approximate time for 1 individual to equip a farm perimeter with rebar posts, insulators, and the fladry line was 8.5 per hour per km, or $68 per km. One individual required 1.6 hour per km ($12.80) per week for monitoring. Assuming a 14-week growing season, monitoring costs would be estimated at $179 per km. The total cost for fladry was $588 per km per year, assuming that fladry has a 3-year life. Rebar posts were estimated to be useable for approximately 6 years at a cost of approximately $40 per km per year. Insulators were estimated to cost $40 per km per year. The total costs to establish and maintain fladry on a 150-ha farm would be $4,392 per year. Annual depredation losses would have to exceed 37 lambs or 11 calves to equal the approximate costs of using fladry on a 150-ha farm.

Discussion

Prior to this research, no controlled experimental assessment (i.e., with treatment and control farms) had been done on the use of fladry as a nonlethal management method for free-ranging wolves or coyotes. We found a difference in wolf visitation inside pastures on fladry-protected farms compared to control farms. Although there was some variation in fencing, all farms had electrified 3 to 5 strands of wire with a total height of 115 cm. The top wire was not electrified. Further, the bottom wire on all farms was not electrified and was 22 to 33 cm above ground level. As such, the livestock fencing was not designed to serve as predator-proof fencing and would not effectively prevent access by coyotes or wolves. Dorrance and Bourne (1980) reported that coyotes still penetrated a 7-strand electric fence, even though the bottom wire (15-cm above ground level) was electrified. Coyotes and wolves also could likely access all of our pastures by jumping the 115-cm fence. For example, Gates et al. (1978) found that conventional sheep fence (111 cm high) was not effective at preventing coyotes from entering pastures. Only coyote-proof fencing (150 to 168 cm high with 12 strands) reduced coyote access to pastures (Gates et al. 1978). Thus, before fladry was placed, we suggest that all of our farms had an equal likelihood of access and use by wolves and coyotes.

Fladry has been used to confine wild wolves overnight (Okarma and Jedrzejewski 1997). Musiani and Visalberghi (2001) used 2 groups of captive wolves and indicated that fladry effectively confined wolf movements to certain areas for short periods (e.g., 30 minutes) and could possibly reduce depredations on livestock by creating virtual barriers that wolves do not like to cross or that impair predation ability. Musiani et al. (2003) reported 15 of 18 experiments were successful at preventing captive wolves from accessing food for 28 hours. Musiani et al. (2003) also conducted bait station trials on free-ranging wolves around 2 sites (100 m²) where wolves previously fed on wild ungulates. Fladry barriers prevented access by wolves to the baited sites for the duration of the experiment (i.e., 60 days). Field trials on livestock operations in both Alberta, Canada, and Idaho suggested that fladry excluded wolves up to 60 days (Musiani et al. 2003). However, Shivik et al. (2003) found that fladry did not effectively protect bait sites from scavengers, including wolves, bears (*Ursus americanus*), and bald eagles (*Haliaeetus leucocephalus*). Fladry also has been used in wolf depredation management scenarios (Bangs et al. 2006). Our study suggests that fladry, if it is maintained, can exclude wolves from livestock pastures for up to 75 days.

The long-term usefulness of fladry as a nonlethal tool is unknown. Because fladry is a neophobic device, wolves may eventually become habituated to it (Musiani and Visalberghi 2001; Musiani et al. 2003). The amount of time it takes wolves to become habituated is likely linked to the frequency of their visits to fladry-protected pastures. In our study, human scent around livestock pastures could have acted as a slight deterrent to wolves. We traversed weekly through areas typically unused by livestock owners, and we attempted to minimize this bias by visiting farms for the same amount of time and performing similar tasks at each farm.

