CHAPTER 9

Dogs as mediators of conservation conflicts

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9.1 Introduction

There are many positive aspects to human–wildlife interactions, such as wildlife viewing and hunting. However, human safety and economic well-being can be adversely impacted by wildlife, for example, by aircraft and vehicle collisions with wildlife, depredation of livestock by predators, and wildlife-borne pathogens that can infect humans and livestock. These and other conflicts are of global importance and are increasing in magnitude. When such conflicts occur, wildlife, humans, and other resources—primarily livestock—can suffer. Historically, humans have been quick to resolve conflicts with wildlife, especially wild carnivores, using lethal means. Advancing technologies associated with firearms and poisons, coupled with establishment of bounties, often resulted in highly efficient carnivore removal efforts. Thus, in many developed regions of the world human populations increased while populations of conflict-associated species, such as carnivores, decreased, often to the point of extirpation. Increasing human populations also put severe pressure on populations of other wildlife species—directly via harvest for food and other resources, and indirectly via competition from land development and introduced domestic livestock on habitat formerly used by wildlife alone. Today, however, many societies have come to value wildlife more highly, necessitating development of management strategies that preserve human health and allow human commercial interests to succeed in the presence of broad and thriving communities of wildlife species.

As a result of recently increased public interest in wildlife, and large carnivores in particular, dwindling predator populations have gained protection and extirpated populations have been reestablished. For example, gray wolf (*Canis lupus*) populations in North America and Europe have successfully recovered following generations of persecution by humans and this has resulted in an increase in livestock depredations (Mech et al., 1995). Conflicts revolving around shared pathogens of wildlife and livestock are also increasing with particular concern over wildlife diseases, such as bovine tuberculosis and brucellosis that have moved from livestock into wild ungulates, which may in turn serve as reservoirs of diseases and continually transmit infection back to livestock (Frölich et al., 2006; Schmitt et al., 2006; Walter et al., 2012). These challenges as well as others have the potential to be addressed through the strategic development and deployment of livestock protection dogs (LPDs). Worldwide, the recent recovery of large carnivore populations and their recolonization of human-dominated landscapes has prompted resurgence in the use of LPDs. This resurgence began in North America and followed in particular regions of Europe where large carnivores had been extirpated. During the 1970s, LPD use in North America was prompted at least partly by the banning of predator toxicants (Linhart et al., 1979). Use of dogs has

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also expanded for a variety of other conservation-specific practices to address increasing wildlife–human conflict challenges.

This chapter is a review of past and present use of dogs for mediating wildlife–human conflict. An underlying assumption herein is that current and future use of dogs in wildlife management benefits wildlife conservation if social pressure to implement lethal control of wildlife is reduced or eliminated. Historically, such pressure most frequently resulted from depredation to crops and livestock. This chapter also highlights other past and present uses of dogs and future areas of research that are needed to more effectively and extensively use dogs to address conservation conflicts. There are significant unexplored avenues that deserve attention in terms of the use of dogs for resolving conservation conflicts. Humans are ingenious and dogs are malleable; as such, we are still determining how broadly and specifically dogs can be employed to play major roles in resolving conflicts between humans and wildlife.

9.2 History of use of dogs in conservation and management

Livestock protection dogs, as pastoral protectors of livestock, have long been used in the context of wildlife conservation and management. Protecting livestock is one of the oldest anthropogenic functions of dogs (Coppinger and Coppinger, 2001; Landry and Valensi, 2011). The use of dogs in agriculture appears to have originated concurrently with the domestication of sheep and goats in western Asia as early as 9,000 to 10,000 ybp (Gehring et al., 2010a; Landry, 1999). Archeological sites dating to 5,585 ybp provide physical evidence of dogs and sheep together (Olsen, 1985). Livestock protection dogs were historically developed to protect small stock from predators and their use was common around the world (Coppinger and Coppinger, 2001; de la Cruz, 1995) though their current use worldwide is less common (Landry, 2010).

The use of LPDs has continued uninterrupted for hundreds of years in areas where predators have persisted over millennia, such as the Iberian Peninsula, Italy, the Balkans, the Carpathian Mountains, Turkey, the Caucasian Mountains, Russia, Central Asia, the Himalaya Mountains, and the Atlas Mountains of North Africa (Landry, 1999; Rigg, 2001). Conversely, regional predator extirpations resulted in many societies ceasing to employ LPDs as they were no longer essential. As a result, many local LPDs were maintained through the creation of breeds (e.g., Great Pyrenees) and persist only as pets. Thus the knowledge of how to raise and train them to protect livestock has not been passed on to the current generation of livestock producers in many regions of the world.

The versatility and adaptability of LPDs has contributed to the resurgence in their use where wolves are recovering (e.g., the Alps, the Jura Mountains, the Iberian Peninsula, eastern Germany, Finland) or have been reintroduced (Yellowstone) and where bear (*Ursus* spp.) populations have re-established (e.g., the Pyrenean Mountains). The use of LPDs in North America began more recently as there were no livestock in the New World until European introductions. Among the first employments in North America was the involvement of mixed-breed dogs that were raised and kept with sheep by Navajo people who learned and adopted the processes from Spanish missionaries (Black and Green, 1985; Coppinger and Coppinger, 2001).

Protecting livestock through the implementation of LPDs is also relatively new in Nordic countries, and their recent use and results are being documented across Finland (Otstavel et al., 2009), Norway (Hansen and Smith, 1999; Hansen, 2005), and Sweden (Levin, 2005). Similar exploration into the use of LPDs is occurring in response to growing predator populations and increases in livestock predation, combined with the demand for non-lethal solutions in Australia (van Bommel and Johnson, 2012), Poland (Nowak and Myslajek, 2004; Śmietana, 2005), Slovakia (Rigg, 2005), Switzerland (Landry et al., 2005), and Portugal (Ribeiro and Petrucci-Fonseca, 2005). Predator movements into new areas of Spain, such as Avila, are being monitored by researchers and they are also working closely with livestock producers using LPDs to evaluate outcomes.

The resurgence of LPD use has been facilitated by the creation of governmental and private organizations (Table 9.1). These organizations, as well as

Table 9.1 Organizations from around the world that are promoting and evaluating the use of livestock protection dogs to alleviate damage to resources by wildlife.

Organization	Country	Website
Cheetah Conservation Fund	Namibia	<http://www.cheetah.org/>
Invasive Animals Cooperative Research Centre	Australia	<http://www.invasiveanimals.com>
United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services	USA	<http://www.aphis.usda.gov/wildlife_damage/nwrc/>
Livestock Guarding Dog Project at Hampshire College	USA	
Wind River Bear Institute	USA	<http://www.beardogs.org/programs/wrkbd.html>
Association for Nature WOLF	Poland	<http://www.polishwolf.org.pl>
Association Chiens de protection des troupeaux Suisse	Switzerland	<http://www.cpt-ch.ch/fr/association-cpt-ch/>
Pôle Grands Prédateurs (Jura Mountains)	France	<http://www.polegrandspredateurs.org>
La Pastorale Pyrénéenne (Pyrenees)	France	<http://www.pastoralepyreneenne.fr>
Grupo Lobo	Portugal	<http://lobo.fc.ul.pt/>
The Slovak Wildlife Society	Slovakia	<http://www.slovakwildlife.org>
BBPS Semperviva	Bulgaria	<http://www.save-foundation.net/semperviva/dog.htm>
Arcturos	Greece	<http://www.arcturos.gr>

others from around the world, are conducting research and promoting the use of LPDs to protect livestock and ensure sustainable agricultural practices continue while also easing conflict associated with predators. For example, multiple programs in the USA have conducted research into the use of LPDs and have facilitated deployment of LPDs to alleviate predation issues (Coppinger and Coppinger, 1978; Green and Woodruff, 1999; Lorenz, 1985; Sims and Dawydiak, 1990). Further, novel uses for LPDs are being explored and evaluated worldwide and are discussed in this chapter.

9.3 Reducing predation in agricultural systems

Efficacious tools that agricultural producers can adapt into their normal husbandry practices are needed to reduce economic losses associated with damage due to wildlife. Lethal control, as a management tool, can be effective (Conover, 2002). However, livestock depredations commonly recur annually after individual predators are removed lethally following depredation (Fritts et al., 1992; Gehring and Potter, 2005) and lethal control does not appear to reduce depredations on a regional scale (Musiani et al., 2005). Alternatively, non-lethal management tools are regarded by society as more humane than lethal means and deserve evaluation to determine efficacy (Reiter et al., 1999; Reynolds and Tapper, 1996). Numerous non-lethal management options exist; however, few provide reliable or long-term protection (Shivik, 2004). Livestock protection dogs may be the best preventive method for addressing predation on livestock because they act as a disruptive-stimulus tool (Gehring et al., 2010a) that remains with the mobile flock, as opposed to other stationary tools (e.g., audio and visual repellents). The use of LPDs is, however, context dependent. For instance, LPDs are generally regarded as effective in reducing livestock depredation caused by coyotes (*C. latrans*; Andelt and Hopper, 2000; Andelt, 1992; Green et al., 1984; Smith et al., 2000), but their effectiveness against wolves is sometimes more tenuous (Gehring et al., 2010a).

