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Livestock Depredation by Wolves

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White Paper

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Executive Summary/Abstract:

The state of Colorado expects recovering and dispersing wolf (*Canis lupus* and *C. l. baileyi*) populations to reach the state in the near future. Likewise, the western Distinct Population Segment of recovering gray wolves may be delisted soon. In preparation for this eventuality, the Colorado Division of Wildlife (CDOW) has initiated the development of a state wolf management plan in an effort to deal with the many controversial issues surrounding this topic, which includes the possible depredation upon livestock and other domestic animals by wolves. This paper deals specifically with cow-calf and sheep depredation and examines the actual threat to Colorado's livestock industry as well as the threat to individual ranchers should wolves establish packs in the state. I found that while wolves prefer wild game and are less likely to depredate livestock when game is available, wolves are opportunistic and will depredate livestock. Such depredations will not likely have any detectable negative effect on overall livestock production in the state but individual ranchers could experience significant losses through surplus killing or chronic depredations, with sheep producers more likely to experience such losses. If Colorado desires to monitor the effects of depredations by wolves, qualified staff must be employed and depredation trends monitored to evaluate the impacts. I also found that management of threats to livestock through the development of long-term strategies and identification of threat inducing factors are important for determining future allocations of resources in the application of combinations of wolf management tools to minimize risks to livestock producers. Such strategies will need to be employed along with active wolf management by USDA Wildlife Services or CDOW,

particularly in areas where chronic depredations and conflicts do arise (assuming eventual de-listing of the gray wolf from Endangered Species Act protections).

General livestock depredation information:

Wild predators make impacts upon the livelihoods of farmers and ranchers around the globe (Moberly et al 2003; Cozza et al 1996; Wolf Trust 2004a) and likewise the expansion of human activities has caused declines in carnivore populations as well as a constriction or loss of carnivore ranges and habitats (Woodroffe *in* Patterson et al 2004; Alderton 1994; Musiani and Paquet 2004; USGAO 2001; Breitenmoser 1998; WS 1997). A common example of a carnivore coming into conflict with humans throughout a large portion of the world is the gray wolf, with the conflict generated generally relating to actual or feared livestock depredation (Kumar 2001; Mech 1995; Bradley 2004). This conflict has likely existed as long as humans have had domesticated ungulates and continues to be a significant obstacle to wolf recovery in areas with livestock production worldwide (Mech 1995; Fritts et al 2003 *in* Bradley 2004).

In Montana, the origins of negative livestock–wolf interactions apparently began with the local eradication of the plains bison (*Bison bison*) and the subsequent introduction of domestic cattle (*Bos primigenius* subspecies) combined with locally dense populations of wolves (a situation that in turn encouraged the wolf to turn to cattle as prey and thus likely encouraged Montana to begin its first wolf bounty program in 1883) (Riley et al 2004 *in press*). Colorado began its own wolf bounty program in 1876 and even private ranches have offered bounties in the past. The Club Ranch in Colorado

offered a $50 bounty per wolf in 1909, while the Piceance Creek Stock Growers' Association in north-central Colorado offered $150 per wolf in 1912. It was in 1915 that the first federal wolf hunters were hired by the U. S. Biological Service to operate (until 1942) in Colorado, Wyoming, Montana, the Dakotas, Arizona and New Mexico. The last reported wolf in Colorado was killed in 1943 in the Upper Conejos River drainage (Anonymous 2004).

The state of Colorado has a long history of ranching reaching back to the 1800's (Colorado Cattlemen's Association 2004; Colorado Wildlife Commission 1982; Miller et al 2003), and ranching continues to contribute significantly to the state economy today. In 1993 Colorado produced an approximate $4.1 billion dollars in agricultural products, of which about 71% were cattle, sheep and other livestock receipts (CASS 1995a *in* WS 1997). More recent data (CASS 2002 and 2003) shows that Colorado's overall estimated gross agricultural products have slipped to $3.31 billion since the 1993 numbers but livestock related receipts still account for the vast majority of the state's agricultural income (64% or $2.14 billion in 2002-down from 2.25 billion in 2001).

