

HUMAN INJURIES INFLICTED BY BEARS IN ALBERTA: 1960-98

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Abstract: Between 1960 and 1998, bears caused 42 serious or fatal human injuries in the Province of Alberta---29 (69%) by grizzly (brown) bears (*Ursus arctos*) and 13 (31%) by American black bears (*U. americanus*). Considering Alberta's estimated bear population figures---about 1,000 grizzly bears and 38,000-39,000 black bears---these raw numbers suggest the extent to which grizzly bears are the more dangerous of the 2 species. Serious and fatal bear-inflicted injuries increased in number in Alberta, including its national parks, each decade, from seven during the 1960s to 13 during the 1990s, an increase proportional to the province's human population growth during the same period. Of all bear-inflicted serious injuries and fatalities, roughly half (52%, 22 of 42) occurred in Alberta's national parks, and 95% of these (21 of 22) were caused by grizzly bears. All but 1 black bear attack (92%, 12 of 13) occurred outside the national parks. Two factors have characterized grizzly bear-inflicted injuries in the national parks: 1) large numbers of visitors in grizzly bear habitat, and 2) difficulties with management of people's food and garbage (particularly before the mid-1980s). The grizzly bear population found outside Alberta's national parks is estimated at about 4 times that found within park boundaries, but these bears on provincial lands inflicted only 28% (8 of 29) of the serious or fatal injuries. These data point to 2 primary needs: 1) the disproportionate occurrence of grizzly bear incidents within the national parks and the association of these injuries with high visitor numbers and food and garbage management difficulties highlight the continuing need to address these challenges in Alberta's national parks; and 2) the location of nearly all black bear attacks outside the national parks underlines the need for improved communication to people using black bear habitat regarding the rare but potential danger from attempted predation on people by black bears.

Ursus14 (1): 000-000

Key words: Alberta, American black bear, bear attacks, bear behavior, brown bear, Canada, human deaths, human injuries, predatory bears, *Ursus americanus*, *Ursus arctos*.

Bear attacks on human beings are rare phenomena of significant interest to the public and wildlife managers. Researchers and managers believe many bear attacks could be prevented through applying knowledge of bear behavior and ecology (Herrero 1970 a,b, 1985, 1989, Martinka 1982, Herrero et al. 1986, Middaugh 1987, McCrory et al. 1989, Herrero and Fleck 1990, Gunther 1994, Herrero and Higgins 1995, 1998, 1999, Gniadek and Kendall 1998, Miller and Tutterow 1998). The more serious bear-inflicted human injuries usually have been carefully investigated and accurate documentation exists facilitating analysis and understanding. Herrero and Higgins (1999), as part of an analysis of bear attacks in British Columbia, Canada, recently reviewed research regarding injuries to people inflicted by American black or grizzly/brown bears in North America.

Because different jurisdictions such as national parks, provinces and states, often manage bears differently, analysis of bear attacks at this level is worthwhile because it can provide insight and

guidance to managers as well as persons at risk. Most recent studies of bear attacks in North America have focused on national parks (Herrero 1985, Gunther 1994, Gniadek and Kendall 1998), and to a lesser extent states or provinces (Middaugh 1987, Miller and Tutterow 1998, Herrero and Higgins 1999).

We documented and analyzed all known serious and fatal bear-inflicted injuries that occurred in the Province of Alberta, 1960-1998. Alberta is located in the southwestern portion of Canada and has an area of 661,185 km². The current human population is estimated to be about 3 million. Historically, grizzly bears ranged throughout the province (Nagy and Gunson 1990). Today the range is primarily in the western approximately one-third of the province with most grizzly bears being found along the eastern slopes of the Rocky Mountains. Black bears are found in most forested areas or about three-quarters of the province. Only the south-eastern-most portion of the province is without substantial tree cover.

Province-wide population estimates with confidence limits do not exist for either grizzly or black bears. There are estimated to be significantly more grizzly and black bears on lands under provincial versus federal (national park) jurisdiction (Table 1). Both species are hunted except in national parks and certain other, relatively small, protected areas.

Alberta has 3 national parks, Banff, Jasper and Waterton Lakes, totaling 18,024 sq. km. that support grizzly bears (Table 1). These parks have about 8.5% of the estimated occupied grizzly bear range in the Province (212,240 sq. km.: derived from Nagy and Gunson 1990), and they support an estimated 17 – 20% of the grizzly bear population. These parks receive heavy visitation. Average visitation for the period from 1993 – 1998 was significantly higher for Banff and Jasper than for Waterton Lakes (Table 2). This averaging period was chosen as being representative of the latter part of our study period. With the exception of Kananaskis Country, which is adjacent to Banff National Park, large provincial protected areas with grizzly bears receive low visitation.

Banff, Jasper and Waterton Lakes National Parks also have black bears. Wood Buffalo National Park has only black bears and receives few visitors, averaging approximately 5,700 visitors per year over the period 1994 – 1998. The combined national park areas with black bears are 62,831 sq. km. This supports an estimated 3-6% of the black bear population in Alberta.