Overall, effectiveness of LPDs against predators has been the research objective of a few studies, and more recently their efficacy for repelling wild ungulates has begun to be assessed. Among predator-focused studies, most have relied on producer-based

reporting and surveys rather than field experimentation (Gehring et al., 2010a). A study evaluating LPD efficacy with wolves suggested that LPDs displayed protective behavior against free-ranging wolves and defended experimenter-created bait stations (Coppinger et al., 1987, 1988). Linhart et al. (1979) demonstrated that LPDs reduced sheep depredation by coyotes on three ranches over a 20-day period, and coyotes appeared to be displaced from ranches for an additional 20 days after LPDs were removed. Gehring et al. (2010b) documented almost no use of LPD-guarded livestock pastures by wolves and coyotes, with visitation indices declining to zero. This suggested that LPDs can be effective for reducing the risk of livestock depredations by these predators on pastures associated with small- and medium-sized cattle farms.

A significant reduction in predation often results following the introduction of LPDs into a flock or herd. For example, reductions in wolf-caused mortality of up to 75% have been documented in protected sheep herds in Portugal (Ribeiro and Petrucci-Fonseca, 2005). Based on a recent survey of livestock producers that employ LPDs, 90% of survey respondents reported reductions in predation with an average decrease of 64% in predation rates observed associated with the use of LPDs in western USA (M. Marlow, USDA APHIS WS, pers. comm.). The presence of LPDs with a flock does not always prevent wolves from attacking, but can reduce the number of livestock killed per attack and can inhibit surplus killing behavior (Rigg, 2005), especially when several LPDs are present within the flock and working together to protect it. When using two or more LPDs within a flock, dogs appear more confident and efficient than a solo dog in protecting and confronting a threat. The use of LPDs has also proven effective against attacks by other predators including lynx (*Lynx lynx*), wolverines (*Gulo gulo*), bears, black-backed jackals (*C. mesomelas*), golden jackals (*C. aureus*), leopards (*Panthera pardus*), cheetahs (*Acinonyx jubatus*), lions (*Panthera leo*), Chacma baboons (*Papio ursinus*), and even free-ranging dogs (Hansen, 2005; Landry and Raydelet, 2010; Marker et al., 2005; Rigg, 2005).

In general, LPD pups should be raised with the species of livestock they are to protect. Though not ideal, it is possible to raise pups with sheep and then to introduce them into a flock of goats or cattle, even as adults (Landry, 2011; Marker et al., 2005). Oftentimes, integrating a pup into a herd can be facilitated by introducing it into a herd that already contains at least one established adult LPD. The number of LPDs to employ should be based on likely adversaries and characteristics of the surrounding environment (Landry and Raydelet, 2010). Individual dogs may demonstrate particular behaviors, thus selecting individuals that complement one another based on their strengths can be advantageous. For specific information on selecting, raising, and implementing LPDs for protecting livestock see Lorenz and Coppinger (1986); Sims and Dawydiak (1990), and Dohner (2007).

9.4 Livestock protection dog breed selection

Dogs used for protecting resources fall into distinctive groups that are typically identified by organizations such as the American Kennel Club and the Fédération Cynologique Internationale; oftentimes including working dogs and herding dogs. Working dogs include, but are not limited to, LPD breeds as well as breeds thought of as 'sled dogs.' There are over 40 breeds of LPDs throughout the world today, the most common being Akbash, Anatolian Shepherd, Great Pyrenees, Komondor, Maremma, and Kangal. Beyond purebred breeds, there are also unlimited and unrecognized mixed-breeds and mongrels, sometimes called 'landrace' dogs, which are tasked with protecting livestock, often with positive results. Other groupings that may include breeds mentioned herein include utility or pastoral groups. Commonalities of these groups are the inclusion of large, strong, and intelligent dogs that are engaged in physically active work. Working dog breeds are typically motivated to respond to stimuli (e.g., approaching wolves) by protective instincts. Although LPDs are more adept at protecting a flock, they demonstrate proficiency in protecting property as well, though to a lesser degree. Conversely, herding-dog breeds are instinctually motivated to move (i.e., herd)

livestock by approaching and pushing them in a variety of styles.

Breeds commonly used within a region are frequently those that were developed there. For example, in western Turkey, LPDs commonly used are of the Akbash breed while in eastern Turkey one finds more Kangals. Anatolian Shepherds are also from Turkey and may be indistinguishable from Kangals, though they are recognized as a separate breed. Both have been exported across the globe and are gaining popularity in places such as Africa and the USA. Anatolian Shepherds and Kangals were selected for use in Africa, as they are independent in their thinking, can move long distances with their herds each day, and can be left unattended.

There are apparent physical differences between breeds. However, differences among individuals within a breed are often more notable than those between breeds. Rearing and bonding processes used with pups apparently have a greater effect on the development of an effective dog than the breed itself. These differences emphasize the importance of selecting individuals from proven breeders. General differences among breeds described by varying combinations of attributes, including attentiveness, trustworthiness, and aggressiveness, further facilitate breed selection based upon needs in a particular situation. Additionally, breed-specific physical attributes, such as dominance display, agility, and strength are important considerations as well. For example, Karakachan dogs of Bulgaria are known for their aggression and determination in pursuing predators, which may be necessary in situations where the possibility of predation by large and persistent predators is high.

Herding breeds such as Border Collies, Australian Shepherds, and heelers were evaluated for excluding ungulates such as deer from crops and did not perform well (VerCauteren et al., 2005). Characterization of herding breed styles is frequently attempted but is discouraged due to the high level of variation between individuals within breeds. Characteristics such as strong-eyed dogs versus loose-eyed dogs oftentimes can be the result of upbringing or even the basics of a particular task at hand. Border Collies have been a popular breed for wildlife-hazing jobs and were used successfully to haze elk (*Cervus canadensis*) in Canada and white-tailed deer (*Odocoileus virginianus*) in Missouri, USA, (Beringer et al., 1994; Kloppers et al., 2005). Additionally, Border Collies diminished hazards through hazing birds from airports and communities (Ball, 2000; Holevinski et al., 2007, respectively).

Mixed or crossbreeds have also been utilized and have excelled in protecting stationary resources such as orchards and organic farms in the USA, suggesting that choosing a dog with the ability to withstand weather extremes is possibly more important than selecting a specific breed for some jobs (Curtis and Rieckenberg, 2005; VerCauteren et al., 2005). The use of mixed breeds in livestock protection is relatively common, sometimes with the intention of benefiting from desired characteristics possessed by contributing breeds. However, it has been claimed that crossing breeds can actually disrupt these desired heritable traits, potentially creating unintended results (Dohner, 2007). The dogs used as LPDs to protect sheep and goats within the Navajo Reservation in the USA, and in Turkey and Uruguay, may be of no single identifiable breed but the result of crossing several breeds (Black and Green, 1985).

Less common breeds, such as the Karelian Bear Dog breed that was developed for hunting aggressive game, have become valuable in specialized roles. Karelian Bear Dogs have been used and proven effective in hazing bears, thus mitigating bear–human conflict in several locales in North America (see Section 9.5.3). This is one particular role in which very specific breed characteristics are important and selection of the 'wrong' breed may have dire consequences. Breed selection based on traits commonly exhibited by that breed is a good starting point in the selection process. Refinement of a particular bloodline by breeders and trainers plays an equally important role in development that must also be taken into consideration. Beyond these considerations in selecting a dog for a particular purpose, and possibly the most important factor, is the training provided to the individual dog from an early age which will essentially determine the potential for success of that individual in its desired role.

9.5 Non-traditional uses in other conservation conflicts

The demonstrated adaptability of dogs has prompted the use of various breeds of dogs in research and management contexts for reducing a variety of conservation conflicts. Researchers have demonstrated the abilities of dogs to protect various resources of value to humans from wildlife species other than predators, primarily white-tailed deer and Canada geese (*Branta canadensis*). Dogs have been used against deer to protect cattle (from the threat of bovine tuberculosis; VerCauteren et al., 2008; Box 9.1), forest plantations (Beringer et al., 1994), orchards (Curtis and Rieckenberg, 2005), and vegetable farms (VerCauteren et al., 2005). They have been shown to be effective in deterring geese from golf courses (Woodruff and Green, 1995) and landscapes around office complexes (Castelli and Sleggs, 2000). Further, use of LPDs in protecting non-traditional animals such as penguins in Australia is being explored (Lustig, 2011). Accounts of chickens, geese, and even pigs benefiting from farmyard LPDs are commonly heard.

9.5.1 LPDs for reducing transmission of wildlife-borne diseases

Along with endemic infectious disease-causing pathogens, a growing number of emerging diseases continue to manifest and become established in wildlife. Wildlife serves as hosts, reservoirs, and vectors, transmiting pathogens to livestock and humans. The disease threats to livestock posed by wildlife are analogous to predation and in many cases infectious agents have larger and further reaching implications. Wolves, for example, may greatly impact the profit of local livestock producers (Gehring et al., 2006), while bovine tuberculosis (TB) established in free-ranging deer that repeatedly transmit it to cattle could lead to regional, state, national, and international movement and trade restrictions that impact the economic viability of not only individual producers but entire industries. Brucellosis, foot and mouth disease, *Escherichia coli*, and keratoconjunctivitis are other wildlife-mediated parasites and diseases of livestock that LPDs could help curtail. Pathogens, of course, may also be transmited from livestock to wildlife

Box 9.1 TB dogs: novel disease management strategy in Michigan, USA

Disease transmission between wildlife and livestock is a worldwide issue. Culling potential reservoirs is a common strategy for mitigating potential spread. However, there is a need for additional tools to address disease issues. VerCauteren et al. (2008) theorized that LPDs raised and bonded with cattle could be employed to reduce the risk of bovine tuberculosis (*Myobacterium bovis*; TB) transmission between white-tailed deer and cattle by minimizing contact between the two species as well by reducing the use of cattle feed by deer (Figure 9.1). Due to the numerous modes of

Figure 9.1 In Michigan, USA, research is evaluating the use of livestock protection dogs to minimize potential for transmission of bovine tuberculosis from white-tailed deer (*Odocoileus virginianus*) to cattle. Photo credit: Kurt VerCauteren.

continued

Box 9.1 *Continued*

transmiting causative agents of disease (i.e., direct via contact with infectious hosts, indirect via contaminated fomites, etc.), mitigation tools must be adaptable and versatile. In this particular situation, there was both risk via potential physical contact and close proximity, as well as a more likely potential for transmission through contaminated feed in concentrated form (i.e., hay bales) and dispersed feed (i.e., available forage in pastures).