Therefore it is understandable that ranchers are concerned about possible losses of livestock due to predation by an expanding gray wolf population and range since wolf depredations can have a significant impact upon the private livestock resources of an individual rancher (Mech et al 2000; Fritts 1982; Cozza et al 1996; Fritts et al 1992; Balser 1974, Dorrance and Roy 1976, Gee 1979, Robel et al 1981, Weaver 1983 and Hoffos 1987 *in* Montag 2002). Musiani and Paquet (2004, *citing* Mech 1995 and 1999) as well as Blanco (2002) remind us that wolves are returning to areas with current land

practices and lifestyles that may be incompatible with populations of wild wolves. The potential for conflict with agricultural interests now reduces or inhibits the opportunities for wolf recovery in areas with widespread grazing. Current animal husbandry practices also may not be effective at reducing wolf depredation and may inhibit future range expansion of recovering wolf populations (Bangs et al 1998; Linnell and Brøseth 2002). Nonetheless core areas throughout the Colorado Rockies have been identified as suitable for supporting wolf populations (Phillips et al 2000; Carroll et al 2003), and thus this issue of potential livestock depredation must be examined if wolves are to be allowed to establish populations within the state.

Around the world, recovering predator populations have sparked a great deal of research into the issue of potential livestock depredation, particularly in North America (Wolf Trust 2004a; Mech 1995; Boitani 1992). The concerns regarding livestock depredation by recovering gray wolf populations remains highly controversial in nature despite relatively low numbers of wolf depredations upon livestock (Mech 1995, 1999, 2001; Mech et al 1996 and Phillips and Smith 1998 *in* Miller et al 2003; Meier 2001; Lohr et al 1996 and Fritts et al 1997 *in* Musiani and Paquet 2004; Bangs et al 1998 and Bangs et al 2004 *in* Bradley 2004) and the assumed cross-purposes of promoting wolf recovery versus the killing of wolves for livestock protection has greatly complicated wolf recovery efforts. However, most livestock producers have made an effort to cooperate with wolf recovery efforts due to the belief that potential conflicts will be dealt with in a fair and equitable fashion (Miller et al 2003).

Thus, as Colorado prepares a plan to manage gray wolves which are expected to

be found at some time within its boundaries due to regional recovery efforts, the possible impacts related to depredation upon livestock by recovering wolf populations must be fully understood for the plan to be comprehensive and developed with complete and fair economic considerations in mind.

Will wolves depredate livestock and what are the likely depredation rates Colorado will encounter if wolf populations become established in the state?

The existing body of literature clearly recognizes that wolves have been considered a threat to livestock, including cattle, sheep (*Ovis aries*), turkeys (*Meleagris gallopavo*), horses (*Equus caballus*) as well as other livestock and, by extension, the livelihoods of the farmers and ranchers who depend upon the animals for their welfare (Van Camp 2002; Young and Goldman 1944, Carbyn 1983 and Fritts et al 1992 *in* Paul and Gipson 1994; Bangs et al 2004 *in* Bradley 2004). At least 21 of 34 wild canid species in the world have been recorded attacking or having attacked domestic livestock, including the gray wolf (Alderton 1994). Eurasian livestock are predated upon more frequently where wild prey items are scare or absent altogether (Jhala and Giles 1991, Vos 2000 and Fritts et al 2003 in Bradley 2004).

Jethva and Jhala (2004) showed that while cattle made up a significant portion of wolf diet in the Bhal region of India, (26% of the local wolf population's diet according to the proportion of scatological content analysis), direct intensive observational data shows that only 8% of the diet biomass of cattle intake is from wolf depredations, and the rest (18%) is a result of scavenging, which cannot be differentiated in scatological

analysis. In this study cattle depredations only made up 4% of total predation events, with the vast majority of the wolf predations occurring upon wild male 'black buck' (*Antelope cervicapra*).

