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Original Article

Mad Cow Policy and Management of Grizzly Bear Incidents

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ABSTRACT Protection of humans and livestock from disease has been used to justify many aggressive and costly wildlife control programs. Recent regulatory changes on livestock carcass disposal aimed at controlling the spread of bovine spongiform encephalopathy in Canada have led to substantial increases in exposed livestock carcass dumps. Such "boneyards" are known to attract grizzly bears (*Ursus arctos*), which leads to human–bear conflict. We compiled data on human–grizzly bear interactions in an agricultural landscape in southwestern Alberta over a 12-year time period (1999–2010) overlapping regulatory changes. Boneyards increased markedly after regulations were enacted and grizzly bear incidents increased correspondingly, particularly those related to dead livestock. The high rate of conflict results in frequent management captures, relocations, and translocations that create a likely population sink. Although work is underway to reduce human–bear interactions, revisions are needed to recent regulatory changes, such that they take wildlife into account. When combined with programs aimed at ensuring proper storage of attractants, we believe that such policy reforms will make it possible for humans to coexist with grizzly bears in southwestern Alberta.

KEY WORDS Alberta, bear–human conflict, bovine spongiform encephalopathy, BSE, grizzly bears, *Ursus arctos*, wildlife disease.

Government programs that aim to manage diseases that threaten human health or livestock can involve draconian methods for control of wildlife. An early example occurred in 1924 when 22,000 deer were culled in Stanislaus National Forest in California, USA, to prevent the spread of foot and mouth disease, a viral disease affecting cloven-hoofed animals (Hagan 1958). Veterinary cordon fences, used to prevent diseases from spreading to livestock from wildlife, have been used repeatedly in Africa with significant ecological effects (Gadd 2012); the Kuke fence completed in 1958 and later buffalo fences built across the Okavango Delta in Botswana ultimately led to the elimination of a vast migration of nearly 1 million blue wildebeest (*Connochaetes taurinus*; Williamson and Mbano 1988, Mbaiwa and Mbaiwa 2006). Aerial gunning has been used to kill >100,000 water buffalo (*Bubalus bubalis*) in the Northern Territory of Australia during the Brucellosis and Tuberculosis Eradication Program (Robinson and Whitehead 2003). Thousands of bison (*Bison bison*) have been killed upon leaving Yellowstone National Park, USA, over concerns that they might spread brucellosis to cattle (Scurlock and Edwards 2010). In England, thousands of badgers (*Meles meles*) have been killed in continuing efforts to prevent the spread of bovine tuberculosis (Krebs et al. 1998, Donnelly et al. 2003); likewise, New Zealand maintains broad-scale programs to poison brushtail possums (*Trichosurus vulpecula*) to protect cattle from the same disease (Ramsey and Efford 2010).

In Canada, mad cow disease, or bovine spongiform encephalopathy (BSE), was discovered in cattle in Alberta, Canada, during 2003. This discovery led to a number of regulatory changes regarding the disposal of livestock, which had potential implications for wildlife. Prior to 2003, rendering companies removed most dead cattle from ranching operations free of charge for use in animal feed. After the discovery of BSE, the Canadian Food Inspection Agency (CFIA) and the provincial government enacted a set of regulations limiting options for disposal of cattle carcasses (CFIA 2009). These regulations led to rendering companies charging for their services. The BSE "crisis" caused substantial economic losses to the Canadian cattle industry, with estimates exceeding US$ 5 billion (Le Roy and Klein 2005). As a result, many ranchers were unable to afford the cost of rendering, which led to dead cattle being left on the landscape (Bergeron and Gagnon 2006).