Researchers evaluated four Great Pyrenees LPDs and found that they were highly effective in preventing deer from using cattle feed (likely the greatest risk factor of TB transmission on farms). Dogs also prevented deer from approaching cattle in core areas of pastures and were very effective throughout pastures. Direct observations documented 79 events in which deer approached to within 5 m of cattle in pastures not protected by LPDs compared to only 3 events in LPD-protected pastures. Further, researchers observed 113 events during which deer consumed concentrated feed in unprotected pastures and no events in LPD-protected pastures.

In this situation, LPD pups were bonded with calves beginning at 8 weeks of age and demonstrated their versatility and potential in the novel role of protecting cattle from non-traditional threats. Researchers concluded that LPDs may be a practical tool to minimize potential for livestock to contract TB from infected deer in small-scale cattle operations. Operationally, producers that rotate pastures frequently have developed strategies to make it easy to provide resources for LPDs that are inaccessible to livestock (Figure 9.2).

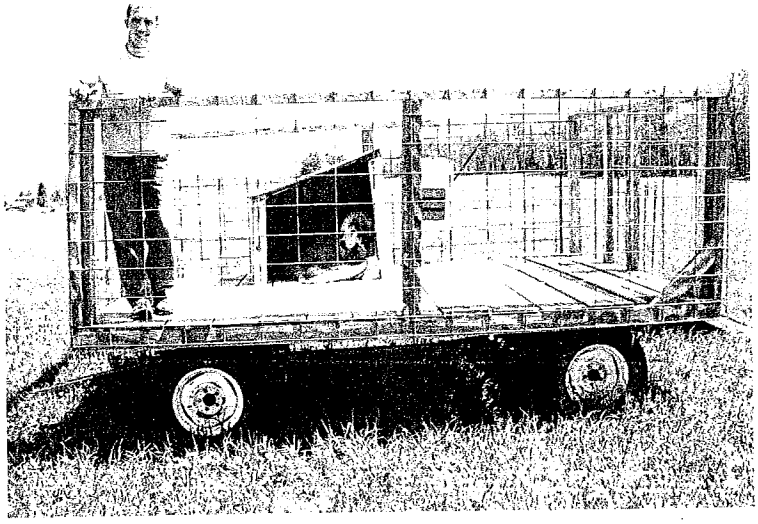

Figure 9.2 Mobile livestock protection dog station used to minimize time away from livestock by providing a cattle-free loafing and feeding area for a working dog. Photo credit: National Wildlife Research Center.

and thus threaten conservation efforts (Ward et al., 2009). Die-offs of wild bighorn sheep (*Ovis canadensis*), for example, have been caused by pneumonia that they may have contracted through contact with domestic sheep (e.g., Clifford et al., 2009; Schommer and Woolever, 2008). The presence of LPDs, though, may serve to deter wildlife from coming in contact with livestock and thus reduce the risk of disease transmission to wildlife.

Wildlife carrying diseases that threaten livestock are often not species we traditionally consider employing LPDs to manage. Furthermore

the motivation of these species is not uniform. Wild ungulates can be attracted to areas where livestock are present due to the availability of food resources, which can be natural vegetation, standing agricultural forage, stored agricultural feedstuffs, and mineral supplements such as salt. Wild ungulates may also be attracted to livestock with the intent of procreation. Bighorn sheeprams, for example, may be attracted to domestic ewes in heat (Singer et al., 2001) as feral boar swine (*Sus scrofa*) are to domestic sows (Wyckoff et al., 2012).

Though regulated recreational hunting is the primary means of managing populations of wild ungulates, non-lethal means to aid in reducing disease threats from wildlife are needed and an integrated approach that employs a combination of multiple strategies will enhance the likelihood of success. Traditional non-lethal strategies for deterring wild ungulates from livestock and crops include various applications of fencing and frightening devices (see VerCauteren et al., 2006 and Gilsdorf et al., 2002 for reviews). Most fencing strategies could be considered physical deterrents while most frightening devices function as psychological deterrents (VerCauteren et al., 2006). Dogs have the potential to function first as psychological deterrents that can turn into physical deterrents when called for by especially persistent individuals or groups of wildlife. Dogs belong in a category of deterrent we define as 'biological control.' Non-lethal biological control strategies for protecting resources from wildlife are generally considered more 'green' and acceptable to various publics than alternative methods.

Livestock protection dogs offer many advantages over traditional physical and psychological strategies. Unlike fences or frightening devices, LPDs are mobile, moving with the herds or flocks they are protecting on open range or within fenced pastures. They are dynamic, adjusting real-time to varying settings, situations, and threats. Livestock protection dogs also provide 24-hour protection 7 days per week, as they are with livestock and vigilant at all times, poised and ready to position themselves to repel intruding wildlife. The presence of LPDs alone is often psychological deterrent enough to prevent wild ungulates from approaching areas, and thus livestock, where LPDs are present, since they represent and purvey aggression and predation risk. We have observed, and have numerous anecdotes from livestock producers who employ LPDs, that wild ungulates quickly learn to completely avoid areas inhabited by LPDs (e.g., Gehring et al., 2010b; VerCauteren et al., 2008). Once the routine of local wildlife using an area is broken, they and subsequent generations are less apt to attempt to enter the area, thus making the job of the LPD easier.

Although LPD breeds have been developed and employed by humans for centuries, their use to deter wild ungulates is in its infancy. We predict that their potential efficacy and ability to deter wildlife without requiring lethal actions will lead to their widespread adaptation and employment in a variety of situations. Livestock protection dogs may either be motivated to pursue wildlife in a predatory manner or chase them off as a protective response. Regardless, the result of excluding the animal being targeted is still the same. Hansen and Smith (1999) reported that LPDs chased and repelled moose (*Alces alces*) and roe deer (*Capreolus capreolus*) in Norway. Similarly, LPDs repeatedly proved effective in deterring white-tailed deer (Beringer et al., 1994; Coppinger et al., 1988; Curtis and Rickenburg, 2005). VerCauteren et al., (2008) demonstrated that LPDs reduced transmission potential of bovine tuberculosis from free-ranging deer to cattle in a controlled experimental setting (see Box 9.1). Livestock protection dogs prevented deer from coming in direct contact with cattle, from coming in contact with and potentially contaminating hay and grain meant for cattle, and greatly reduced their use of pastures in general. Lending credence to the concept, Gingold et al. (2009) reported that mountain gazelles (*Gazella gazelle*) in large enclosures that contained cattle herds with LPDs avoided cattle and were more vigilant and active than gazelles in enclosures that contained cattle herds without LPDs. In the Alps, LPDs are also sometimes used to prevent red deer (*Cervus elaphus*) from grazing new spring grass in pastures or destroying sheep enclosures.

As LPDs are used more extensively for the purpose of reducing likelihood of disease transmission between wildlife and livestock, potential exists for development of new lines or 'breeds'

of LPDs. Dog breeders and members of livestock industries employing dogs for keeping wild ungulates from contacting livestock or feed meant for livestock will undoubtedly pair their best performing dogs, over time developing genetic lines excelling at and specifically suited to this purpose. We have already observed this occurring in the Great Lakes region of the USA, where Great Pyrenees have been employed for about 10 years to reduce contact between deer potentially infected with TB and cattle. The LPDs in this area are being called 'TB Dogs.'

Other potential applications include employing LPDs in north-western USA, where *Brucella* is established in free-ranging elk and bison (*Bison bison*) and these species have the potential to transmit it to cattle. In this setting, cattle are often on open range or in very large pastures. The presence of LPDs with cattle has the potential to keep elk and bison from using areas occupied by cattle, thus reducing the risk of disease transmission while allowing them access to graze in other areas. Similarly, in the Alps, LPDs may also be used to prevent contact between domestic sheep and chamois (*Rupicapra rupicapra*), ibex (*Capra ibex*), or red deer, thus reducing potential for transmission of keratoconjunctivitis.

Additionally, LPDs could benefit conservation by decreasing disease transmission risk in the other direction, from livestock to wildlife. Domestic sheep, as mentioned above, may pose health risks to wild bighorn sheep in western USA or chamois and ibex in the Alps, through transmission of viral and bacterial diseases. Anecdotal evidence suggests LPDs can function to deter bighorn sheep from approaching and coming in contact with domestic sheep (C. Urbigkit, pers. comm.) and researchers are initiating efforts to rigorously evaluate their efficacy.

Although disease transmission by wild ungulates has been the focus to this point; dogs could also serve to reduce disease transmission potential mediated by other species of wildlife. Raccoons (*Procyon lotor*), Virginia opossums (*Didelphis virginiana*), and Eurasian badgers (*Meles meles*), for example, may play a role in TB persistence (Atwood et al., 2009; Böhm et al., 2009; Gallagher and Clifton-Hadley, 2000) and dogs may serve both as non-lethal deterrents and lethal measures to keep them from coming in direct contact with livestock or contaminating feed destined for consumption by livestock.

