HUMAN INJURIES INFLICTED BY BEARS IN BRITISH COLUMBIA: 1960–97

STEPHEN HERRERO, Environmental Science, Faculty of Environmental Design, University of Calgary, Calgary, AB T2N 1N4, Canada, email: herrero@ucalgary.ca
ANDREW HIGGINS, Environmental Science, Faculty of Environmental Design, University of Calgary, Calgary, AB T2N 1N4, Canada, email: andrew.higgins@questepc.com

Abstract: There is controversy in British Columbia regarding how dangerous bears are. Grizzly bear (*Ursus arctos*) population estimates range from 10,000–13,000; black bears (*U. americanus*), 120,000–160,000. From 1960–97, significantly fewer grizzly bears inflicted about 3 times as many serious injuries ($N = 41$ versus 14) but the same number of fatal injuries ($N = 8$) as black bears. The trend in terms of average number of bear-inflicted injuries/year increased each decade from the 1960s through the 1990s, as did the human population in British Columbia. It is likely that more people in bear habitat affected this increase in the number of injuries. In 88% of serious or fatal grizzly bear attacks, those injured were engaged in hunting, hiking, or working, typically in back-country areas. In 77% of black bear attacks, those injured were either hiking, watching the bear, working, or recreating, typically in front-country areas. Eighty-one percent of parties injured by grizzly bears and 69% of parties injured by black bears were composed of 1 or 2 people. Bear access to human food or garbage was associated with a relatively small number of incidents for each species. In grizzly bear incidents where the age and sex class were known, adult females were identified in 79% of incidents. All incidents where the gender of an attacking black bear was known involved males. These incidents were equally divided between adults and subadults. Poor health of the bear was identified in 16% of black bear and 7% of grizzly bear incidents. Sixty-two percent of the serious or fatal grizzly bear incidents, where the bear's motivation could be inferred, were categorized as involving a bear being startled at close range (<50 m) and 19% involved ungulate carcasses. For black bear incidents, where the bear's motivation could be inferred, 83% involved possible predation. None involved ungulate carcasses and none involved the bear being startled. Risk of bear attack can be managed through individual responsibility and communication targeted at individuals and groups such as ungulate hunters, hikers and campers, and persons working in bear habitat.

Ursus 11:209–218

Key words: bear attacks, bear behavior, black bear, brown bear, human deaths, human injuries, hunting, predatory bears, predation on people, *Ursus americanus, Ursus arctos*

In 1967, 2 young women were killed during a 24-hour period by different grizzly bears in Glacier National Park, Montana. These were the first fatal grizzly bear-inflicted attacks in the park. In an article in *BioScience*, one biologist wrote that grizzly bears in Glacier and Yellowstone national parks were too dangerous and they should be extirpated (Moment 1968, 1969). This opinion spurred the first scientific assessment of bear-inflicted injuries and their circumstances (Herrero 1970*a*). One of these circumstances was the potential danger of grizzly bears that have become food-conditioned by eating people's food or garbage and have become habituated to the presence of people. These behavioral changes seemed the most probable explanation for the bears' behavior in Glacier National Park and in subsequent incidents in which grizzly bears attacked and killed sleeping tourists camped in tents or in the open in Glacier and Yellowstone national parks (Herrero 1985, 1989). These were offensive attacks, not defensive actions, such as a sow grizzly with cubs might make when encountering a person at close range (Herrero 1985).

Within a few years of the 1967 fatalities, Glacier and Yellowstone national parks responded by implementing some of the best food and garbage management practices in North America. The Rocky Mountain national parks (Banff, Jasper, Kootenay, Waterton, and Yoho) in Canada followed suit, but only after a food-conditioned and human-habituated grizzly bear killed 1 person and seriously injured 3 others near Banff in 1980 (Herrero 1985). As a result of improved food and garbage management techniques, Glacier and Yellowstone national parks in the United States have dramatically reduced injury rates by both grizzly and black bears. At the same time they have handled, killed, or translocated dramatically fewer bears (Gunther 1994, Gniadek and Kendall 1998). While never as high as their U.S. counterparts, injury rates in the Canadian Rocky Mountain national parks also have decreased with better food and garbage management techniques (Herrero unpublished data).

Herrero (1985) also identified and evaluated other circumstances associated with grizzly bear attacks such as sudden surprise and harassment, and for black bears, rare instances of predatory attacks (Herrero 1985, Herrero and Higgins 1995). Herrero and Fleck (1990) showed that bear-inflicted injuries (grizzly and black bear combined) in North American national parks were few between 1980–85. Total number of park visitors/bear-inflicted injury varied between 317,700 for Kluane to 6,693,859 for Yoho. Back-country overnight users had significantly greater chances of injury. Here, rates varied from 5,691 visitors/injury for Waterton to 118,297 for Denali. Many national parks had no injuries during 1980–85.

With an estimated 120,000–160,000 black bears and 10,000–13,000 grizzly bears, British Columbia (B.C.) supports some of the highest numbers of bears of any jurisdiction in North America (BC Bear Facts, undated

publication, Ministry of Environment, Lands and Parks, Victoria, British Columbia, Canada). Most bears exist outside of national parks or other protected areas and they are hunted. B.C. covers 948,000 km^2, and has a human population of approximately 3,941,500. During the mid to late 1990s, about 450 grizzly bears and 5,885 black bears were known or estimated to have been killed by people each year in B.C. through a combination of legal hunting, poaching, and as a result of bear–people conflicts (BC Bear Facts, undated publication, Ministry of Environment, Lands, and Parks, Victoria, B.C., Canada). At least 1 prominent outdoorsman is of the opinion that current management policies combined with large numbers of bears creates danger that is unacceptable to the point that "To insure public safety...bear populations [should be reduced] by about 25% in parks and places where people and bears must co-exist" (Shelton 1994:209). One of the objectives of our paper is to provide data on the extent and nature of bear-inflicted injuries in B.C. so that management policies regarding human safety around bears in B.C. can be objectively evaluated.