The above regulations, and subsequent changes in livestock disposal, have potential implications for wildlife. In particular, in areas of western Canada cattle ranches overlap with the range of grizzly bears (*Ursus arctos*). Grizzly bears are known scavengers of livestock carcasses and access to such carcasses can cause increased frequency of grizzly bear incidents (see Hopkins et al. 2010 and Methods for definitions), and lead to

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conflict "hotspots" (Wilson et al. 2005, 2006). Encounters with humans resulted in marked population declines and large-scale extirpations of grizzly bears during the 19th and 20th centuries (Brown 1985, Mattson and Merrill 2002); most recently, the species has been listed as threatened in Alberta, with reductions in bear–human conflicts highlighted as a critical step in the species' recovery (Alberta Sustainable Resource Development 2010). Today, incidents have become rare in national parks and some public lands (Mattson et al. 1996, Mattson and Merrill 2002, Gunther et al. 2004), but human–bear conflicts persist on agricultural lands, largely driven by the attraction of anthropogenic foods for bears, including livestock and cattle carcass dumps ("boneyards"; Mattson 1990; Anderson et al. 2002; Gunther et al. 2004; Wilson et al. 2005, 2006).

The changes to regulations regarding the disposal of dead livestock have the potential to influence bear–human interactions and bear incidents where cattle ranches and grizzly bears overlap. We examined the causes and temporal patterns of grizzly bear incidents over a 12-year period, spanning the changes in CFIA regulations, in southwestern Alberta. We tested the prediction that these regulations have led to an increase in the number of incidents involving grizzly bears. Our results highlight how CFIA regulations were established with little consideration for the welfare of wildlife, and we recommend management strategies and policy changes to reduce bear incidents.

STUDY AREA

The study took place in southwestern Alberta, Canada near the town of Pincher Creek (Fig. 1). The eastern portion of the roughly 3,000 km^2 study area was relatively flat and was dominated by agricultural lands used for ranching. There was a sharp transition from these agricultural lands to rugged mountainous areas on public lands to the west. Human activities varied throughout the study area and included natural gas extraction, logging, recreation, and seasonal cattle grazing on public lands, and primarily cattle grazing and crop production on private lands. The study area encompassed portions of the Municipal District of Pincher Creek and Cardston County, where there were >750 farms reporting cattle, and >200,000 head of cattle (data provided by Cardston County). Grizzly bears used all portions of the study area (with some bears inhabiting private lands almost exclusively) and frequently traveled into British Columbia, Canada, and Montana, USA, which were adjacent to the study area (Northrup et al. 2012). The grizzly bears in this area were part of the Northern Continental Divide