9.5.2 Border Collies for reducing avian conflicts

In some cases, conflict between humans and large bird species is a major wildlife management concern. The presence of large populations of gull species near airports could lead to an increase in aircraft–bird strikes. Additionally, there are aesthetic and human health concerns with the congregation of large populations of bird species at localized sites. For example, the ring-billed gull (*Larus delawarensis*) population in the Great Lakes region of the USA has shown a dramatic, exponential increase in numbers, estimated at 10% per year since the early 1970s (Solman, 1994). After being nearly extirpated by the early 1900s, this population rebounded to 27,000 nesting pairs in Lake Michigan and Lake Huron by 1960 and by the mid 1980s had reached over 700,000 nesting pairs (Greenlaw and Sheehan, 2003). Conflict arises with ring-billed gulls at public beaches due to complaints that large numbers of gulls are not aesthetically pleasing. Further, gull feces at beaches may be an important source of *E. coli* and other pathogens that could jeopardize human health and safety (Converse et al., 2012).

Since 2008, Border Collies have been used for displacing gulls in some areas near the Great Lakes of the USA and Canada (Hartman et al. 2009; Hiller, 2009; Toronto Beaches Plan, 2009). Though not yet optimized or rigorously evaluated, the concept shows promise for lessening conflict associated with beach recreation and public safety concerns. Koski and Kinzelman (2010) indicated that Border Collies appeared to be effective at displacing gulls from beaches but the use of dogs was costly and required trained dog handlers to constantly supervise dogs. Converse et al. (2012) found that average daily gull counts were reduced from 665 to 17 gulls when Border Collies were deployed on one study beach. They also found that *Enterococcus* spp. and *E. coli* densities were reduced when gulls were excluded by dogs. Although the Converse et al. (2012) study included only 1 beach site where dogs were used for only 16 days to exclude gulls, it does highlight dogs as a possibly important management tool

to reduce human–gull conflict at public beaches. E. Alm and T. Gehring (unpublished data) currently are conducting more rigorous evaluations with experimental design evaluating the efficacy of Border Collies on public beaches to reduce gull use and microbial contamination and have thus far demonstrated reduced gull use and lower *E. coli* densities at Border Collie-protected beaches.

Woodruff and Green (1995) reported anecdotal accounts of the successful use of Border Collies for dispersing Canada geese from golf courses in New York, Oregon, and Idaho, USA, and from alfalfa fields in Oregon, USA, when alternative methods were ineffective or impractical. Border Collies, rather than traditional LPDs, are often used for dispersing bird species due to their innate pursuit behavior of groups of targeted animals. Castelli and Sleggs (2000) conducted an *a posteriori* examination of the efficacy of Border Collies for reducing goose conflicts on a corporate office complex in New Jersey, USA, that included manicured lawns and a pond. Interviews with property managers indicated that goose feces, general annoyance, and helicopter safety were the primary conflicts with geese. Dogs were contained by an invisible electric fencing system and were allowed to chase geese 24 hrs per day every day, with minor exceptions for special events. The original two Border Collies purchased were not from working stock, exhibited little herding instinct, and were not effective at hazing geese. Subsequently, another pair of Border Collies (from working stock) replaced the original pair. Thereafter, property managers observed an abrupt decline in on-site goose numbers and within three years geese were rarely observed on the property. Property owners believed this success justified the costs of the program. A caveat is that data from aerial and ground counts appear somewhat contradictory to owners' observations and authors' results and discussion. Aerial counts were in sharp decline for several years before dogs were introduced and ground counts the year prior to dog introduction had already dropped to an extremely low level, additionally both aerial and ground counts remained near zero after dogs were implemented. Although strong evidence of efficacy in the use of Border Collies for reducing conflict with geese was lacking in the Castelli and Sleggs (2000) review, it did highlight the possible future application of dogs for addressing this problem and the need for more rigorous study.

Holevinski et al. (2007) found that Border Collies deployed by handlers during daylight hours were successful at displacing geese (i.e., >90% of geese present displaced) during 94% of hazing events (n = 113) at three locations (hazing sites) in New York, USA. In this setting the geese had access to aquatic habitats that dogs couldn't efficiently access. Border Collies were present on individual hazing sites only a small proportion of the time, however, and geese readily returned to areas when dogs were absent. The use of Border Collies coincident with small, remote-controlled boats increased the success rate of displacing geese during 97% of hazing events (n = 37). Swift (2000) reported >67% reduction in numbers of geese encountered after four weeks of patrolling with Border Collies several times per day at each of two locations in another region of New York. Researchers recorded eventual reductions of 80–100% at established molting and feeding areas as long as regular patrols were maintained. Preusser et al. (2008) evaluated Border Collies, remote-controlled boats, and Border Collies in conjunction with remote-controlled boats; they found the dog–boat combination to be most effective.

Results of these studies suggest that frequent and persistent hazing by Border Collies can displace geese from particular locations. Hazing alone will not reduce goose populations, so problems across larger landscapes may not be solved as birds may simply shift their use to adjacent areas. Additional management actions such as egg addling and goose roundup and removals may be required to reduce area-wide goose numbers (Preusser et al., 2008; Swift, 2000). Preusser et al. (2008) suggested that such integrated approaches could reduce human–goose conflicts across large landscapes but extensive coordination of local projects, inclusion of public involvement processes, and intensive long-term commitment of resources would be required.

Airports are a particular area of emphasis for use of Border Collies for hazing geese and other birds that may pose risk of bird–aircraft collision. Civil and military airports have implemented handler–dog teams to augment existing bird-strike

management operations. Although reports of initial results at some airports suggest promise for reducing avian abundance and numbers of bird–aircraft collisions (e.g., Carter, 2000; O'Rick, 2000; Patterson, 2000; Froneman and van Rooyen, 2003), to date there have been no rigorous, long-term evaluations of the efficacy of using dogs as bird deterrents at airports.

9.5.3 Karelian Bear Dogs for reducing conflicts with bears

The Karelian Bear Dog breed was developed from hunting stock existing in the Karelian region of north-eastern Europe (astride the current Finnish–Russian border) during the 1930s and 1940s. These were versatile dogs used for hunting predators, cervids, and smaller mammalian and avian species. In North American wildlife conservation applications, Karelian Bear Dogs are primarily used for managing (and protecting people from) their namesake species, although they have been used for other applications where a well-trained versatile hunting dog would be beneficial. Although not typically aggressive toward humans, they were bred for strong hunting and fighting instincts and a very confident and independent temperament. Thus, extensive and highly skilled training is required for wildlife management and conservation applications.

In Canada, the Alberta Ministry of Environment and Sustainable Resource Development (ASRD) initiated the Karelian Bear Dog Program in 2001 to protect people and property while maintaining viable black bear (*U. americanus*) populations in the province (ASRD, 2009). Four Karelian Bear Dogs were deployed with ASRD personnel with a goal of interacting with bears such that bears learn to recognize and avoid humans and human-occupied areas through aversive conditioning. They are also used to track bears and mountain lions (*Felis concolor*) in residential areas, and to locate tranquilized bears. In addition to bear management, they are used to assist with public education, detect wildlife carcasses or parts, improve public and officer safety at response sites, and respond to conflicts involving other wildlife including moose, bighorn sheep, elk, wolf, and mountain lion. As of March 2009, Karelian Bear Dogs had been employed by ASRD for 1,643 bear-related conflicts, 350 ungulate-related conflicts, 190 mountain lion-related conflicts, and 13 wolf-related conflicts in Alberta.

In the USA, Washington Department of Fish and Wildlife (WDFW) first used a Karelian Bear Dog in 2003 and as of 2012 had four experienced adults in service and two pups in training, with each Karelian Bear Dog assigned to a specific wildlife officer/handler (WDFW, nd a; Grimley, 2012). Through the use of Karelian Bear Dogs for addressing bear–human conflicts, the WDFW has reduced their need for lethally removing black bears because of their success in training bears to avoid humans. Their original Karelian Bear Dog was involved in more than 50 bear-related captures and releases and another has helped capture over 50 mountain lions and 100 bears (WDFW, nd b). The dogs are also used to track animals, find carcasses, and will potentially be used in search and rescue.

Karelian Bear Dog programs in both Alberta and Washington were developed in partnership with Wind River Bear Institute (Table 9.1; WDFG, nd a; ASRD, 2009). The WRBI developed an approach for teaching problem bears to avoid areas used by humans instead of destroying the bears or relocating them outside their home ranges (returns are common). Specially selected and trained Karelian Bear Dogs are integral to the process. The WRBI breeds Karelian Bear Dogs and matches individual dogs to prospective owners (including agency personnel and private citizens), trains dogs and owners in bear education and deterrence, and provides community education to help people avoid creating conditions leading to human–bear conflicts.

The efficacy of Karelian Bear Dogs in reducing human–wildlife conflict has not been rigorously evaluated and reported in the scientific literature, although both ASRD and WDFW appear convinced that they provide real value for managing problem wildlife. On-line sources stress the importance of identifying and selecting for those dogs with the inherent tendency to stand up to large mammals such as bears and mountain lions, as not all Karelian Bear Dogs have that trait. Equally important, is matching individual people with a particular Karelian Bear Dog—and not all people have the proper temperament to train and handle them. As with nearly all types of deterrence approaches, Karelian

Bear Dogs are likely not ideal for all applications and their optimal use requires careful planning, training, and prudent deployment in management scenarios.