A Mongolian study found the predation rate of gray wolves upon livestock in the Gobi Gurvan Saikhan National Park to be at 2.3% annually (Khuukhenduu and Bidbayasakh 2001). In Britain, lamb losses annually are caused by the following factors: 40% of total losses are due to abortions and stillbirths, 30% of total losses are due to starvation and exposure, 20% of total losses are due to infectious diseases, 5% of total losses are due to congenital birth defects and 5% of total lamb losses are due to "predation and misadventure" (MAFF 1995 *in* Wolf Trust 2004a) from which we can safely assume that wolf or other canid depredations actually occurred at a rate significantly less than the 5% rate of the entire category.

In the western United States, rates of up to 4-8% of lambs lost (of total annual lambs) annually to coyotes (*Canis latrans*) have been recorded (a reported 45,000 lambs annually due to coyotes in Wyoming alone). However, in most cases around the world livestock losses by wild canids, including the gray wolf, is less than 2% of the total livestock loss in a given year, regardless of how numerous the canid predator populations are (Alderton 1994). In 2002 wolves caused less than ~0.000008% of total livestock losses in Montana (including weather, disease and other causes), 9 of 2,450,000 cows and 13 of 335,000 sheep by the 108 wolves in the state at that time (According to the Montana Department of Livestock *in* Van Camp 2003). In Idaho in 2001 10 cattle and 54 sheep were confirmed (11 and 62 respectively included both the confirmed and probable

numbers of cattle and sheep lost) to have been killed by wolves, while 2,600 cattle and 11,600 sheep were killed by OTHER predators, including 60% of the total predations attributable to coyotes and 9% by domestic dogs (*Canis lupus familiaris*) (as compared to ~.005% due to wolves) (USFWS 2004; Defenders of Wildlife 2004; NASS 2001; Van Camp 2002). Domestic dogs are a much more significant predator upon livestock than wolves in many parts of the world (Wuerthner 2003?; Meriggi and Lovari 1996; Montag 2002) and are known to be a significant predator on sheep and lambs throughout the year in Colorado today (CASS 1995b *in* WS 1997).

To paint the complete picture, it is important to understand that predation from *all species of predators* account for only 3% of the *total* livestock losses (as accounted for in the GYA by the USFWS *in* Van Camp 2002) recorded in the northern Rockies. To summarize the impacts of wolf-specific livestock depredations in the entire northern Rockies recovery area in 2001, there were a total of 40 confirmed cattle lost to wolves with 6,130,000 cattle left (after all other losses or 0.0000065%) and 138 confirmed sheep lost due to wolves with 1,215,000 surviving (after all other losses or 0.00011%) (Van Camp 2002). *Most* Western Distinct Population Segment (DPS) wolf packs exposed to livestock do not seem to depredate every year on the available livestock, which remains consistent with findings in Minnesota, Wisconsin and British Columbia (Fritts and Mech 1981, Fritts 1982, Fritts et al 1992, Treves et al 2002, and Tompa 1983 *in* Bradley 2004) but packs depredating tended to repeat the behavior, even if it was more than a year between the depredations (Bradley 2004). However, the actual average loss of livestock from predators such as wolves and coyotes in North America varies from region to

region, even where these predators are relatively numerous (Alderton 1994).

Colorado's recent history of recorded livestock depredation shows that mountain lions (*Felis concolor*), black bears (*Ursus americanus*), coyotes, domestic dogs, red foxes (*Vulpes vulpes*), bald eagles (*Haliaeetus leucocephalus*) and golden eagles (*Aquila chrysaetos*) take livestock in Colorado (Henne 1977, Nass 1977, Nass 1980, Tigner and Larson 1977, O'Gara et al 1983, Shaw 1987, CASS 1995b and Phillips et al 1996 *in* WS 1997). Even larger corvids such as ravens (*Corvus corax*), crows (*Corvus branchyrhynchos*) and black-billed magpies (*Pica pica*) will attack newborn lambs and calves (Wade and Bowns 1982 *in* WS 1997).