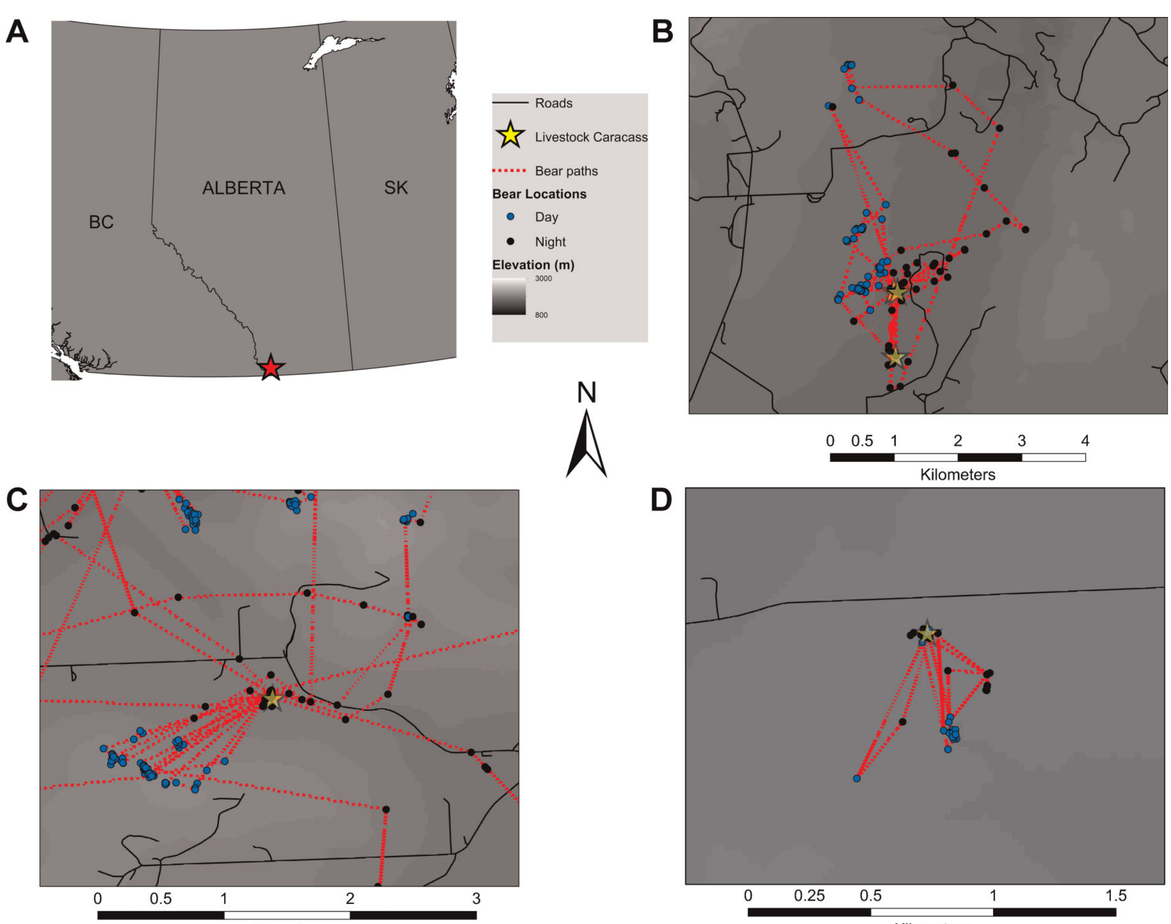

Figure 1. Location of study area in Canada (A), and locations of cattle carcasses, paths, and locations by night and day (night determined as the time between PM civil twilight and AM civil twilight) for 3 grizzly bears collared with Global Positioning System (GPS) collars between 2008 and 2010, in southwestern Alberta, including 6 days of GPS locations for 1 subadult female (B), 1 month of GPS locations for 1 adult male (C), and 3 days of GPS locations for 1 female with 2 cubs of the year (D).

Ecosystem and Flathead grizzly bear populations, which held some of the highest recorded densities of grizzly bears in interior North America (McLellan 1989, Kendall et al. 2008). This population currently is expanding (Kendall et al. 2008), but the number of bears estimated to be in our study area remained constant, or possibly decreased during the study period (1999–2010; Mowat and Strobeck 2000, Alberta Grizzly Bear Inventory Team 2007).

METHODS

Incident Data

Hopkins et al. (2010, p. 157) describe a bear incident, as "an occurrence that involved a human–bear conflict or episodes where bears caused property damage, obtained anthropogenic food, killed or attempted to kill livestock or pets, or were involved in vehicle collisions." Under their definition of anthropogenic food, they include any food having human origin, including livestock (Hopkins et al. 2010).

We reviewed all Alberta Sustainable Resource Development, Fish and Wildlife Division (FW) occurrence reports that occurred in the study area between 1999 and 2010 and that involved grizzly bears, to determine whether they could be considered incidents, as defined above. Reports are filed by FW enforcement personnel whenever wildlife sightings, encounters, or incidents are reported by the public or investigated. These reports were as innocuous as a bear being seen by hikers, or as serious as a bear being killed in self-defense. More serious occurrences (e.g., livestock depredation) are investigated by FW enforcement personnel, while more innocuous incidents (such as sightings) are usually unsubstantiated.

When reviewing FW occurrence reports, we excluded all reports that did not meet the above definition of a grizzly bear incident, except for reports in which grizzly bears were observed in the yard of a private residence. In general, the presence of a bear in a ranch yard denotes potential habituation of the bear to people, as well as the potential for the bear to obtain anthropogenic food or to come into conflict with pets or livestock. In particular, ranch yards often contain potential attractants, such as grain in grain-storage bins. Furthermore, in many instances where bears were seen in the yard of a private residence, extreme actions were taken (e.g., discharging a firearm in the direction of the bear). A similar approach was taken by Wilson et al. (2005, 2006) in characterizing human–bear conflict in ranch lands of Montana; therefore, all incidents and instances of bears being in a yard are hereafter included in the term "incident." We only considered reports in which FW enforcement personnel spoke directly with the reporting individual and documented the subsequent conversation (22% of incidents), or for which FW investigated the incident on site (78% of incidents).