9.5.4 Dogs to reduce deer and other wildlife damage to crops

Coppinger et al. (1988) demonstrated the potential of a dog that naturally chased deer, and whose movements were spatially restricted by invisible electronic containment fencing, for protecting a heavily damaged apple orchard in Missouri, USA. Beringer et al. (1994) further explored the potential of dogs for protecting crops from deer browsing in a multi-year study examining the protection of white pine (*Pinus strobes*) seedlings. In the first year of study, plots were randomly assigned one of three treatments: electronically contained dogs, a chemical deer deterrent, or a control with no form of deer deterrence. Treatments were rotated among plots each year so that each plot received each treatment type. Over three years, the mean percentage of total seedlings with evidence of browsing was 13, 37, and 56% for dog, chemical, and no protection treatments, respectively. Dog-protected plots retained higher seedling biomass in the first two years of study and for the three-year mean, but these treatments had equivalent seedling biomass in the last year. An economic evaluation (see Box 9.2) of net present value of crop over a typical eight-year rotation suggested a clear superiority of dog protection (high returns) compared to chemical protection (losses or small returns) or no protection (large losses).

VerCauteren et al. (2005) compared crop protection dogs, contained with shock-collar based electric dog-containment systems, to double-strand electric polytape fence for protecting organic crops from deer browsing during three growing seasons in Wisconsin, USA (Figure 9.3). Dogs were randomly applied to one of three fields (1.4 ha) and polytape fencing was applied to the remaining fields (1.2 and 3.7 ha, respectively). Early on, five dogs were rejected as behaviorally unsuitable, before a Siberian Husky and a Siberian Husky–Malamute mix were identified as having suitable temperament. After these two dogs were placed in service, no crop damage was observed in the dog-protected field.

9.5.5 Dogs, mesopredators, and grassland bird conservation

Hansen and Smith (1999) noted that LPDs excluded and/or killed mesopredators in protected pastures

Figure 9.3 Organic crop-protection dog on duty in Wisconsin, USA. Such dogs were evaluated and proven effective in their ability to reduce wildlife damage to crops. Photo credit: National Wildlife Research Center.

Box 9.2 Economics of using livestock protection dogs

In comparison to the costs of other techniques for addressing predation issues with livestock, costs associated with LPDs are relatively low. Results from a 2009 survey in western USA indicated that average investment for nonlethal techniques such as shed lambing (US$18,000) and fencing (US$8,000) were four to nine times greater than using LPDs (<US$2,000; M. Marlow, pers. comm.). Further, the effectiveness of LPDs in mitigating depredation (mean decrease of 64%) was deemed nearly as great as that of shed lambing and greater than fencing. Survey respondents also provided information pertaining to start-up costs associated with incorporating LPDs into their operations. Purchase prices averaged US$413 per puppy with an additional average of $618 spent on that puppy during the first year of use. As adults, LPDs reportedly cost an average of US$115/month. Researchers have estimated annual costs associated with LPDs at US$937, $850, and $1,040/year (Landry et al., 2005; VerCauteren et al., 2008; and Gehring et al., 2010b, respectively).

Little effort has been put into evaluating savings realized by employing LPDs. A study in South Africa showed that of 70 LPDs placed in South Africa between May 2005 and July 2011, producers saved an average of US$3,189 ± $302 per farm annually due to a reduction in depredation for all livestock species (Rust et al., in press). In VerCauteren et al.'s (2005) comparison of crop protection dogs (Figure 9.3) to fencing for protecting organic crops from deer browsing in Wisconsin, USA, prior to introducing dogs the study field sustained US$3,762–5,200/year of damage. Fields protected by polytape fencing experienced browsing losses estimated at US$638–3,797 during the study. Protection by dogs cost US$3,575 for the first year, including fence installation and materials, dogs and related supplies, with annual maintenance of US$650 thereafter. The estimated annual average cost of dogs over a 25-year period was US$767 including initial costs. The annual cost for a 2.4m-tall woven-wire fence would have been approximately US$650 and would likely have provided a similar level of protection (assuming proper installation, maintenance, and consistent gate closure). Thus dogs may be a preferred alternative for those who prefer not to fence fields due to aesthetic or other practical reasons.

and VerCauteren (unpublished data) documented fewer small mammals in pastures protected by LPDs, and observed LPDs to occasionally capture and consume them. We also documented the killing of ≥10 Virginia opossums per year on one farm, although population abundance and the number of unharmed opossums was not measured. The presence of free-ranging dogs interfered with Indian fox (*Vulpes bengalensis*) use of areas, causing foxes to shift their use of resources (Vanak and Gompper, 2010). Vanak et al. (2009) also noted that Indian foxes modified their foraging behavior by being more vigilant and consuming less food in the presence of dogs. Similarly, Gehring et al. (2010b) noted a slight decrease in mesopredator visitation to livestock pastures following deployment of LPDs. Ground-nesting bird nests were also more abundant in the presence of LPDs, possibly because of greater rates of nest predation from mesopredators in non-LPD-protected pastures (Gehring et al., 2010b). Similarly, in western USA LPDs are employed in areas inhabited by sage grouse (*Centrocercus urophasianus*), a species of conservation concern, and it is thought the presence of LPDs reduces impacts of predators on the grouse (C. Urbigkit, pers. comm.). Individual LPDs, though, could depredate nests themselves or adversely influence wildlife indirectly (Weston and Stankowich, Chapter 4).

A parallel phenomenon is observed with wild apex predators; wolves, for example, may limit the presence and thus impact of mesopredators on small prey (Ritchie and Johnson, 2009). Thus, apex predators and LPDs play similar roles in mediating mesopredators (Vanak et al., Chapter 3), and the latter might also serve as a more general tool for wildlife conservation objectives, such as reducing mortality of ground-nesting birds and nest predation as stated above.

9.5.6 Dogs and conservation of declining wildlife species

The image of traditional uses for LPDs surrounded by numerous sheep in a high European mountain meadow may still be a reality. However, societal demands for alternative means for protecting

resources without sacrificing the existence of wildlife species is expanding that image to diverse landscapes accompanied by various species. For example, Maremma LPDs originating from Italy are being used on the beaches of Australia to protect little penguins (*Eudyptula minor*) from predation by red foxes (*V. vulpes*) (Lustig, 2011). Additionally, sage grouse in the western USA appear to be inadvertent benefactors of LPDs used to protect sheep from predators (Urbigkit, pers. comm.). The potential for the use of dogs in various roles for protecting resources is virtually unlimited, especially when a well thought out strategy is implemented.

Even large predatory species can be indirectly afforded protection, through the implementation of LPDs to minimize conflict over predation. Protecting livestock in some areas like the Trans-Himalayan region is a key step toward predator conservation of species such as the Himalayan wolf (*C. l. himalyensis/chanco*) and the snow leopard (*Uncia uncia*; Namgail et al., 2007). Tigers (*Panthera tigris*) in Bangladesh are experiencing reduced levels of persecution by humans partly due to the implementation of dogs to alert citizens (i.e., potential prey) to the presence of tigers, thus reducing the potential for attack on humans (Kerley, 2010; Khan, 2009). Dogs from local pastoral communities are also functioning similarly to traditional LPDs in the southern part of Africa (South Africa, Lesotho, and Botswana). For example, efforts of the Cheetah Conservation Fund (CCF) have afforded protection to cheetahs by using LPDs as a tool enabling livestock owners to reduce both perceived threats and real predation, thus minimizing retributive killing of cheetahs and other potential predators (Marker et al., 2005). Once widespread across Africa, Asia, and the Middle East, the cheetah has undergone a serious decline over the past century with population estimates falling from around 100,000 animals in 1900 to less than 10,000 by 2007 (Bartels et al., 2001). One of the few remaining strongholds for cheetahs is in Namibia. Namibia contains the largest remaining population of free-ranging cheetahs in the world, estimated at 3,000 adult animals, of which 95% occur on private rangeland (Marker, 2002). As such, a high degree of conflict exists with producers who perceive cheetahs as posing a threat to their livestock and farmed game (Marker-Kraus et al., 1996). Although there is minimal evidence to support this perception (Marker et al., 2003), there has been widespread killing and capture of cheetahs on rangelands. Almost 7,000 cheetahs were reportedly removed from Namibian rangelands during the 1980s (CITES, 1992), halving Namibia's cheetah population between 1975 and 1987 (Morsbach, 1987), and the conflict continues (Marker et al., 2007). In an effort to understand and resolve this conflict that imperils the cheetahs' Namibian stronghold, the CCF explored diverse techniques to lessen actual or perceived depredation on livestock (Marker et al., 2003). The strategy that seemed likely to have most relevance to the Namibian situation was the use of specialized LPDs.