Prior to the early 1980s, Alberta national parks with grizzly bears had extensive food and garbage available to grizzly and black bears. However, after one person was killed and three others seriously injured by a human food-conditioned grizzly bear near the town of Banff, in Banff National Park, major bear-proof food and garbage storage began to be implemented (Herrero 1985). By the mid-1980s much less food and garbage was available to grizzly bears in Alberta's national parks or Kananaskis Country.

Table 1. Grizzly and black bear population estimates and ranges sizes, Alberta, Canada.

	Range Size ^a (km ²)		Population Estimate	
	Grizzly Bear	Black Bear	Grizzly Bear	Black Bear
AB provincial	194,216	433,058	860 ^b	37,000 ^b
Banff National Park	6,641	6,641	55 – 80 ^c	50 – 62 ^f
Jasper National Park	10,878	10,878	100 – 110 ^d	70 – 90 ^g
Waterton Lakes National Park	505	505	20 – 25 ^e	40 ^e
Wood Buffalo National Park	0	44,807	0	1000 – 2000 ^h
TOTAL	212,240	495,889	1035 – 1075	38,160 – 39,192

^a These are crude range size estimates. The Alberta provincial estimates do not include national parks. Grizzly bears are found in approximately one-third of the total Alberta lands including national parks; black bears in approximately three-quarters.

^b B. Treichel, Alberta Environment, Wildlife, Edmonton, personal communication, 2000. Bears in national parks are not included.

^c G. W. Vroom, Banff National Park, Warden Service, Banff, personal communication, 1975; and M. Gibeau, same address, personal communication 2000.

^d Russell et al. 1979

^e R. Watt, Waterton Lakes National Park, Warden Service, Waterton, personal communication, 2000.

^f Kansas et al. 1989.

^g W. Bradford, Jasper National Park, Warden Service, Jasper, personal communication, 2000.

^h S. Malcolm, Wood Buffalo National Park, Warden Service, Ft. Smith, NT, 2000.

Table 2. Visitor use numbers, 1993-1998, and serious injuries and fatalities, 1960–98, for national parks, Alberta, Canada.

Park	Average Frontcountry Visitors per Year ^a	Average Backcountry User Nights per Year ^a	Total number of serious injuries + fatalities
Banff	4,508,440	19,423 ^b	10
Jasper	1,693,570	21,704 ^c	8
Waterton Lakes	372,180	2,656	4

^a For the period from 1993 – 1998.

^b Backcountry visitation results for were unavailable for one portion of Banff National Park for 1997. Data for this area were averaged over the number of years for which data were available. Backcountry visitation data for Banff National Park also include visitation to Alpine Club of Canada huts, backcountry shelters, and horse users in order to maintain comparison with earlier published data.

^c Backcountry visitation results for Jasper were unavailable for 1994, 1995 and 1996.

METHODS

Data for 1960 - 79 were from a previously analyzed database as described in Herrero (1985). We collected data for 1980 - 93 by contacting all management agencies within Alberta with jurisdiction over bears, and requesting copies of investigation reports and other such information on bear attacks. This was part of a larger effort to systematically update a North American database on bear-human interactions that was begun in 1967 by the senior author. Data from 1994 - 98, inclusive, were based on annual summaries and detailed case reports gathered by both the Natural Resources Service of Alberta Environment, and the national parks within Alberta. Other sources for data included other published accounts (e.g., Tough and Butt 1993), and interviews with victims.

We entered individual incidents into a database and classified data according to methods described by Herrero and Higgins (1995). The following definitions guided data classification:

Startled: the bear was seemingly first aware of the person(s) at a close distance, typically less than 50 m, but occasionally greater. The bear showed stress behaviours such as: salivating, vocalizing, clicking upper and lower teeth together, standing upon hind legs, running toward or away from the person(s), hitting the ground with forepaw(s), and rotating ears back. The person's behaviour prior to the encounter may have contributed to the bear's being startled. For example, the person may have been downwind of the bear, or may not have been making loud noise. There may have been high ambient noise such as at a location near a rushing stream. Dense vegetation may have impeded vision. We regard bear attacks preceded by the bear's being startled as defensive (some have used the term provoked in this context).

Predation: was identified by a series of behaviors—searching, following and/or testing, attacking (capturing), killing, sometimes dragging a person, sometimes burying, often feeding upon. To be classified as predation, killing and some related behaviors had to be reported. Vocalizing and stress behaviors by the bear were usually absent.

Attempted predation?: some of the behaviors associated with predation occurred but killing did not.

Predatory attacks: involved "predation" or "attempted predation?"

Front-country: locations were within 2 km of travelled roads, including auto access campgrounds, landfills, picnic areas, rural home sites. This also included the portion of hiking trails that were within 2 km of travelled roads. A travelled road was defined as a paved road or a high-speed gravel road that had regular vehicle traffic.

Back-country: locations were greater than 2 km from travelled roads. Back country locations included trails, backcountry lodges, backcountry cabins, and backcountry campsites.