All incidents were reviewed for repetition by examining reports filed on the same dates, and by mapping all incidents using ArcMap 9.2, to review spatially overlapping reports. Unrepeated incidents were summarized by year, type of incident, and outcome. We further summarized the number and type of incidents that led to management trapping, translocation (transportation outside of a bear's expected home range), and relocation (transportation of the bear within its expected home range), which are commonly used to manage bears involved in repeated incidents (Hopkins et al. 2010).

To test the prediction that the CFIA regulations led to increased grizzly bear incidents we examined these data as an uncontrolled before–after pseudoexperiment, in which the enactment of the regulations (done in 2003) acted as the treatment. We compared the number of incidents before and after the enactment of regulations. We obtained data on the number of dead cattle picked up by rendering companies in the 2 counties in which this study took place (the Municipal District of Pincher Creek and Cardston County) and compared these data before and after regulations. Both the number of dead cattle picked up for rendering, and subsequently the number of grizzly bear incidents, could be influenced by cattle production. To test for this potential, we used the number of cattle produced in Alberta as a baseline against which to compare dead cattle picked up and grizzly bear incidents (livestock data obtained from the government of Alberta Agriculture Statistics Yearbook, available from http://www.agric.gov.ab.ca/flippingbook/stats-yearbook/html/index.html). We standardized all data and calculated the annual difference between dead cattle and cattle produced, as well as the difference between incidents and cattle produced. We compared these differences before and after enactment of regulations. For all statistics, we excluded data for 2003 and 2010. Regulations were enacted during 2003, so this year could not logically be assigned to a group. Livestock production data were not available for 2010. We conducted all statistical analysis in the R statistical software (R Development Core Team 2008).

Radiotelemetry Data

Between 2008 and 2009, we captured 7 grizzly bears following the methods of Cattet et al. (2003) and fit them with Tellus II GPS radiocollars (Televilt, Lindsberg, Sweden) set to obtain fixes once every hour. We examined these data to determine whether bears were using areas with known cattle carcasses. We obtained information on the locations of cattle carcasses opportunistically through discussion with ranchers, as well as through visits to sites used by grizzly bears (J. M. Northrup, unpublished data).

RESULTS

Incident Data

We compiled 383 occurrence reports classified as grizzly bear incidents between 1999 and 2010. Incidents increased throughout the study period, with a marked increase from 2004 onward (Fig. 2). This increase was coincident with a precipitous decline in the number of livestock carcasses collected for rendering (Fig. 2). Types of incidents were diverse, though the largest single source was associated with dead livestock (Fig. 3). Furthermore, these livestock-related incidents increased during our study period, particularly from 2004 onward (4/yr prior to 2004 vs. 11.7/yr from 2004 onward; Table 1). Incidents related to grain bins (metal