Colorado's annual sheep and lamb losses to predators from 1994-1996 were about 30,000 head each year, with the vast majority (~90%) of those losses occurring in the western half of the state (CASS 1995b and CASS 1997 in WS 1997). Respectively, coyotes, black bears, mountain lions, dogs, foxes and golden eagles were the significant predators on sheep in Colorado during this period. Coyotes and black bears (in that order) were the most significant predators on cow/calf operations (WS 1997). NASS (1996) reports that Colorado experienced a predation-caused calf loss rate of 5.8% and a cow loss rate of 0.9% of total losses (including losses to disease, weather, poison plant ingestion, old age, etc.), or a 3.72% overall depredation rate when combined. It is clear that Colorado livestock producers experience significant losses from wild predators, but it also appears unlikely that wolf re-colonization in the state would result in appreciable increases in depredation rates or direct economic losses due to the evidence of low wolf depredation rates in other regions of North America and the further likelihood of wolves

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displacing other predators as their occupied range expands into the state.

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The following table summarizes wolf depredation in the Western Distinct Population Segment (DPS) by state (USFWS 2004, Defenders of Wildlife 2004, Meier 2001):

Confirmed[1] Wolf Depredation in the Western Distinct Population Segment 1987-2003

	Montana				Wyoming				Idaho				Compensation Paid
Year	cattle	sheep	dogs	other	cattle	sheep	dogs	other	cattle	sheep	dogs	other	*Bailey Wildlife Foundation*[2]
1987	6	10	0	0	0	0	0	0	0	0	0	0	$3,049.00
1988	0	0	0	0	0	0	0	0	0	0	0	0	$0.00
1989	3	0	0	0	0	0	0	0	0	0	0	0	$1,730.00
1990	5	0	0	1	0	0	0	0	0	0	0	0	$4,100.00
1991	2	2	0	0	0	0	0	0	0	0	0	0	$1,250.00
1992	1	0	0	0	0	0	0	0	0	0	0	0	$374.00
1993	0	0	0	0	0	0	0	0	0	0	0	0	$0.00
1994[3]	6	0	0	0	0	0	0	0	0	0	0	0	$5,701.00
1995	3	0	0	4	0	0	0	0	0	0	0	0	$1,633.00
1996	10	13	0	1	0	0	0	0	1	24	0	1	$7,483.00
1997	19	41	0	0	2	56	0	0	1	29	0	4	$31,935.00
1998	10	0	0	1	2	7	0	3	9	5	0	1	$12,156.00
1999	20	25	0	2	2	0	1	6	11	64	0	7	$35,461.77
2000	14	7	0	5	3	25	0	6	15	48	0	0	$50,446.25
2001	12	50	4	2	18	34	0	2	10	54	0	2	$60,574.41
2002	20	84	5	5	23	0	0	0	9	15	0	4	$61,095.67
2003	24	86	0	1	34	7	10	0	6	118	0	5	$82,604.23
TOTAL	**155**	**318**	**9**	**22**	**84**	**129**	**11**	**17**	**62**	**357**	**0**	**24**	**$359,593.33**

TOTAL ALL STATES CATTLE	301
TOTAL ALL STATES SHEEP	804
TOTAL ALL STATES DOGS	20
TOTAL ALL STATES OTHER[4]	63

1: In 2003 an additional 21 cattle, 31 sheep, 1 mule and 1 horse were classified as 'probable' wolf depredations.
2: BWF compensation payments also include 'probable' wolf depredations.
3: Compensation Payments in 1994 include 7 cattle in Canada.

4: Total 'other' confirmed livestock taken from 1987-2003 also included llamas, goats and a foal.

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Do wolves prefer wild game over livestock?

It has been recorded that wolves in general prefer wild prey and wolf-livestock problems tend to be minimized where wild prey is abundant (Van Camp 2003; Jethva and Jhala 2004; Alderton 1994; Mech 1995; Tompa 1983, Bjorge and Gunson 1983 and Fritts et al 2003 *in* Bradley 2004). The greater Yellowstone area populations of wolves prefer elk (*Cervus elaphus*), which forms 80% or more of their annual prey composition, but this is a region with large areas that do not currently support livestock grazing (Van Camp 2003; USFWS et al 2004). Jethva and Jhala (2004) report that even in relatively livestock dense regions of India that livestock depredations by wolves make up only 4% of total wolf predation events.