Motivation: we evaluated a bear's motivation primarily by the circumstances of the attack, and the bear's behavior prior to and during the attack. For example, a black bear that followed, killed, dragged and partially consumed a person would be classified as predacious. In some incidents, there was insufficient information to infer a motivation, or the observed behaviors did not allow clear inferred motivation. In these incidents, the inferred motivation was classified as "unknown".

We believe the data for Alberta represent all fatal and serious injuries (defined as those requiring 24 hours or more of hospitalization) inflicted by bears during 1960–98, although a few incidents may be missing from the early decades. Because the data represent the population of such incidents and not a sample of them, we did not use statistics to test for significance. However, we did not generalize results beyond the population and time period we studied. Some details regarding certain incidents were lacking. In these cases we had a sample of data and tested for significant differences using the χ^2 test with William's correction factor to test for differences between frequencies (Zar 1984). We did not analyze incidents of minor injury because of inconsistent recording. Because some incidents resulted in injury to more than one person, the total number of serious and fatal injuries was greater than the total number of incidents. Depending on the variable under study, we have presented our results either in terms of the number of injuries, or the number of incidents. This decision was made based on whether the variable was primarily a function of the injury or of the incident.

We obtained visitor-use data for the national parks from Parks Canada. Human population data were obtained from Statistics Canada.

RESULTS

Serious or Fatal Injuries, 1960-98

Grizzly bears inflicted most (69%, 29 of 42) serious or fatal injuries (Table 3). The percentage of injuries that were fatal was greater for black bears, 42% (5 of 12), than for grizzly bears 32% (7 of 22). The number of serious and fatal injuries inflicted by bears increased each decade from the 1960s to the 1990s ($F = 189.5$, $P < 0.005$; Fig. 1). Within this time period, there was year-to-year variation in the number of serious injuries and fatalities, but no evident 2nd-order trends with time beyond the gradual increase (Fig. 2).

The injury rate from both species of bears combined (expressed as the number of serious or fatal injuries per million people per year) also had no trend 1960 – 98 ($F = 0.13$, $P < 0.76$, Table 4). The increase in the number of serious or fatal injuries by decade parallels the increase in human population.

Table 3. Number of serious or fatal injuries and incidents inflicted by grizzly bears and black bears, 1960–98, Alberta, Canada.

Species	Number of incidents resulting in serious injury or fatality	Number of serious injuries	Number of fatalities	Total number of serious injuries + fatalities ^a
Grizzly	22	22	7	29
Black	12	8	5	13
Total	34	30	12	42

^a A single incident may include multiple serious injuries or fatalities; therefore, the total number of serious injuries and fatalities exceeds the total number of incidents.

Fig. 1. Annual average of bear-inflicted serious injuries and fatalities by decade, 1960–98, Alberta, Canada.

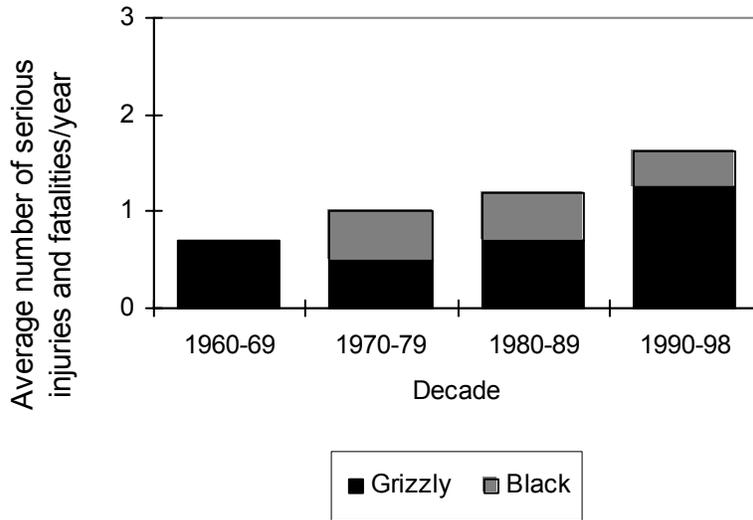


Fig. 2. Bear-inflicted serious injuries and fatalities and human population, 1960–98, Alberta, Canada.