In 1994 the CCF began their LPD program, exploring the use of LPDs in an African system where livestock (cattle, goats, and sheep) mostly range untended over vast areas amongst a multitude of predators, including cheetahs, leopards, caracals (*Felis caracal*), and black-backed jackals. Research and experience has led CCF to employ primarily Anatolian Shepards and Kangals. These breeds were chosen in preference to other available LPD breeds as they are short-coated, well adapted to working in a hot, arid climate, and are heavy, imposing dogs that outweigh the majority of Namibian farmland predators (Richardson, 1994). The dogs are placed primarily with small stock like goats and sheep, which typically roam over large areas in the day (Figure 9.4), are sometimes accompanied by a herder, and are usually corralled at night (Marker-Kraus et al., 1996). Producers in the area have used a variety of techniques aimed at reducing livestock depredation, including employing human herders, donkeys, and even baboons (*Papio ursinus*, Marker-Kraus et al., 1996). Local dogs, called 'pavement specials' were often kept with herds. However, the majority of these dogs were small to medium sized and showed herding behaviors using the eye–stalk behavior to move livestock. It is believed that when a predator approaches the herd, the dog instinctively begins to herd the livestock. This stimulates the predatory motor pattern of the predator (eye–stalk–chase–trip–bite–consume), stimulating it to chase and kill

Figure 9.4 Anatolian Shepherd and flock of goats in Namibia. Photo credit: Laurie Marker.

livestock. Herds that had dogs with these behaviors actually had higher losses than those with no dog (Marker-Kraus et al., 1996).

The performance of LPDs placed with 117 producers in Namibia between 1994 and 2002 were evaluated through surveys. Nearly 75% of producer responses indicated a large decline in the numbers of livestock lost since using a LPD (Marker et al., 2005). A follow up survey in 2009 of 164 producers showed that >90% of the dogs reduced or eliminated livestock losses (Potgieter, 2011; Potgieter et al., in press). The majority of producers felt they had benefited economically from employing LPDs (Potgieter et al., in press).

Overall, this long-term case study has shown that the relatively simple strategy of placing LPDs with Namibian livestock can be an effective tool for local producers. The dogs reduced livestock losses and 89% of the farmers surveyed in 2009 perceived their LPDs as economically beneficial, thus resulting in reduced conflict with predators. Importantly, illegal cheetah removals and lethal predator control efforts have dropped (Marker et al., 2003; Potgieter, 2011), though it is hard to assess the extent to which these changes were due to LPDs versus other factors, such as education and changes in cheetah population size. The success of CCF's work in Namibia has encouraged the use of LPDs in other African countries, including South Africa (Rust et al., in press), Botswana, Kenya, and Tanzania (Stannard, 2006; L. Marker, unpublished data).

9.6 Potential limitations, conflicts, and problems

As with any wildlife damage management strategy, an integrated approach utilizing multiple techniques improves the overall potential for success. For example, the effectiveness of LPDs can be maximized when used in conjunction with night penning and with the presence of a human herder (Espuno et al., 2004). Use of LPDs is not without its problems or limitations. Each LPD is an individual, and one may perform excellently in the same situation where another fails. Every situation that an LPD is put into is unique as well, and it is the responsibility of LPD owners to deploy and prepare each LPD in a way that maximizes the potential for success. For example, LPDs protecting livestock on the open range are exposed to greater risk of predation and frequently more LPDs are necessary than with livestock in fenced pastures (Andelt and Hopper, 2000). Each dog is also an investment in time and money for the producer, they mature at about 2 years of age and there is no guarantee that given individuals will perform to expectations and remain healthy. Most have a working lifespan of about 7 years. Some individuals tend to roam, leaving their livestock unprotected. Others can show aggressive behaviors toward livestock, pets, and humans they are not familiar with, which can be especially problematic on open range and public lands. Husbandry practices also impact the application of LPDs. For example, in some regions such

as Jura and Vosges of France, flocks of sheep are dispersed in small groups (from 2 to 15) making it logistically impractical to deploy a LPD with each group (Landry and Raydelet, 2010). In open mountain rangelands in Norway, systematic patrolling of small dispersed flocks of sheep by herders with LPDs has been evaluated and found to be only moderately effective (Hansen et al., 2002).

9.6.1 Behavioral problems of LPDs impacting livestock and wildlife

A variety of behavioral problems may arise between LPDs and livestock or LPDs and non-target wildlife. These problems need to be detected, addressed, and eliminated early and rapidly to ensure the development and maintenance of an effective LPD. Occasionally, when introduced into a flock with young animals (especially lambs), LPDs might demonstrate unacceptable behaviors while being playful, such as chasing and biting or pulling at wool, ears, and tails (Landry et al., 2005). Juvenile livestock may not be able to defend themselves, and may become frightened or injured. Therefore, dog owners need to intervene promptly to correct dogs and eliminate the development of inappropriate habits or aggression.

The CCF surveyed Namibian producers and monitored behaviors and successes of dogs placed through their program, evaluating the benefits and drawbacks. Three primary LPD behaviors first identified by Coppinger and Coppinger (1980) were examined. These behaviors included: (1) attentiveness—the tendency of the dog to stay with the flock; (2) trustworthiness—the lack of predatory or other inappropriate behaviors towards the flock; and (3) protectiveness—the tendency of the dog to display protective behaviors. Almost all the evaluated dogs demonstrated inappropriate behaviors at some stage of their development, most often when they were young and formative (Marker et al., 2005). The three most common problems were: (1) chasing non-target wildlife (see Box 9.3), which sometimes resulted in the dogs killing and even feeding on wildlife such as kudu (*Tragelaphus strepsiceros*) or chasing warthogs (*Phacochoerus africanus*) which could gore an LPD; (2) staying at home instead of going out with livestock; and (3) harassing or even killing livestock. In Namibia, the majority of problems were corrected through training under direction of the CCF, with dogs becoming attentive, trustworthy, and protective. Seldom was it necessary to resort to transferring a dog into a pet situation or culling it. To prevent such behavioral problems, it is recommended that young, unproven dogs be monitored by a herder who has the skills to correct the dog's behaviors (Marker et al., 2005; Schumann, 2003). In addition, the CCF has developed a farmer training course and dog training guide that presents to farmers predicted behaviors and ages at which to closely monitor the dogs during growth and development (Schumann, 2003). Dogs and farmers are monitored regularly by CCF during these key times (Marker et al., 2005; Potgieter et al., in press). The satisfaction of producers with their LPDs was dependent primarily on how attentive the dogs were to their flocks, followed by trustworthiness and protectiveness.

Organized LPD breeding and development programs provide consistency and expertise that maximizes the potential for success in deploying effective dogs. For example, in Switzerland and Turkey the breeding of LPDs is regulated by breeding centers, which should guarantee the quality of the LPDs they produce. In Namibia, the CCF serves as a breeding center, as farmers do not want to be burdened with the downtime of females with pups. Puppies are born at CCF's model farm and raised with the flock until they are placed with herds. All puppies are neutered prior to placement and farmers attend a mandatory training day prior to placement, which provides farmers with guidelines for management and training. Training and management strategies to overcome traditional challenges and broaden the application of LPDs are being examined (e.g., VerCauteren et al., 2012). Such strategies include raising pups in a training setting until at least 12 months of age before introducing them into a new flock. It is theorized that the dog will have passed through its problem stages by this age and will thus integrate and be accepted into its new setting more seamlessly.

Box 9.3 Impacts of dogs on wildlife

Although the goal of placing trained dogs on the landscape is directed at protecting resources such as livestock, crops, or even wildlife species, unintentional and detrimental outcomes toward local wildlife species also may occur. The nature of the job of LPDs leaves them in a role with great independence; producers rely on them to take appropriate action when non-target species of wildlife approach the livestock. An approaching animal may be perceived as a threat, and thus confronted with potential for over-reactive aggression by the LPD. Particular breed characteristics, as well as training and experience, all contribute to how a dog will respond in such a situation and thus the outcome.

Several studies have examined the effects of feral and free-ranging dogs and quantified results (e.g., Young et al., 2011; Ritchie et al., Chapter 2). Free-ranging LPDs with livestock have been shown to chase, kill, and even eat local wildlife such as mountain gazelle (*Gazella gazella*; Gingold et al., 2009). One study even suggested that free-roaming dogs consumed more livestock than wolves (Echegaray and Vilà, 2010). Occasionally, feral and free-ranging dog categorizations are combined, thus LPDs are implicated with the impacts of truly feral dogs. Livestock protection dogs used in Namibia were reportedly observed chasing wildlife by 19% of survey respondents (Potgieter, 2011) and this misbehavior was easily corrected (L. Marker, unpublished data). Furthermore, aside from the potential negative direct impacts of dogs on wildlife, there is the potential for the spread of canine pathogens such as canine distemper virus, adenovirus, and parvovirus (e.g., Laurenson et al., 1998). Thus all LPDs should have all appropriate vaccinations.

Examples of LPDs demonstrating pursuit behavior toward non-predator species initially motivated researchers to develop and evaluate the use of LPDs for the purpose of excluding wildlife from livestock-related resources in attempts to alleviate transmission of disease (Gehring et al., 2010b; VerCauteren et al., 2008). Results showed that LPDs effectively reduced the potential for disease transmission by excluding deer; however, the presence of other wildlife, such as mesopredators and rodents, was also reduced concurrently. The goal of using LPDs is to allow them to work independently with livestock with no or little supervision from a herder or handler. In attempts to minimize the negative impacts of LPDs on non-target wildlife species, emphasis has been placed on targeted training to deter predators, the importance of containing LPDs with protected livestock, and reprimanding offending dogs when negative behaviors are exhibited. The CCF's research has shown that corrective training early will correct most behaviors (Marker et al., 2005, Potgieter et al., submitted). In some instances, Namibian farmers have witnessed their LPDs fighting with predators, and the dogs have been documented killing black-backed jackal, leopards, and Chacma baboons that were threatening livestock (Marker et al., 2005). Eurasian badgers, red foxes (*V. vulpes*), marmots (*Marmota marmota*), young wild boars, and wolves have reportedly been killed by LPDs (J.-M. Landry, unpublished data). In the USA, LPDs have been known to kill coyotes and mesopredators (Gehring et al., 2010b; C. Urbigkit, pers. comm.). The impact of LPDs on large prey is unsubstantiated and documented cases involve only a few particular dogs (Lapeyronie and Moret, 2003; Potgieter, 2011). The CCF recommends corrective training immediately and has successfully used a dangle stick, if a herder is available to monitor, and has had success in stopping dogs from chasing wildlife (Schumann, 2003).