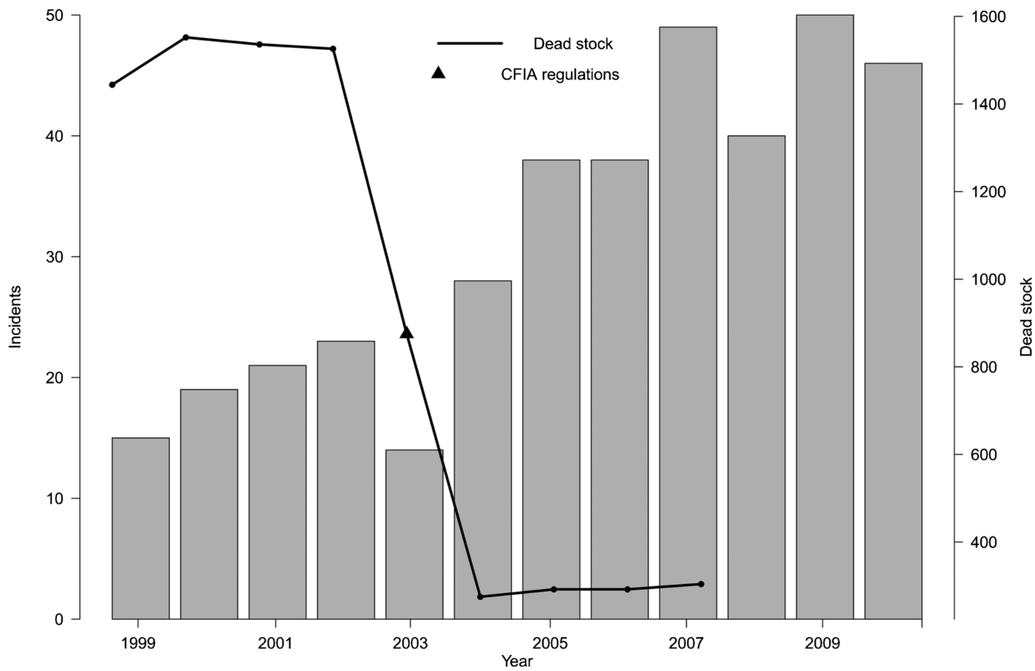

Figure 2. Number of grizzly bear incidents by year between 1999 and 2010 in southwestern Alberta, Canada, and number of dead livestock carcasses collected by the rendering company West Coast Reduction between 1999 and 2007 in Cardston County and the Municipal District of Pincher Creek, the 2 counties in which the study took place. Livestock data provided by Cardston County.

or wooden sheds used to store harvested grain) were the second most common type of incident (20% of all incidents) but were the most common incident type for which management capture efforts were initiated (42%).

Captures and removals of bears occurred every year (Table 1), with an average of 5.1 bears captured and 4.6 bears removed, translocated, or relocated each year. Nearly one-third of bears captured were females (Table 1), although sex was not always reported, so this number should be considered a minimum. Incidents occurred in all months when bears were active (Mar–Dec), although most often during late summer and autumn (67% of conflicts Jul–Oct).

Significantly more incidents occurred on an annual basis after the 2003 regulations ($\bar{x}$ prior to 2003 = 19.75,