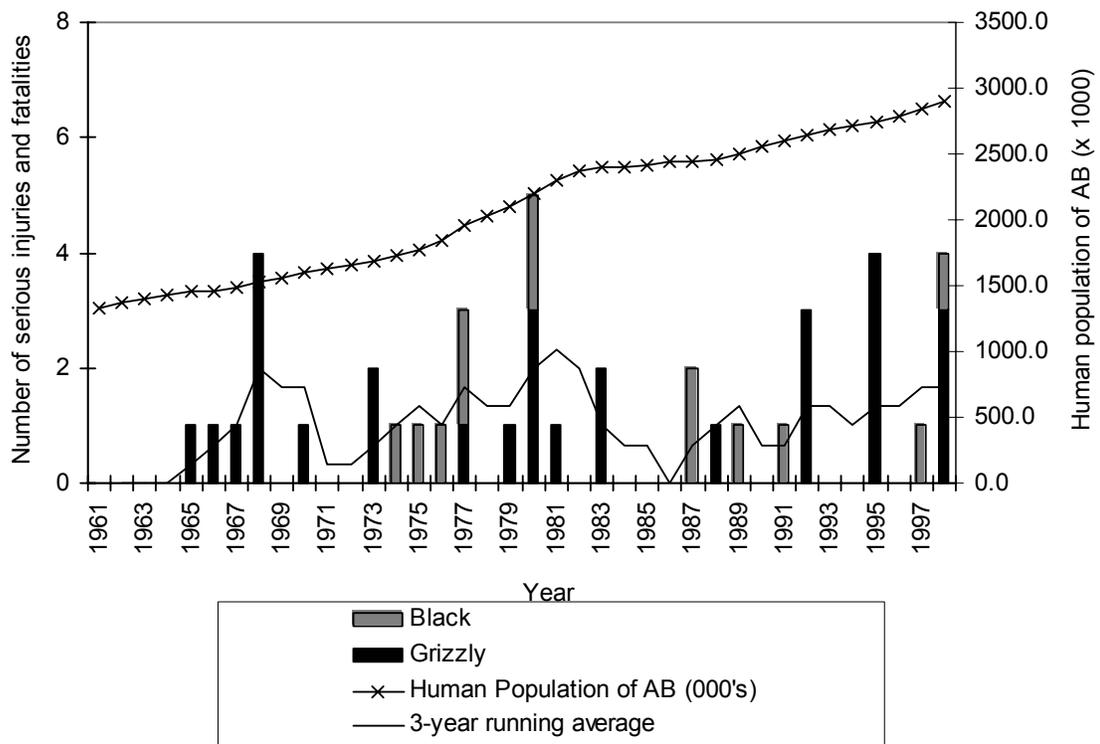


Table 4. Combined injury rates for grizzly and black bears, 1960–98, Alberta, Canada.

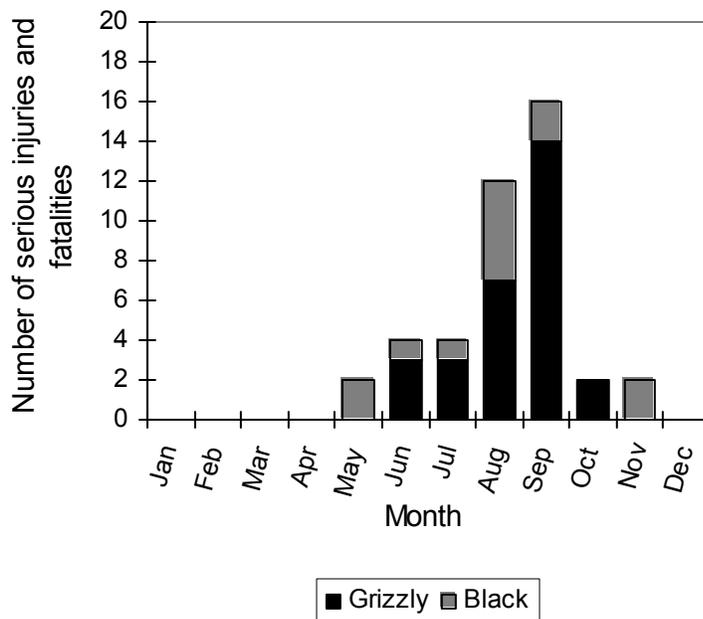
Decade	Number of serious or fatal injuries	Average human population	Annual injury rate (per million people)
1960s	7	1,431,000	0.49
1970s	10	1,799,600	0.56
1980s	12	2,394,100	0.50
1990s	13	2,719,311	0.53*

* The annual injury rate for the 1990s was calculated for the 9-year period from 1990 to 1998.

Serious injuries and fatalities were clustered from May - November, with the peak in September (Fig. 3). There were no serious injuries or fatalities recorded in the months from December to April, inclusive, when most bears are in their dens.

For incidents where the time of the attack was known, 73% (16 of 22) that involved grizzly bears, and 73% (8 of 11) that involved black bears, occurred during the daytime (between 0600 and 1800). Three incidents for each species occurred during the evening (between 1800 and 2400). Three grizzly bear and no black bear incidents occurred between 2400 and 0600. Two of these nighttime, grizzly bear incidents we classified as predatory.

Fig. 3. Monthly distribution of serious injuries and fatalities inflicted by bears, 1960–98, Alberta, Canada.



The percentage of serious injuries or fatalities that occurred in the national parks versus Alberta provincial lands per decade varied between 42-62% (Table 5). The percentage occurring in the national parks declined from the 1960s through the 1980s and then increased in the 1990s (Table 5). The percentage of grizzly bear-inflicted injuries that occurred in the national parks far exceeded the proportion of this species found there versus provincial lands. Grizzly bears inflicted all but 1 of the serious injuries or fatalities (21 of 22) that occurred within the national parks from 1960 – 98. All but 1 of the serious injuries or fatalities (12 of 13) inflicted by black bear, 1960 – 1998, occurred on provincially managed lands.