In parts of the world where natural prey species have been eliminated from the ecosystem, the wolf populations tend to decline, as in the Bavarian Forest of Germany where the gray wolf went extinct about 40 years after the last red deer (*Cervus elaphus*) was killed. In portions of Italy, Spain and Portugal, wolves' diets are derived from a combination of livestock and refuse where wild game has been eradicated (Alderton 1994). Such reduction of normal prey can cause wolves to turn to livestock to fill part of their dietary needs (Mech 1995). A wolf feeding on an existing kill is less likely to kill again and one harried from its prey will likely have to kill again and thus ranchers unsuccessful in removing or dealing with the wolf threat and only succeed in harrying the wolf from a kill may, in fact, exacerbate the problem and encourage the wolf to kill again (Alderton 1994).

Habitat may influence predation upon livestock (Mech 1995, Fritts 1982, Treves

et al 2004; Bradley and Pletscher 2004 *in* USFWS 2004; Bradley 2004). Treves et al (2004) report that under certain conditions wolves can select for livestock over wild prey when hunting in areas with high proportions of pasture and (counter-intuitively) high proportions of white-tailed deer (*Odocoileus virginianus*) combined with low proportions of crop lands, coniferous forest, herbaceous wetlands and open water. When such variables as these (that can affect prey selection and availability for wolves) and others, such as road density and farm size are considered, predictions can be made regarding the likely occurrence and extent of future livestock depredations.

Bradley and Pletscher (2004 *in* USFWS 2004; Bradley 2004) report that depredation occurred on Montana and Idaho ranches where there was a higher presence of elk, where the ranches were larger and where more cattle were grazed and grazed at distances further from human habitation, supporting the findings of Mech et al (2000). Cattle grazing in tall growth are apparently twice as likely to be predated upon by wolves in an uncited study in Alberta (Alderton 1994). By utilizing open pastures, it may be possible to reduce predator attacks. A Minnesota study in severe winter indicates that white-tailed deer fawns become more susceptible to wolf predation under the severe winter conditions and the resultant loss correlates to a reduction in numbers of domestic animals lost, theoretically with potential livestock losses replaced by natural fawn loss (Alderton 1994).

Meriggi and Lovari (1996) conducted an extensive examination of southern European wolf predation and concluded that in northern and eastern Europe as well as in North America, wild wolves prefer native wild ungulates to domestic prey items, but in

southern Europe the wolf has also adapted to feed on fruit, trash and smaller mammals. In examining 15 other studies across 15 years of work they also found that large prey (ungulates, from depredation or scavenging) make up the bulk of wolf diets despite other reports that refuse has become the species' primary food source in southern Europe.

Further, availability of even relatively few wild ungulates could have a significant impact on the reduction of livestock depredations if such prey were accessible. However, scarcity of wild prey does appear to enhance depredation of livestock (Pulianen 1965, Mech 1970, Fritts and Mech 1981, Gunson 1983, Bjorge and Gunson 1983 and Tompa 1983 *in* Meriggi and Lovari 1996). The presence and availability of more than a single type of prey species was also found to be significant in preventing conversion to livestock depredations in recovering wolf populations when seasonal and yearly fluctuations in single prey species are in low cycles (Fritts and Mech 1981; Peterson et al 1984; Fuller 1989 and Huggard 1993 *in* Meriggi and Lovari 1996).

Exaggerated, misidentified and underrepresented livestock depredation/loss causes:

Threats posed by wild canids to livestock have often been seriously exaggerated (Alderton 1994). Attempts to obtain accurate statistics on wolf depredation rates in Indian surveys has proven impossible due to many farmers and shepherds lumping losses from disease and accidents into their mortality reporting (Kumar 2001). Gipson and Ballard (1998) examined several accounts of 'infamous' North American livestock killing wolves, including several removed from Colorado, and found that many cases appeared to be exaggerated or focused upon wounded or aged wolves who are more likely to prey

upon livestock. They also found that several of these famous cases suggested wolf-dog hybrid attacks rather than depredation by wild wolves (Gipson and Ballard 1998).