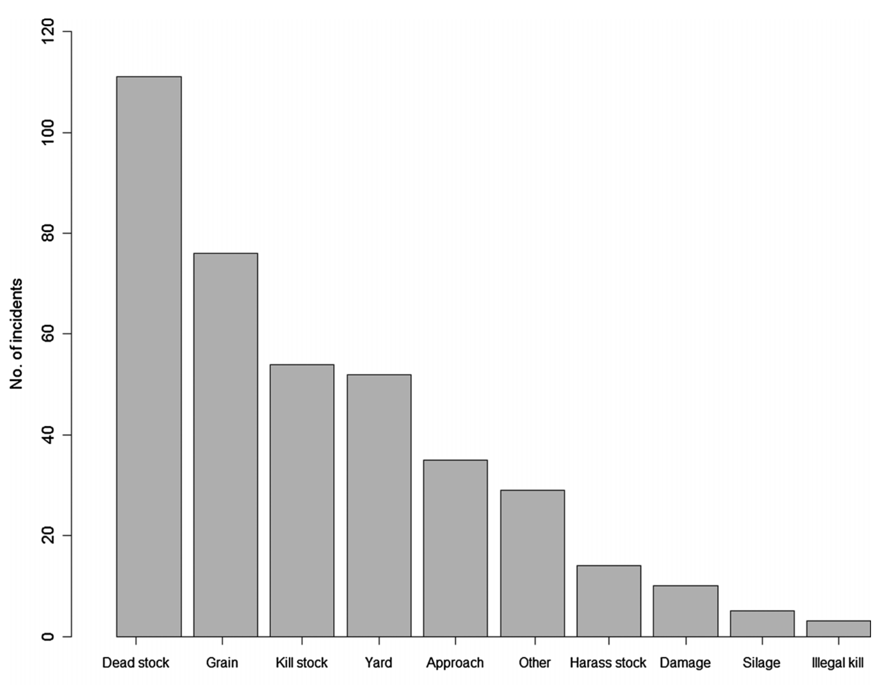

Figure 3. Number of grizzly bear incidents, by cause, between 1999 and 2010 in southwestern Alberta, Canada. "Approach" indicates a bear approaching a person to close proximity, "Other" indicates an incident related to attractants other than dead livestock, silage, or grain; "Damage" indicates damage to personal property; and "Yard" indicates a bear in the yard of a private residence.

Table 1. Number of bears captured, removed, female bears captured, and conflicts related to dead cattle by year for 383 grizzly bear incidents between 1999 and 2010, in southwestern Alberta, Canada.

Year	Capture	Removed[a]	*F* captured	Dead cattle incidents
1999	5	5	3	4
2000	5	4	0	3
2001	2	2	0	6
2002	6	6	4	5
2003	3	2	0	2
2004	8	7	4	5
2005	3	3	2	11
2006	3	1	1	6
2007	11	11	0	10
2008	8	8	3	21
2009	4	4	1	16
2010	3	2	1	13
Total	61	55	19	102

[a] No. of bears translocated, relocated, or destroyed.

$\bar{x}$ after 2003 $= 40.67$, $t = -5.68$, $P < 0.001$), while significantly fewer dead cattle were picked up ($\bar{x}$ prior to 2003 $= 1{,}538$, $\bar{x}$ after 2003 $= 290.75$, $t = -129.41$, $P < 0.001$). When accounting for baseline annual cattle production there were significantly more corrected incidents on an annual basis after the regulations ($t = 5.58$, $P < 0.01$) and significantly fewer dead cattle were picked up ($t = -4.58$, $P < 0.05$).

Radiotelemetry Data

Telemetry relocations confirmed that ≥ 3 collared grizzly bears in our study area used livestock carcasses (Figs. 1 and 4). Bears tended to use carcasses and boneyards more at night than during the day. However, we have an incomplete inventory of carcass dumps because they are located on private lands, limiting our ability to inventory them. Known carcass dumps were revisited by grizzly bears, and wolves (*Canis lupus*) and cougars (*Puma concolor*) also frequented carcass dumps (Morehouse and Boyce 2011; J. Banfield, University of Alberta, personal communication). All but one bear in our study frequented adjacent management districts in British Columbia and Montana, which highlights the international nature of this population.

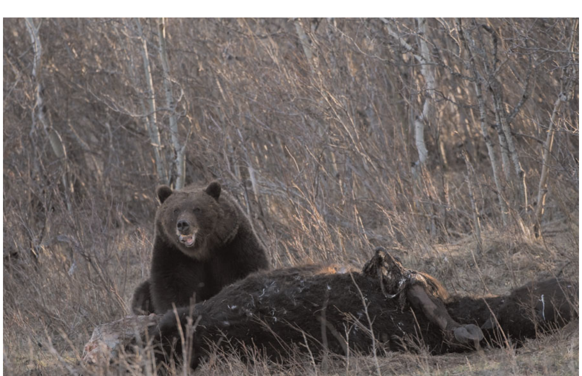

Figure 4. Grizzly bear feeding on dead livestock in southwestern Alberta, Canada in 2010. Photo credit: Sinclair Imagery Inc.

DISCUSSION

The high proportion of grizzly bear incidents related to dead livestock, as well as the marked increase in incidents since 2003, are major management concerns. While incidents in the conterminous United States, both on public and private land, have decreased during this period (Madel 2008), the trend in incidents in southwestern Alberta is moving in the opposite direction. Furthermore, these incidents have led to a high rate of management capture, which increases the likelihood of injury, repeat conflict, or mortality (Riley et al. 1994, Blanchard and Knight 1995, Linnell et al. 1997, Cattet et al. 2008). With an estimated 51 bears in the area (Alberta Grizzly Bear Inventory Team 2007), the situation in southwestern Alberta likely constitutes a population sink sustained by dispersal from large populations in adjacent areas of Montana and British Columbia.