Table 5. Bear-inflicted serious injuries and fatalities by decade, for national parks and areas outside national parks, 1960–98, Alberta, Canada.

Decade	Total number of serious injuries and fatalities	Number of serious injuries and fatalities outside national parks	Number of serious injuries and fatalities in national parks (%)
1960–69	7	3	4 (57)
1970–79	10	5	5 (50)
1980–89	12	7	5 (42)
1990–98	13	5	8* (62)
Total	42	20	22 (52)

* Includes one incident resulting in 4 injuries caused by a single grizzly bear in Banff National Park. This bear became food-conditioned at the Revelstoke dump in British Columbia. The bear was captured at Revelstoke and relocated to eastern British Columbia, nearby Banff National Park.

People and Parties Injured

In 90% (19 of 21; $G_1 = 15.5$, $P < 0.001$) of incidents involving grizzly bears where the size of the party was known, the injured parties consisted of 1, 2 or 3 people. These small parties were injured more often by a grizzly bear than larger parties, but we do not know the relative proportions of different party sizes for persons traveling in bear habitat. In 100% (11 of 11; $G_1 = 14.6$, $P < 0.001$) of incidents involving black bears where the size of the party was known, the parties consisted of 1 or 2 people. The remaining black bear incident involved a larger party of an unknown size outside of a bear's den, and resulted in one fatality and one serious injury.

Sixty-two percent (8 of 13) of persons injured by black bears, were hiking, working, or recreating (Table 6). Fifty-nine percent (17 of 29) of persons injured by grizzly bears were hunting, hiking, or working (Table 6). Twenty-eight percent (8 of 29) of grizzly bear-inflicted injuries occurred while the person was in camp.

Seventy-six percent (32 of 42) of victims of serious or fatal injuries were male. The ratio of male to female victims was larger for grizzly bear than for black bear-inflicted injuries (4.8:1 and 1.6:1, respectively). Of the 13 victims of black bear attacks, 5 were female and 8 were male. Of these, 60% (3 of 5) of the female victims suffered fatal injuries, compared to 25% (2 of 8) of the male victims. Of the 29 victims of grizzly bear attacks, 5 were female and 24 were male. Of these, 20% (1 of 5) of the female victims suffered fatal injuries, compared to 25% (6 of 24) of the male victims.

Seventy-one percent (5 of 7) of victims of predatory black bear attacks were adults, and 29% (2 of 7) were youths (age 10-19). Two of the 4 victims of predatory grizzly bear attacks were adults, and 2 were children (age < 10).

Table 6. Activities of victims prior to injury by bears in Alberta, Canada, 1960–98.

		Activity Class*					
		Camping	Hiking	Miscellaneous Recreation	Occupational	Other and Unknown	All
Grizzly Bear Incidents	Specific activities	Backcountry: 3 Frontcountry: 4 Unknown: 1	Hiking (noise level unknown): 5 Hiking (quietly): 4 Hiking (noisily): 1 Walking: 1	Hunting: 4 Horseback riding: 1 Playing: 1 Fishing: 1 Cycling: 1	Geological exploration: 1 Relocating trapped bear: 1		
	Total number of victims	8	11	8	2	0	29
	Activity Class*						
		Camping	Hiking	Miscellaneous Recreation	Occupational	Other and Unknown	All
		Specific activities	Backcountry: 1 Frontcountry: 1	Hiking (noise level unknown): 1 Walking: 2	Sitting: 2 Picking berries: 1	Geological exploration: 1 Farming: 1	Unknown: 2 Other: 1
Black Bear Incidents	Total number of victims	2	3	3	2	3	13

* Although some persons injured could have been put into more than 1 activity class, they were not. We used what we judged to be the primary activity to classify the incident.

Bears that Inflicted Injury

In none of the 34 incidents were injuries caused by >1 bear.

For incidents involving grizzly bears where the age and sex of the bear was known (N=22), the bear was identified as adult female in 59 % (10 of 17) of the incidents (Table 7). In 9 of these 10 incidents, cubs were reported to have been present. Where only the age-class was known, 94% (17 of 18) of the grizzly bear incidents involved an adult.

In incidents involving black bears where the age and sex of the bear was known (N=12), the bear was male in 5 of 7; $G_1 = 1.2$, $P = 0.266$) of the incidents where the sex of the bear was known (Table 7). The bear was an adult in 83% (5 of 6) of the incidents and subadult in 17% (1 of 6) where the age class of a black bear was known. Three of the 7 black bears involved in potentially predaceous attacks were adult males, 1 was a subadult male, and 3 were an unknown sex and age class. One of the 12 black bear incidents involved a bear (unknown sex and age) that attacked a man who had shot and injured the bear. Another incident involved a female apparently acting in defense of her cubs. Although body condition and disease cannot be ruled out as possible contributors to attacks, they

seemed to be associated with a small fraction of attacks. In 1 of the 12 incidents involving black bears, the bear was noted as being thin and having low food-value items in its stomach, when necropsied by Alberta Environment personnel. Possible predation was the inferred motivation in this incident. In 1 of 22 incidents involving grizzly bears, the bear was noted as having high *Trichinella sp.* This incident was characterized as being a sudden encounter where the bear was defending a food source.