Another major problem with assessing threats from canid predators has been determining the exact cause of mortality, as when dog and coyote depredations are misidentified as wolf depredations (Cozza, et al 1996; Alderton 1994; Blanco 2002; Montag 2002). It is possible and even likely in a large percentage of reported "wolf kills" that have evidence of wolves or coyotes at a kill is actually evidence of scavenging after the livestock has already died of another cause (Alderton 1994, Jethva and Jhala 2004; Blanco 2002). Even careful studies of wolf scats can be misleading, as can direct evidence of a predator feeding from a carcass, as the incident could again be a case of scavenging (Main 2001, Jethva and Jhala 2004). Jethva and Jhala (2004) also report a significant difference in interpretation of feeding habits of wolves between scat content analysis and actual observed feeding behavior, with scatological evidence wrongly indicating a much greater rate of livestock depredation that actual observations produce. Likewise it can be difficult to determine whether a single wolf or an entire pack is responsible for a depredation event (Fritts et al 1992) but the determination of individual versus pack participation can have significant management implications (Bradley 2004).

It is clear that depredations where wolves are present are most often attributed to the wolf, despite studies showing as much as 10% of closer investigations show that coyotes were, in fact, responsible (Alderton 1994). In other parts of the world, feral dogs frequently take sheep but wolves are still often blamed (Alderton 1994; Ciucci and Boitani 1998; WS 1997). Reports in Italy and Spain show that in more than half of the

reported 'wolf-kills', the wolf was in fact blameless, with wild dogs packs or other factors often being the actual cause of death (Meriggi and Lovari 1996; Alderton 1994; Boitani 1983; Francisi et al 1993 *in* Cozza et al 1996). Montag (2002) cites Dahier and Lequette (1997), suggesting that when direct observations of livestock depredations are lacking, it is unlikely that a shepherd will admit that an attack was committed by a dog.

In calf/cow depredation by wolves in Minnesota the issue of misidentification can be exacerbated when compensation is paid for presumed canid depredations on cattle. Alderton (1994) also reports that over 70% of all carcasses involved in a compensation situation had disappeared and that not all of the claimed calves had even existed. When ranchers put out cows assumed to be pregnant and no calf ever becomes evident, it was assumed to be due to depredation, when as much as one in four of the claimed pregnancies could have been mistaken. However, because it is difficult to find wolf kills to verify depredations, more livestock may be lost to wolf depredation than can be verified (Roy and Dorrance 1976 *in* Mech et al 2000; Fritts 1982). One study found that cattle depredation detections may be only 1 in 8 of actual depredations occurring (Oakleaf et al 2003 in Bradley 2004). Connolly (1992 *in* WS 1997) determined that most depredation complaints in Colorado are investigated by Wildlife Services (WS) to determine if a depredation has, in fact, occurred and which predator is likely to be responsible if such a depredation has taken place. However, only a small portion of current coyote depredations are actually confirmed by WS. The best tools currently available for determining depredation rates by wolves are field specialists and the monitoring of trend data for confirmed and probable depredations over time.

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Colorado, if a determination is made to assess livestock depredations from recovering wolf populations, will need to ensure that wolf specialists are on hand or trained to an adequate level for field assessments of depredations. Likewise trend data should be closely monitored so that assessments regarding economic impact thresholds to livestock producers can be identified.

Do wolves commit 'surplus killing'?

Short et al (2002) describes 'surplus killing' as the killing of prey by a predator beyond the immediate needs of the predator for food or food storage and is typified in the trait of low or no use of the carcasses by the predator. Under normal circumstances, wild canids only kill sufficient to meet their needs; however when canids do encounter potential prey in confined pens or restricted areas, they have been known to respond to the stimuli by killing more than they would need or could use. This is not likely a 'blood-lust' as it has been described in popular writing, but rather a response to the mass panic of the prey group, disturbed by the predator and unable to escape their confinement (Alderton 1994).