9.6.2 Conflicts with various public interest groups

Current societal changes toward recreational land uses create new challenges for agricultural uses, including the use of LPDs in proximity to recreational lands. For the most part, this is the first time in history that producers employing LPDs have had to worry about conflicts with recreationists such as backcountry hikers and mountain bikers. Remote alpine areas have always been destinations for recreational purposes, but today many recreationists are not familiar with agriculture and agricultural practices. Thus, conflicts can occur when recreationists, unwittingly or otherwise, disrespect the work of producers by disturbing livestock (e.g., passing through idle flocks). Situations like this can be challenging for LPDs because of their alarming behaviors (e.g., rapid approach, barking) and because they are often unsupervised and roaming freely with the herd. Unfortunately, some LPDs have bitten people and injured or killed companion dogs in proximity to their flocks. Conflicts occasionally arise when LPDs are deployed near the residences

of humans, usually due to barking or dissuasive behavior that may be frightening. To avoid conflicts, some producers forgo deploying LPDs in proximity to human dwellings or communities. Evaluations of relative levels of aggression of different LPD breeds have been conducted to determine particular breeds that could potentially be more or less dangerous towards people passing by a herd (Durand and Le-Pape, 1998; Green and Woodruff, 1988; Hansen and Bakken, 1999; Landry, 2004; Landry and Raydelet, 2010). Of the breeds evaluated, Great Pyrenees have proven to be the least aggressive toward humans. The presence of a companion dog with recreationists increases the probability of approach by LPDs (Landry, 2004), and thus increases the probability of conflict. Additionally, hunters may complain that LPDs disturb wildlife and even render hunting more difficult. Further, some may also be concerned that LPDs may attack and kill their hunting dogs during hunting activities. In the French Jura Mountains, 30% of interviewed LPD owners commented on conflicts with hunters (Landry and Raydelet, 2010). Such conflicts could lead to the death of LPDs (shot or poisoned), but fortunately these events seem uncommon. As part of their seasonal husbandry, French producers often remove their livestock and LPDs from rangelands by the time hunting seasons begin, which serves to lessen the potential for conflicts. To help address these issues, entities in several countries (e.g., Namibia, France, Switzerland, USA) have established educational campaigns, enlisting various media, to inform the public about how to behave when meeting LPDs and to educate them about pastoral agriculture and the role of LPDs in protecting livestock from predators in a non-lethal manner (Table 9.1; Figure 9.5).

Another issue that can create conflict with local humans involves LPDs that leave their livestock and begin to roam. One or a variety of containment strategies can be implemented to encourage LPDs to remain with livestock and minimize potential roaming. To determine the best and most cost-effective option for containing LPDs and livestock in pastures, producers need to consider their existing infrastructure and management practices. Existing livestock fences provide a visible boundary that may facilitate training LPDs to remain within the perimeter. When existing fences prove insufficient for containment, adding strands of electrified wire can serve to help contain LPDs. Supplemental training may be required to ensure individual LPDs maintain respect for electric fences and to deter escape behavior, by setting up scenarios where LPDs come in contact with electric fences and thus learn not to test them. While training LPDs for electric fences, producers must ensure that when dogs receive negative stimuli (electrical shock) that they associate it with the fence and not the individual doing the training. Shock-collar based electric dog-containment systems facilitate the establishment and maintenance of a LPD's respect for a perimeter. They also minimize the potential for negative association with handlers, since the handler need not be near the dog or even present (Schilder and van der Borg, 2004). Successful containment not only reduces the potential for conflict but also ensures safety of LPDs. For more detailed information on fencing options see VerCauteren et al. (2008) and Gehring et al. (2010c).

As a result of the types of conflicts described above, local authorities could restrict or even ban the use of LPDs in particular areas (Landry et al., 2005). For example, since 2004 a division of Switzerland has maintained a list of 'dangerous' breeds that includes the Spanish Mastiff, a commonly used LPD in Spain. Such breeds must always be muzzled and leashed, thus they are not allowed to function as guardians of livestock. In some regions, associations of producers who employ LPDs have formed to serve as references for local and federal authorities, to help educate the public, and to aid in mitigating conflicts by overseeing LPD use.

In some areas where wolves have re-established or been re-introduced, LPDs have become entangled in political controversy. Although LPDs should serve as a tool to help allow livestock and wild carnivores to inhabit common areas, some argue that LPDs are a danger to people and pets, and thus recreational activities, and that livestock should not be protected by this means; as such, wolves should be controlled with lethal methods. Others pressure producers who employ LPDs, claiming that "working with LPDs means accepting the wolf" (Landry et al., 2005). It is essential that conflicts such as these be identified and understood because there is concern they could lead

ATTENTION

Sheep Grazing in This Area

FROM: _____ **TO:** _____

Livestock Protection Dogs in Use

Sheep operators use dogs to manage and protect their sheep by scaring off predators. The dogs are here to protect the sheep. If you do not appear to be a threat to the sheep, many times the dogs will just watch you.

Please Avoid Conflict With Protection Dogs.

Don't:

- Hike or ride your all-terrain vehicle/mountain bike into or near the flock.
- Make quick or aggressive movements around the dog(s) or sheep.
- Attempt to hit or throw things at the dog(s) or sheep.
- Yell at dog(s) or sheep, unless approached—then, yell "go back" or "no!"
- Try to outrun the dog(s).

Do:

- Stop and dismount if mountain biking.
- Put your bike between you and the dog.
- Walk your bike until you are well past the sheep.
- Keep your distance from the flock.
- Keep your dog(s) leashed at all times.
- Watch for the protection dog(s) and the herder.
- Remain calm and quiet if a dog(s) approaches.

If you have questions about livestock protection dogs or other wildlife damage management issues, please call Wildlife Services—a program within the U.S. Department of Agriculture's (USDA) Animal and Plant Health Inspection Service (APHIS)—at 1-866-4-USDA-WS (1-866-487-3297), or visit the APHIS Web site at [illegible]

USDA APHIS WS NATIONAL PUBLIC LANDS

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Figure 9.5 Sign used in the USA to educate land users about the role of livestock protection dogs and how to respond to their presence to avoid conflict. Courtesy of the USDA APHIS WS.

to the malicious deaths of LPDs or that LPDs could be banned from protecting livestock in some areas. Because of this, research into human dimensions associated with the employment of LPDs in various settings for various purposes is needed, as are educational efforts so that various segments of the public can understand and appreciate LPDs and the job they do.

9.6.3 Mortality of dogs

Although free-ranging dogs can adversely affect wildlife, they can also serve as prey for other wild carnivores (Vanak and Gompper, 2009; Athreya, 2006; Butler et al., Chapter 5). Predation of livestock, and now LPDs, in western USA has become more commonplace over the last 15 years due to the reintroduction of the gray wolf (see Box 9.4). Between 1987 and 2005, 18 LPDs were reportedly killed by wolves in western USA. In contrast, from 2005 to 2010, 28 LPDs were reported to have been killed by wolves and another 30 injured (M. Marlow, pers. comm.). In one area of Romania, 157 adult LPDs were killed by wolves from January 2001 to October 2002, of which 77% were killed near the flock, which was left unhurt. Nearly all LPDs were consumed (Mertens and Schneider, 2005). One hypothesized cause for this situation was a lack of training and uncontrolled breeding among LPDs and stray dogs, a lack of selection, and resultant smaller and less-effective offspring. Additionally, the use of too few dogs per flock may be leaving LPDs susceptible to attack by packs of wolves.

Occasionally, wolves and LPDs have been observed in proximity apparently tolerating one another, even following depredation events. In one particular situation, following the removal of a depredating wolf that had apparently befriended an LPD, the LPD also preyed on sheep and had to be removed as well (Bangs et al., 2005). Other predators, including bear, coyote, and mountain lion have occasionally been reported to kill LPDs. Livestock protection dogs have been killed by wolves in Portugal and France, but compared to other causes of death these events are rare (Riberio and Petrucci-Fonseca, 2005; J.-M. Landry, unpublished data).

Organized LPD breeding and deployment programs have enabled researchers to follow and evaluate the success and other aspects of individual dogs. Causes of mortality in LPDs are quite diverse and often not due to old age. For example, in the CCF program in Namibia, only dogs that died as pets (18%) and those that worked on commercial farms (6%) were reported to die of old age (Figure 9.7). On average, dogs in the CCF program had a working lifespan of 4.3 years, similar to that reported in the USA where fewer than 50% of working LPDs lived that long and 36% lived to 6 years of age (Green et al., 1994; Lorenz et al., 1986). The leading cause of death in Namibia was field accidents (36%, 77 dogs) including dogs that were killed by snakes, baboons, other predators, lost in the veld, and other accidents (e.g., drowned in a river, kicked by a horse, killed in a dog fight); 41 dogs (19%) died of unknown causes and 39 (18%) died of medical or health related issues (Figure 9.7). Culling by owners also accounted for a substantial proportion of working dog deaths, particularly on commercial farms, usually as a result of the dog chasing or harassing stock. In Portugal, 97 LPDs were deployed and 75% were still alive after 7.5 years of life, the main causes of mortality were disease (e.g., leishmaniasis, leptospirosis, hip dysplasia) and accidents (Ribeiro and Petrucci-Fonseca, 2005).