Table 7. Sex and age classes of grizzly and black bears involved in serious injury or fatal incidents in Alberta, Canada, 1960–98.

Sex	Age Class	Grizzly Bear	Black Bear
Male	Adult	6	4
	Sub-adult	1	1
	Unknown	0	0
Female	Single Adult	1	0
	Adult with Offspring	9	1
	Sub-adult	0	0
	Unknown	0	1
Unknown	Adult	1	0
	Sub-adult	0	0
	Unknown	4	5
Total		22	12

Bear Attacks - Associated Variables

For black bear attacks where the duration was known two lasted <2 minutes, one lasted 5-10 minutes, and three lasted 10–30 minutes. For grizzly bear attacks where the duration was known, seven lasted <2 minutes, three 2-5 minutes, one 5-10 minutes, one 10-30 minutes, and one 2-3 hours. The 2-3 hour incident was fatal and involved a bear that was trapped, drugged and being relocated.

In 25% (3 of 12) of incidents involving black bears, human food or garbage was noted within 100 m of the attack site, and the bear was judged to be “searching for food or garbage”. These 3 incidents resulted in 3 serious injuries.

In 14% (3 of 22) of incidents involving grizzly bears, human food or garbage was noted within 100 m of the attack site. In 27% (6 of 22) of incidents, the bear had a known history of feeding on human food or garbage; and in 9% (2 of 22) of incidents, the bear was “searching for food or garbage”. In total, 36% (8 of 22) of grizzly bear incidents were associated with one or more of these food or garbage variables. These 8 separate incidents resulted in 3 fatalities and 9 injuries.

Three incidents (resulting in 1 fatality and 3 injuries) involved grizzly bears defending animal carcasses. In these three incidents, the bear sex and reproductive status varied (one male bear, one single bear of unknown sex, and one female bear with two cubs). In all three cases, the bear that inflicted injury was first noticed at less than 50 m. There were no carcass-related incidents involving black bears.

In 50% (4 of 8) incidents on provincial lands involving grizzly bears, the person attacked was hunting immediately prior to the attack.

One fatality was associated with relocating a trapped grizzly bear.

In 64% (14 of 22; $G_1 = 1.62$, $P = 0.203$) of incidents involving grizzly bears, the inferred motivation was “startled”. Of these incidents where the bear’s inferred motivation was “startled,” the initial encounter distance was <50 m in 100% (11 of 11; $G_1 = 14.6$, $P < 0.001$) of the incidents where the initial encounter distance was known.

Only 18% (4 of 22) of the grizzly bear incidents were classified as predatory, whereas 58% (7 of 12) of black bear incidents were judged to be predatory.

Fifty-six percent (10 of 18) of incidents involving grizzly bears where the location with respect to development was known occurred in back-country locations, while 44% (8 of 18) occurred in front-country locations. Fifty-eight percent (7 of 12) incidents involving black bears occurred in back-country locations and 42% (5 of 12) occurred in front-country locations.

DISCUSSION

An estimated 35 times more black bears (Table 1 population estimate 38,160 – 39,192) than grizzly bears (Table 1 population estimate 1035 – 1075) reside in the Province of Alberta on provincially managed lands, and within federally managed Banff, Jasper, Waterton, and Wood Buffalo National Parks. Between 1960-1998 fewer grizzly bears inflicted more than twice as many serious and fatal injuries to people as did black bears. We also recently found similar differences in the ratio of injuries inflicted by black versus grizzly bears for the Province of British Columbia (Herrero and Higgins 1999). This confirms long-standing colloquial knowledge regarding the relative danger of the two bear species.

The total number of injuries and fatalities inflicted by both species of bears combined increased in Alberta each decade since the 1960s. However, if the increasing human population of Alberta is used as a surrogate for the rate of interactions with bears, then the injury rate did not increase. This contrasts with British Columbia where the injury rate during the 1980s and 1990s increased when compared to the 1960s and 1970s (Herrero and Higgins 1999). We speculate, but do not have supporting data, that the increased injury rate in BC was due to a greater increase in outdoor activities than in Alberta, resulting in more interactions between people and bears. Habitat differences may also have played a role. Most BC grizzly bear habitat is moister than grizzly bear habitat in Alberta. This results in denser tree and understory growth and more opportunity for sudden encounters between people and bears.