Okarma and Jedrzejewski (1997) suggested that fladry was specific to wolves. Our visitation data for coyotes suggested that this might be true because we found no long-term exclusion of coyotes from fladry-protected livestock pastures. Further, all coyote depredation occurred on 1 fladry-protected farm. However, we do not believe that this finding suggests that the presence of fladry increased coyote predation. We speculate that the gap between flags on standard fladry may be too great relative to the size of a coyote and did not prevent them from accessing pastures. Additionally, coyotes might have visited livestock operations more frequently than wolves did, thereby making them acclimated to the fladry (i.e., fladry no longer was novel). Mettler and Shivik (2007) found that captive coyotes exhibited a neophobic response to fladry, required >12 hours to become habituated, and dominant coyotes were less neophobic. Sacks et al. (1999) and Séquin et al. (2003) found that alpha (dominant) coyotes were more neophobic than subordinate coyotes, especially within their territories. Mettler and Shivik (2007) suggested that an intensive predator control program may select for neophobic individuals via the continued trapping and removal of bold individuals. Coyotes in our study were not intensively trapped; rather, they were shot opportunistically by farmers. We did not identify the social status of wolves or coyotes in our study; however, we suspect that dominant individuals may have been present and may bave been less neophobic toward fladry (Mettler and Shivik 2007). Conversely, wolves may have been more neophobic and coyotes less neophobic if the fladry farms were located inside or outside of their territories, respectively (Séquin et al. 2003).

Depredations can be costly for individual producers, especially when a significant number of depredations occurs in a single episode. The time it takes to equip a 150-ha farm with fladry would be approximately 40.8 man-hours, costing $326. Once rebar posts are set in the ground and insulators are attached, the maintenance is on an as-needed basis. In a wolf management situation, fladry could be a cost-effective mitigation tool for livestock depredations. However, wolves appear readily to survey the integrity of fladry and access pastures where gaps occur. As such, the time commitment needed to ensure the fladry line is intact may further reduce the application of this nonlethal tool. The lack of ability to predict when or where livestock depredations will occur is also an important factor in using fladry and other preventative methods. For example, during the 2 years of our study, no depredations occurred on the control farms. These farmers would have wasted money, time, and effort by erecting a fladry fence. Thus, it is important for farmers to gauge the risk of depredation with the cost and time commitments of using fladry on their farms.

Management implications

Fladry was effective in deterring wolves from using livestock areas. Fladry was not effective for deterring coyotes. We suggest that it is important to install fladry independent and outside of existing livestock fencing. Fladry may provide livestock owners and management agencies a temporarily effective, nonlethal management tool for reducing wolf-caused depredation of livestock; however, labor and equipment costs can be substantial. Additional research should focus on the relationship between the frequency of visitation to fladry-protected farms and the time it takes for wolves to become acclimated to it. Future research should also attempt to determine if modifications to standard fladry can effectively exclude coyotes from sites.

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Literature cited

Bangs, E., M. Jimenez, C. Niemeyer, J. Fontaine, M. Collinge, P. Krsichke, L. Handegard, J. Shivik, C. Sime, S. Nadeau, C. Mack, D. Smith, V. Asher, and S. Stone. 2006. Nonlethal and lethal tools to manage wolf/livestock conflict in the northwestern United States. Proceedings of the Vertebrate Pest Conference 22:7–16.

Berryman, J. H. 1972. The principles of predator control. Journal of Wildlife Management 6:395–400.

Breck S. W. 2004. Minimizing carnivore–livestock conflict: the importance and process of research in the search for coexistence. Pages 13–27 *in* N. Fascione, A. Delach, and M. Smith, editors. People and predators: from conflict to coexistence. Island Press. Washington, D.C., USA.

Dorrance, M. J., and J. Bourne. 1980. An evaluation of anti-coyote electric fencing. Journal of Range Management 33:385–387.

Fritts, S. H., W. J. Paul, L. D. Mech, and D. P. Scott. 1992. Trends and management of wolf–livestock conflicts in Minnesota. U.S. Fish and Wildlife Service Resource Publication 181. Washington, D.C., USA.

Fritts, S. H., R. O. Stephenson, R. D. Hayes, and L. Boitani. 2003. Wolves and humans. Pages 289–316 *in* L. D. Mech and L. Boitani, editors. Wolves: behavior, ecology, and conservation. University of Chicago Press, Chicago, Illinois, USA.