The Alberta Grizzly Bear Recovery Plan (Alberta Sustainable Resource Development 2010) highlights reduction of human–bear conflicts as an important step toward recovery (Alberta Sustainable Resource Development 2008). However, the CFIA regulations have led to unforeseen difficulties in this step. The number of livestock carcasses collected by rendering companies declined dramatically in direct response to the CFIA regulations. Before 2003, an average of approximately 1,500 dead livestock were collected, falling to almost 300 animals after the regulations. This has resulted in >1,000 cattle carcasses left on the landscape, or roughly 320,000 kg/year of available meat (320 kg/animal). This represents a major food source for scavengers such as grizzly bears, and we know that bears not only fed on these carcasses, but did so repeatedly, and occasionally became problem bears as a result.

Although the most serious incidents were not related to dead cattle, boneyards likely are acting as an initial attractant, which eventually leads to more troublesome behavior. Bears often become food-conditioned in the presence of anthropogenic foods, such as cattle carcasses, which leads to more serious conflicts and conflict hotspots (Herrero and Fleck 1990; Wilson et al. 2005, 2006). The annual rate of incidents related to dead livestock nearly tripled after regulations were enacted, which indicates that bears are responding to this increased anthropogenic food source. While the bear population in this area remained constant, or potentially decreased, between 1997 and 2007 (Mowat and Strobeck 2000, Alberta Grizzly Bear Inventory Team 2007), the population that we studied is contiguous with an expanding population of grizzly bears in the United States (Kendall et al. 2008); thus, this problem might be set to increase.

Although it is legal to maintain boneyards under current federal and provincial regulations (Alberta Agriculture and Rural Development 2002), such disposal of livestock leaves specified risk material (body parts most likely to be infected with BSE) in the environment. Wild animals (including carnivores) held in captivity and fed with BSE-infected feed, have contracted forms of transmissible spongiform encephalopathy (Williams and Miller 2003), although this is highly unlikely in a natural setting. Boneyards have increased throughout Canada (Bergeron and Gagnon 2006). Thus, although it might be unlikely for BSE to be transmitted to wildlife through carcasses, the potential for conflict between humans and wildlife, and for transmission of other diseases to wildlife, is widespread, and other scavengers could be at risk.

MANAGEMENT IMPLICATIONS

The reduction of human–bear interactions and conflicts is a crucial step in the recovery of Alberta's threatened grizzly bear population. In our study area, the FW and local stakeholder groups are working to devise means of disposal that secure carcasses from bears and other carnivores known to scavenge on livestock carcasses, including coyotes (*C. latrans*), wolves, and cougars (Morehouse and Boyce 2011; J. Banfield, unpublished data). However, without changes to the CFIA regulations, these efforts will be hampered, because they disallow removal of carcasses without a permit and unless carcasses are removed to permitted landfills (permits are valid for only 48 hr, and many landfills are not permitted to accept livestock carcasses). Revisions to these regulations are needed; for example, relaxation of carcass-disposal permitting requirements would make it easier for ranchers to remove carcasses from areas where they can be accessed by bears. Additionally, other means of conflict reduction should be examined; innovative disposal methods, such as composting in secure facilities, might offer an effective and secure option, while subsidies to reduce the cost of livestock collection to producers or to the rendering industry should be explored, and new technologies should be investigated to ensure sanitary disposal of carcasses (e.g., there might be other markets for cattle carcasses; Bergeron and Gagnon 2006). Proactive management by Alberta Fish and Wildlife Division is likely to reduce the number of incidents between bears and humans, but a long-term solution must include regulatory reform aimed at facilitating livestock carcass removal from the land. When combined with programs aimed at promoting and ensuring proper storage of attractants, we believe that such policy reforms will make it possible for humans to coexist with grizzly bears in southwestern Alberta.

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