Grizzly bear-inflicted injuries peaked during September with a secondary peak in August. On provincial lands, 3 persons injured during September were ungulate hunting prior to injury. The remaining 11 grizzly bear-inflicted injuries during September were inflicted to people who were recreating in a national park. The monthly peak in number of black bear-inflicted injuries in Alberta occurred during August. In British Columbia both black and grizzly bear-inflicted injuries peaked during August (Herrero and Higgins 1999). A possible explanation for injuries being relatively high during August and September is that this is the season when many berries are ripe and both species of bears are feeding on them. Many people are also active in the outdoors at this time in habitats that produce berries. This supports a long-standing finding that the number of bear-inflicted injuries is best predicted by interaction rates between people and bears within a given area (Martinka 1982).

Bear attacks occurred primarily during daytime reflecting the diurnal activity preferences of both people and bears (Herrero 1985). Only 3 grizzly bear attacks occurred at night between 2400 and 0600. All were associated with apparent food or garbage attractants or a history of feeding on these by the bear involved. Two of these 3 attacks were classified as predatory. An analysis of fatal grizzly bear attacks that occurred in Banff, Glacier (Montana), or Yellowstone National Parks, 1967-1986, showed that all of 8 fatal attacks judged to be predatory occurred during the night (Herrero 1989). Human food or garbage-conditioned grizzly bears are more likely to approach people and camps (Herrero 1985). We believe that such approaches are reluctant. This is suggested by such incidents occurring when the bears have the cover of darkness.

Grizzly bear incidents occurred disproportionately often in the national parks. Here large numbers of people traveling on foot in grizzly bear habitat were occasionally involved in close range, sudden encounters with grizzly bears where the bear attacked defensively. In other national park incidents, people's food or garbage brought grizzly bears into proximity to people. Only 1 human food or garbage related incident occurred on provincial lands. Food and garbage availability, grizzly bears, and large numbers of people seldom if ever occurred together on provincial lands. Human food or garbage-conditioned bears, versus similar non-conditioned bears, are more likely to be involved in attacks on people (Herrero 1970a, 1985, 1989, Gunther 1994). Although human food and garbage became dramatically less available to bears in the Rocky Mountain national parks in Alberta after the mid-1980s, some such problems persisted and visitor numbers continued to increase. Hunting of grizzly bears on much of the land under provincial jurisdiction may have eliminated food-conditioned bears here.

Most black bear incidents occurred on provincial lands. This probably was due primarily to the much larger numbers of black bears found in these lands.

As has been previously shown (Herrero 1970a, 1985), most of the bear-inflicted injuries were to small parties of 1 to 3 people. Data on the frequency of different group sizes in Alberta could not be found so inferences regarding differential risk by party size are weak. Small parties may be less noisy and therefore more likely to surprise a bear this would only account for the grizzly bear incidents preceded by sudden surprise. However, small parties were also most often represented in the black bear attacks where predation appeared to be the primary motive, not defense of personal space following a surprise encounter. When a bear detects a person it must decide whether to flee or remain. If it remains it may or not act aggressively. Perhaps parties of 1-3 people are less intimidating to a bear thus increasing the chance of attack. This suggests that in trying to intimidate a bear the appearance of party strength could be important, particularly regarding potentially predatory bear attacks.

Hiking, walking or camping were common activities preceding both black and grizzly bear-inflicted injuries. These activities exposed people on foot to bears. This sometimes led to surprise or other encounters with grizzly bears, and created opportunity for rare predaceous attacks, especially by black bears. In contrast, all of the grizzly bear-inflicted injuries that occurred in camp were associated with food or garbage related factors.

Fifty percent (4 of 8) of grizzly bear-inflicted injuries on Alberta provincial lands were associated with hunting. Grizzly bears will occasionally aggressively "defend" animal carcasses they have claimed, even if the dead animal was shot by a hunter, but left for a while (Herrero 1985). Even more rarely, grizzly bears will attempt to physically take an animal carcass away from a person. In British Columbia 35% (17 of 49) of injuries inflicted by grizzly bears during 1960-97 were associated

with people involved in hunting-related activities prior to attack. In contrast, there were no recorded injuries inflicted to hunters by black bears in either British Columbia or Alberta during the periods studied. This further demonstrates behavioral differences between black and grizzly bears.

During 1960 – 1998 in Alberta, 5 people died as a result of black bear attacks. Thus, general inference about fatal injury from black bear attacks based on our Alberta data is necessarily constrained. Still, the fact that 3 of those deaths were among the 5 females attacked whereas 2 of 8 males that were attacked died, suggests to us a possible gender-based difference in ability to survive a predaceous black bear encounter. If we are correct, education on how to recognize and deter potentially predaceous black bears, while useful for all travelers in black bear country, could particularly benefit females.

Bears that inflicted injury

These data are consistent with the well-established but poorly documented finding (Herrero 1970a, 1985) that grizzly bear females with young are the most dangerous cohort for this species and adult males the most dangerous category for black bears (Herrero 1985, Herrero and Higgins 1995). These differences seem to be related to evolutionary differences between the species), and between male and female bears (Herrero 1972, 1985).