In central Italy, 10 sheep lost to a pack in a confined pen is a usual occurrence when such constricted conditions exist, although up to 100 sheep lost to a pack in a single night have been recorded. It is also clear that young animals are more susceptible to predation by wild or feral canids than older animals, with sheep and goats favored over cattle (a larger and more difficult target) (Alderton 1994). In Europe, sheep are the type of livestock most likely to fall prey to a gray wolf. In Spain it is estimated that about $1

million (U. S.) is lost annually in stock to wolf depredation, (with about 25% of that being paid for through compensation programs). Surplus killing in confined pens as described above clearly accounts for a significant portion of these losses in some areas. Free-ranging livestock typically do not experience surplus killing incidents.

Coyotes have been recorded as accounting for up to 93% of all predation on lambs and ewes on nine sheep operations in southern Idaho and failed to feed on 1 in 4 of those sheep killed (Nass 1987 *in* WS 1997). While this record displays a significant instance of surplus killing by coyotes, it does not reflect known wolf depredation patterns.

In Colorado black bears and mountain lions are known to be occasionally responsible for surplus killing events which result in large losses of sheep or lambs (Mysterud 1977 and Shaw 1987 *in* WS 1997). Such predators can also induce panic events in confined spaces which can cause frightened sheep to 'pile-up' in a mass stampede which results in the animals smothering each other. Two such incidents were recorded in Colorado in 1995 and included one panic induced by a mountain lion resulting in the deaths of 67 lambs and 14 ewes, while the other panicked 'pile-up', induced by a black bear, resulted in the deaths of no less than 150 sheep and lambs (WS 1997). It is possible that wolves could induce similar catastrophic pile-up events on occasion which would need to be dealt with by local agencies and the affected rancher.

Wolf damage to livestock- abatement and compensation:

There exists a suite of tools and techniques for abatement of wolf depredation,

although none can be considered the 'silver bullet' and each application must be tailored to the specific situation (Shivik and Mason 2004; Cluff and Murray 1995 and Bangs and Shivik 2001 *in* Bradley 2004). Predator control options within Colorado are limited by Colorado State Constitutional Amendment 14, which allows for disturbance-based devices (such as gas exploders, Radio Activated Guards and Motion Activated Guards, shooting, denning, aerial shooting, trained dogs, trapping, snares and M-44s, but restricts the use of snares, leg-hold and body gripping traps and all poisons. Snares, leg-hold and body gripping traps and all poisons are prohibited on public lands (WS 1997). Any methods employed for predator control must comply with this state law unless otherwise superseded by federal law and policy. Currently the Wildlife Services arm of the United States Department of Agriculture, Animal and Plant Health Inspection Service has been authorized and directed by Congress to "protect livestock, property, wildlife and public health and safety from damage caused by predators" (WS 1997).

Most non-lethal tools are either still experimental in nature or of limited usefulness. However, knowledgeable application and field experimentation could lead to and effective strategy to reduce livestock depredations by wolves for specific circumstances. While there may be times when lethal control (trapping, shooting or poisoning) is still the best wolf depredation management tool, Shivik and Mason (2004), amongst others, describe the use of numerous non-lethal methods which include Light Mobile Barriers, Radio Activated Guard (RAG), fladry and electronic aversive conditioning (Breck et al 2002; Shivik 2001; Shivik et al 2002; Shivik and Mason 2004; Bangs and Shivik 2001; Wolf Trust 2004b).

Other management techniques available to livestock producers which may require a change in operation of the livestock production include guard animals (such as dogs, llamas (*Llama glama*), donkeys (*Equus asinus*) as well as grazing sheep with cattle to form a 'flerd' (flock-herd) to take advantage of the inherent difficulty and greater aggressiveness of cattle as a protection measure for sheep) can be effective, as can lambing indoors and maintaining lambs indoors until a couple of weeks old, to reduce lamb depredation by all predators (Musiani 2000; Cavalcanti and Knowlton 1998; Landry 2000; Fonseca 2000; Shivik and Mason 2004; Wolf Trust 2004b).

Altering breeding and birthing dates so that vulnerable young are not available when wild canids are feeding their own young is another possible technique to employ. Animal armor has been able to aid in reducing coyote damage, but prolonged exposure to such methods can result in predator habituation and a change in depredation tactics to overcome the armor or aversion tools. Having human herders and practicing night penning of livestock as well as electrical fencing are other tools that show promise in prevention or reduction of livestock losses to predators (Shivik and Mason 2004; Mertens and Promberger 2000; Mertens et al 2002; Levin 2000).