Mortality from field accidents is to be expected under the dangerous circumstances that working dogs are exposed to, especially for young dogs, which are likely to be relatively inattentive (Lorenz and Coppinger, 1986; Lorenz et al., 1986). Inattentive dogs were found to be more likely to be lost or killed in the USA (Lorenz et al., 1986) and in Namibia, with dogs that were ultimately removed, by either death or transfer, being significantly less attentive than other dogs (Marker, 2002). As CCF's program has progressed, with lessons learned, the lifespan of the working dogs has been increasing. Also, contrary to situations related to wolves in North America and Europe, CCF reported no LPDs to have been killed by the primary species they were protecting livestock from (i.e., cheetahs or leopards). This may be attributed to differences between canid and felid predators, for example wolves may view LPDs as competitors.

Box 9.4 Providing protection to the protector

The use of spiked collars (Figure 9.6) to protect LPDs in the event of attack by predators is relatively common and considered a necessity in areas across Europe populated with wolves. Spiked collars are just beginning to be employed in western USA (C. Urbigkit, pers. comm.). These collars not only provide protection against wolves (which target the neck region when attacking) but may also become a weapon for experienced LPDs. There have been observations of wolves being wounded by spiked collars being worn by LPDs, which gave the LPD the advantage in the conflict (J.-M. Laundry, unpublished data). It has also been observed that LPDs wearing spiked collars appear more self-confident when interacting with wolves.

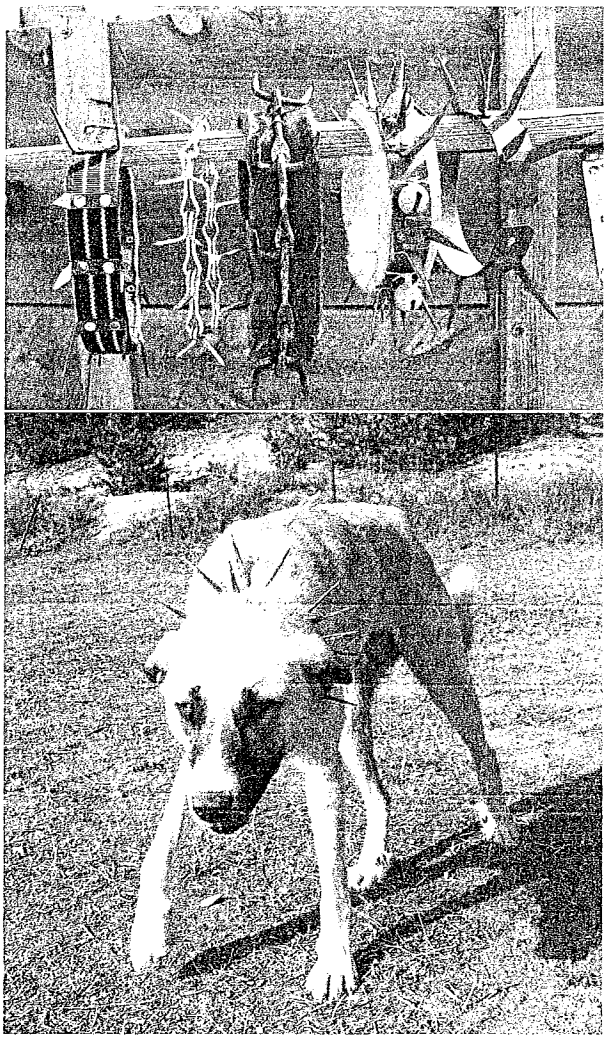

Figure 9.6 Spiked collars used on dogs such as this Anatolian Shepherd provide both protection and an offensive tool against aggressive predators. Photo credit: Cat Urbigkit.

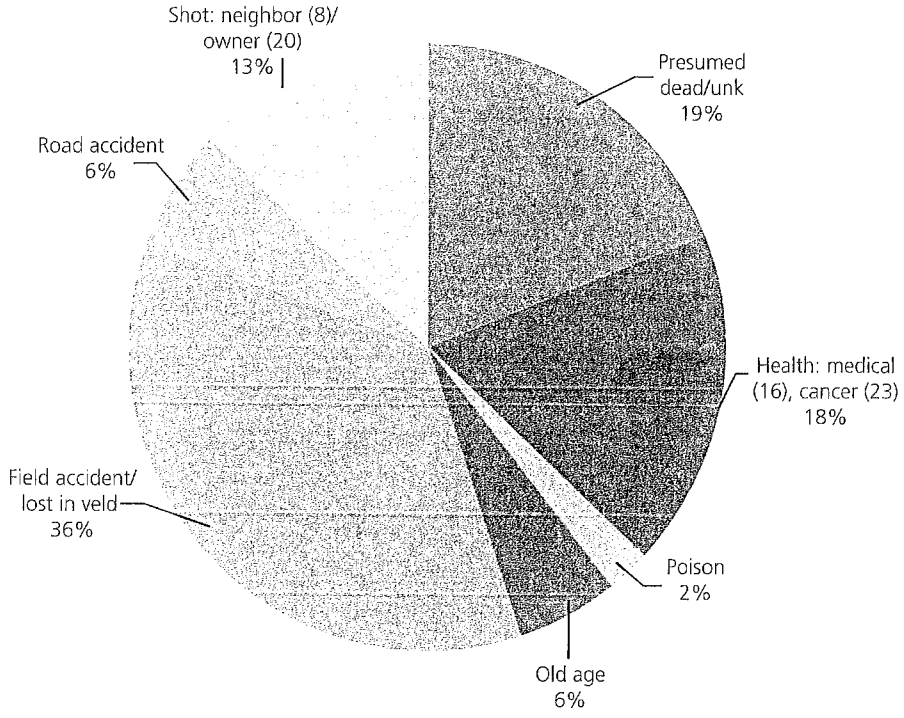

Figure 9.7 Cause of death of Cheetah Conservation Fund's livestock guarding dogs (including adults and immature animals) in Namibia ($n = 216$; 1994–2012).

9.7 Conclusions and future directions

Many challenges undoubtedly lie ahead at the interface between wildlife and human interests, especially as societies continue to become more urbanized and disconnected from natural systems. Past experience has shown that dogs can be effective intermediaries for helping people, livestock, and wildlife coexist. Dogs can be quite flexible and versatile and can be applied to a wide variety of conservation conflicts. Dogs alone, though, may not be able to permanently alleviate damages. Thus, integrated strategies that employ a variety of non-lethal and lethal management tools must be considered (Gehring et al., 2010a).

To date, studies on LPDs were mainly from North America, Europe, and Africa. Yet LPDs originated from Central Asia, where they have been used for centuries without interruption, and thus there are likely lessons and strategies to be learned by studying dogs and their people in this region. Use of LPDs there seems to differ from the occidental way, rather than instilling a strong bond with the animal to be protected LPDs are often chained (Subba, 2012), lack training, and even become feral (Namgail et al., 2007). Better understanding of how well these strategies work with LPDs could lead to new ways of applying them in other areas. Establishing a mechanism for international information exchange, like the former newsletter Carnivore Damage Prevention News (www.lcie.org/res_damage.htm), could facilitate improvements in training and using dogs and accelerate their use for mitigating conservation conflicts.

Many research questions need to be addressed relative to the use of dogs to resolve conservation conflicts, and well-designed experimental studies with large sample sizes of dogs are required. Basic questions related to prescribing the appropriate dog-based solution to the challenge at hand include:

- How many LPDs are needed to protect herds of various species and sizes from various predators in various settings?
- How do dynamics of sex, age, relationship, experience, and so on impact LPDs that are working together?
- Are social interactions between LPDs and flock members enough to protect a flock?
- What is the role of aggression and other behaviors in communicating with wildlife and resulting in protection?
- How do groups of LPDs cooperate, are there synergies and conflicts, and how do they influence the protective ability of the group?
- What are the optimal ways to raise and train dogs for specific uses?
- What new, innovative uses of dogs can be explored?

Extirpation of large carnivores in many areas of Europe likely had detrimental effects on some breeds as fewer dogs were needed to protect flocks, potentially leading to genetic bottlenecks (e.g., Great Pyrenees population in France). Today's gene pools may therefore be impoverished and produce a high proportion of dogs unsuited to livestock protection or conservation applications. Therefore, it would be valuable to study breed-specific questions relevant to contemporary issues, such as:

- Which breeds are most applicable for which use?
- Which breeds have the potential to be further developed and suited for novel purposes?
- Do we need more aggressive LPD breeds to be effective against large predators, such as wolves?
- Do LPDs that are aggressive towards predators also show aggression towards humans?
- As LPDs from Asia are selected from a large gene pool, how do behaviors (e.g., protective behavior) of these dogs differ within breeds, how are they selected, and how effective are they in comparison to LPDs elsewhere in the world?

Ultimately, there will be few simple or universal answers to these questions. Though LPDs have been bred for thousands of years to fulfill the niche of protecting livestock, they are all individuals, varied and versatile, and the humans who train and employ them must also be versatile as well as innovative. Understanding the behavior of dogs as well as that of the wildlife species they are working against will require continued research—and achieving more widespread and successful use of dogs for mediating conservation conflicts will occur as researchers, managers, agricultural producers, and the public at large begin to further unleash the potential of dogs for these important purposes.

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