The differential involvement of adult female grizzly bears with young in attacks on humans is further supported by their forming a small percentage of a grizzly bear population but inflicting a large percentage of injuries to people. For example, in the Greater Yellowstone Area the population had 27.4% adult females (Eberhardt and Knight 1996). These females had an average interlitter interval of 3 years. Therefore, two-thirds of the population, 18.3%, had young with them on average each year. Yet in Alberta females with young inflicted 54% (9 of 17) of injuries where sex and age of the attacking grizzly bear was known. In similar studies in North American national parks, females with young inflicted 74% (20 out of 27) (Herrero 1985: pp.22-23) of grizzly bear-inflicted injuries, and females (whether young were present not stated) inflicted 74% (23 of 31) of injuries in British Columbia (Herrero and Higgins 1999).

The high involvement of grizzly bear females with young in attacks by this species makes it difficult to reduce injuries by increasing hunting take. Grizzly bear populations are sensitive to adult female mortality rates (Harris 1986). An alternate strategy for human safety in grizzly bear habitat is for people to learn to minimize triggering attacks by grizzly bear females with young, and if this fails to minimize injury (Herrero 1985).

Bear attacks – associated variables

Alberta data were consistent with previous findings that surprise encounters with grizzly bears were typically of short duration (<2 minutes) as if the bear was startled, trying to end a threat and then leave (Herrero 1985). Such incidents seldom resulted in fatal injuries but often caused serious injury. Black bear incidents tended to be of long duration (10-30 minutes) suggesting that most of the incidents we analyzed were predatory and the bear persisted either until it was successful or deterred (Herrero 1985, Herrero and Higgins 1995). This interpretation is consistent with our finding that a greater percentage of black bear versus grizzly bear attacks were fatal.

Neither our study nor others of which we are aware determined the percentage of the bear population that had experience feeding on people's food or garbage. However, we suspect that this

association and related habituation, predispose bears, especially grizzlies, toward being more dangerous to people (Herrero 1970a, 1985, 1989, see also Gunther 1994). Half of all serious or fatal grizzly bear incidents in the national parks had some form of food or garbage involvement as did the only black bear incident in the national parks. We suggest that some bears, regardless of species, when rewarded for being bold or aggressive by getting people's food or garbage may transfer these traits into behavior toward people. Despite the association between food-conditioning, habituation and attacks on people, such attacks are still rare. Most bears that are food-conditioned do not attack people. The Alberta data for both species are consistent with, but do not prove, this view. In areas where there is grizzly bear hunting, such as most of the Province of Alberta, human-food conditioned bears, excepting females with young, are probably selectively removed by hunting..

All grizzly bears involved in injurious sudden encounters were first perceived at <50 m by the person(s) injured. We assume, albeit without clear evidence, that in most cases the bear involved was not aware of the person until the same distance and then chose to react to a perceived threat by attack instead of flight. Most grizzly bears flee even when surprised at close range (Herrero 1985). Strategies for avoiding surprise encounters with grizzly bears are well known, as are strategies for minimizing injury if attacked (Herrero 1985).

Most serious and fatal black bear attacks were predaceous whereas most such attacks by grizzly bears involved close range, sudden encounters (defensive behavior). However, both species were involved in each type of situation to some extent. In deciding how to respond to a potentially escalating bear encounter, judging whether the bear is acting defensively or offensively will suggest the best course for human response (Herrero 1985). A reasonable rule of thumb is that most daytime grizzly bear attacks are defensive, and most black bear daytime attacks, if persistent, are predatory. However, both species have shown defensive and predatory behavior during attacks on people.

MANAGEMENT IMPLICATIONS

The detailed management implications that came from a recent similar review and analysis of bear attacks in British Columbia are relevant here but will not be restated (Herrero and Higgins 1999). Most recommendations focused on conveying knowledge regarding bear behavior, ecology and attacks to specific at-risk parties such as hunters. For example, persons traveling in bear habitat during berry season should be aware of the increased chance of encountering bears in this type of habitat and also that bear-inflicted injuries in Alberta and British Columbia most often occurred during the berry production months of August and September.

The disproportionate occurrence of grizzly bear incidents within the national parks and the association of these injuries with high visitor numbers, sudden encounters at close range, and food and garbage management difficulties, highlight the continuing need to address these challenges by communication and management in Alberta's national parks. Bear and people managers will need to continue to identify and help correct such situations while also being alert for any individual bears that become aggressive and dangerous.

The location of nearly all black bear attacks outside the national parks underlines the need for improved communication to people using black bear habitat regarding the rare but potential danger from predatory attacks on people by black bears and how to deter such situations.

ACKNOWLEDGMENTS

Our sincere thanks to the many Alberta conservation officers and Canadian national parks employees who assisted in data collection. Special thanks to R. Flath, J. Gunson (retired), and Bruce Treichel of Alberta Environment for their help in data collection. Thanks to W. Tucker, B. Aris, R. Watt, Glen Peers, and Wes Bradford of Parks Canada, for assisting us with injury and visitor use data in Alberta's national parks. Major editorial assistance came from Rich Harris, Dick Shideler, Kerry Gunther, and John Hechtel. Financial support for this research came from the Alberta Conservation Association

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