Wolf populations can also be managed by direct sterilization (vasectomy) of territorial males with relatively few males requiring treatment to keep wolf numbers significantly reduced in a region (Mech et al 1996). Likewise compensation programs such as direct payment, partial payment and insurance (amongst others) can sometimes effectively reduce the economic burden to an individual rancher should chronic problems with depredation arise (Shivik and Mason 2004; Montag 2002; Blanco 2002; Yoder

2000). A non-profit organization, Defenders of Wildlife, has provided a compensation program that compensates livestock producers for confirmed and some probable wolf depredations relative to wolf recovery efforts in the United States (Fischer 1989 in Bradley 2004; Defenders of Wildlife 2004) but compensation and insurance programs should also include the employment of other wolf management tools (Bradley 2004).

Another wolf management tool that seems to be losing its appeal (as research continues and chronic depredation patterns of specific wolves or packs are detected) is the relocation of problem wolves and wolf packs. They have been found to frequently and quickly return to their former ranges or into new ranges with livestock (Fritts 1982; Bradley 2004). Bradley (2004) made a careful analysis of the applicability of such relocations and reports that the wolf management framework has made controlled experiments of the issue untenable, but that evaluating existing data has proven helpful in assessing the effectiveness of relocations. Of livestock depredating packs that had more than one member relocated in an attempt to change the pack behavior, 68% depredated again within 1 year (Bradley 2004). Relocations were less effective in Idaho but did not experience a higher rate of overall depredation (USFWS 2003 in Bradley 2004) as local packs seem inclined to chronic depredation where depredation does occur. Currently relocation of wolves has been discontinued in the western DPS (Bradley 2004).

Development of long-range strategies and identification of factors that can result in chronic depredation should be of prime concern to wolf management planners to enable the effective allocation of management resources (Bradley 2004).

This white paper was prepared by Michael Francis at the request of CO DoW to assist the deliberations of the CO Wolf Management Working Group. ***Any opinions expressed are his own*** *and do not represent the opinions of the CO DoW or Meridian Institute.*
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Wolf Impacts on other predators and possible implications for livestock:

Before wolf reintroduction, coyote population density in the northern range of Yellowstone National Park (NYP) was estimated to be at .45 per square kilometer in organized packs with established borders. Wolves began to kill coyotes soon after they were released in YNP. During 1996-1998, wolf aggression toward coyotes resulted in an approximate 50% decline in coyote density (up to a 90% decline in core areas occupied by wolf packs) and reduced coyote pack size on the northern range. In the Lamar Valley the coyote population declined from 80 to 36 animals from 1995 to 1998, and average pack size dropped from 6 to 3.8 animals. (Crabtree and Sheldon 1999 *in* Smith et al, 2003).

While the research has not specifically examined the question, it is possible that such instances of coyote and other related predator displacement by wolves could result in an overall reduction in livestock losses in areas where coyote or other predator pressure on such livestock such as sheep is significant.

Conclusion:

In many parts of the world wolf depredation is simply a part of doing business in the livestock industry. However, Colorado ranchers have not had to deal with this problem for many generations now and the possibility of loss due to wolves is an issue of significant concern. With the strong possibility of wolf populations re-colonizing into Colorado in the near future, the possibility of livestock depredations resulting from wolves is a real concern that could significantly affect individual livestock producers.

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However, in the greater picture of livestock expected to be lost across the state on a per annum basis by predators, wolf depredation impacts to livestock production will likely be insignificant, particularly so if effective abatement techniques are applied.

Scattered incidents of depredation could become chronic in some cases for specific ranchers where a problem wolf or pack establishes a territory or experiences a shift in natural prey availability which causes them to predate regularly upon livestock. Such cases could be dealt with by supporting the rancher so affected through state, federal, local or private contributions either in technical assistance or through compensatory avenues. Ranchers themselves could adopt husbandry techniques that help in minimizing potential wolf depredations. In either case, cooperation between the state and the livestock industry is required for wolf management.

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