Gates, N. L., J. E. Rich, D. D. Godtel, and C. V. Hulet. 1978. Development and evaluation of anti-coyote electric fencing. Journal of Range Management 31:151–153.

Halfpenny, J. C., and J. Bruchac. 2001. Scat and tracks of the Northeast: a field guide to the signs of seventy wildlife species. Falcon. Guilford, Connecticut, USA.

Harper, E. K., W. J. Paul, and L. D. Mech. 2005. Causes of wolf depredation increase in Minnesota from 1979–1998. Wildlife Society Bulletin 33:888–896.

Mech, L. D. 1995. The challenge and opportunity of recovering wolf populations. Conservation Biology 9:270–278.

Mettler, A. E., and J. A. Shivik. 2007. Dominance and neophobia in coyote (*Canis latrans*) breeding pairs. Applied Animal Behaviour Science 102:85–94.

Michigan Department of Agriculture. 2003. Michigan Agricultural Statistics 2003–2004. Lansing, Michigan, USA.

Musiani, M., C. Mamo, L. Boitani, C. Callaghan, C. C. Gates, L. Mattei, E. Visalberghi, S. Breck, and G. Volpi. 2003. Wolf depredation trends and the use of fladry barriers to protect livestock in western North America. Conservation Biology 17:1538–1552.

Musiani, M., T. Muhly, C. C. Gates, C. Callaghan, M. E. Smith, and E. Tosoni. 2005. Seasonality and reoccurrence of depredation and wolf control in western North America. Wildlife Society Bulletin 33:876–887.

Musiani, M., and E. Visalberghi. 2001. Effectiveness of fladry on wolves in captivity. Wildlife Society Bulletin 29:91–98.

Okarma, H., and W. Jedrezejewski. 1997. Livetrapping wolves with nets. Wildlife Society Bulletin 25:78–82.

Reiter, D. K., M. W. Brunson, and R. H. Schmidt. 1999. Public attitudes toward wildlife damage management and policy. Wildlife Society Bulletin 27:746–758.

Roughton, R. D., and M. W. Sweeney. 1982. Refinements in scent-station methodology for assessing trends in carnivore populations. Journal of Wildlife Management 46:217–229.

Sacks, B. N., M. M. Jaeger, J. C. C. Neale, and D. R. McCullough. 1999. Territoriality and breeding status of coyotes relative to sheep predation. Journal of Wildlife Management 63:593–605.

Séquin, E. S., M. M. Jaeger, P. F. Brussard, and R. H. Barrett. 2003. Wariness of coyotes to camera traps relative to social status and territory boundaries. Canadian Journal of Zoology 81:2015–2025.

Shivik, J. A., A. Treves, and P. Callahan. 2003. Nonlethal techniques for managing predation: primary and secondary repellents. Conservation Biology 17:1531–1537.

Wydeven, A. P., R. N. Schultz, and R. P. Thiel. 1995. Monitoring of a recovering gray wolf population in Wisconsin, 1979–1991. Pages 147–156 *in* L. N. Carbyn, S. H. Fritts, and D. R. Seip, editors. Ecology and conservation of wolves in a changing world. Canadian Circumpolar Institute, occasional publication 35. University of Edmonton, Edmonton, Alberta, Canada.

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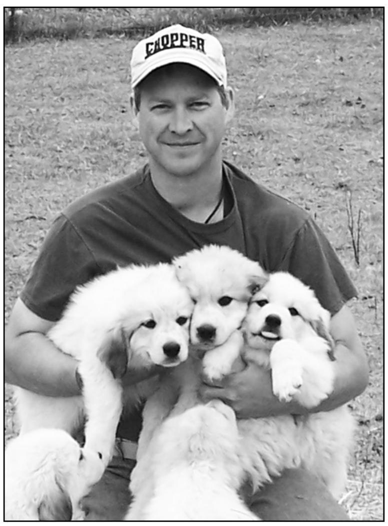

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