Injuries from bears have been little studied in areas where they are hunted outside of national parks and other protected areas. The few existing studies are primarily from a medical perspective, in Alberta (Tough and Butt 1993) and B.C. (Thommasen et al. 1994). Somewhat more in depth studies have been done in Alaska, but these have relied primarily on newspaper accounts of incidents as Alaska does not officially investigate bear attacks (Middaugh 1987, Miller and Tutterow This Volume). Hunting, hiking, and recently, camping were identified as primary activities associated with bear-inflicted injuries in Alaska (Middaugh 1987). Miller and Tutterow (This Volume) reported that between 1986 and 1996, brown bear attacks resulted in 2.75 injuries and 0.42 deaths/year in Alaska, whereas black bear attacks resulted in 0.33 human injuries/year and only 1 fatality during this 11 year period. Alaska has approximately half of the brown (grizzly) bears in North America, with an estimated population of 31,700; at least as many black bears are thought to be in Alaska (Miller and Tutterow This Volume). In the Bob Marshall Wilderness of Montana, grizzly bear-inflicted injury rates were estimated to be 1 injury/4.5 million recreational visitor use days, 1956–94 (U.S. Fish and Wildlife Service 1997).

People's acceptance of injury rates is fundamental to bear conservation. Despite what appear to be relatively low injury rates in national parks and in Alaska and elsewhere, to some people any chance of injury by a wild animal may be unacceptable. For this reason, as well as the general obligations of wildlife managers, we need to understand circumstances associated with bear-inflicted injury so as to better manage bears and risk of injury and to advise the public regarding risk of injury and what individuals can do to decrease that risk. This research was formulated partly to address these questions in the Province of British Columbia.

METHODS

We gathered data for 1980–93 by contacting all management agencies within B.C. 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 by the senior author in 1967. Data for 1960–79 were from the original database as described in Herrero (1985). Data from 1994–97, inclusive, were based on annual summaries and detailed case reports gathered by the Wildlife Branch of the B.C. Ministry of Environment, Lands, and Parks, and by contacting national parks within B.C. Other sources for data included the B.C. Division of Vital Statistics, coroners' reports, and other published accounts (e.g., Thommasen et al. 1994).

The methods used to compile incidents in national parks were an extension of those reported by Herrero and Fleck (1990) for 1980–85. We collected injury data from the national parks through 1997. However, because visitor use data were available only prior to 1994, we calculated injury rates only for 1986–93. These data represent *all* bear-inflicted injuries in the national parks in B.C., including minor injuries. In all other sections of this paper, only serious injuries or fatalities are analyzed.

We entered individual incidents into a database and analyzed the aggregate data. We classified data according to methods described by Herrero and Higgins (1995). We believe the data for B.C. represent all fatal and serious injuries (requiring 24 hours or more of hospitalization) inflicted by bears during 1960–97, 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, all differences are significant. Some details regarding certain incidents were lacking. In these cases, we had a sample of data, and we used the *G* test with Williams correction factor to test for differences between frequencies (Zar 1984). We did not analyze incidents of minor injury because of inconsistent recording, except in national parks in B.C. from 1980–93. Because some incidents resulted in injury to >1 person, the total number of serious and fatal injuries was greater than the total number of incidents.

We obtained visitor-use data for the national parks from Parks Canada and bear harvest data from the Wildlife

Table 1. Number of serious or fatal injuries and incidents inflicted by grizzly bears and black bears, 1960–97, British Columbia, Canada.

Species	Number of incidents resulting in serious injury or fatality	Number of serious injuires	Number of fatalities	Total number of serious injuries + fatalities[a]
Grizzly	44	41	8	49
Black	19	14	8	22
Unknown	1	0	1	1
Total	64	55	17	72

[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.

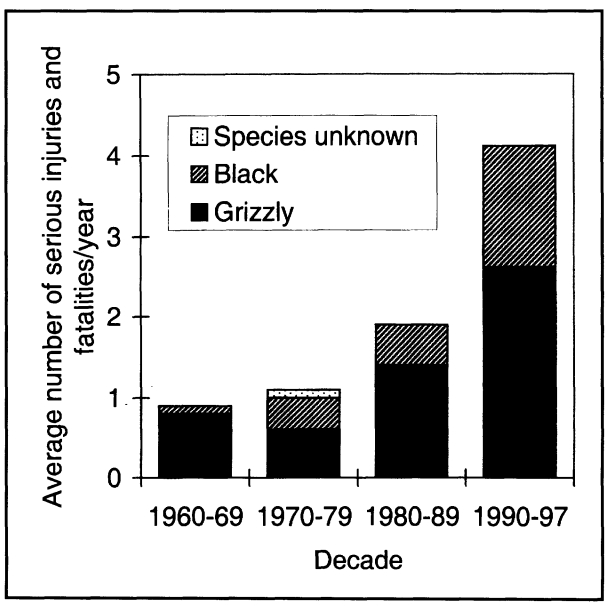

Fig. 1. Annual average of bear-inflicted serious injuries and fatalities by decade, 1960–97, British Columbia, Canada.

Branch of the B.C. Ministry of Environment, Lands, and Parks. Human population data were downloaded from the home page of B.C. Stats, B.C. Ministry of Finance and Corporate Relations.

We sometimes found correlations between different data sets. Only when several converging and independent lines of evidence suggested the same conclusion was correlation assumed to have a reasonable probability of indicating causation.

RESULTS

Serious or Fatal Injuries, 1960–97

Grizzly bears inflicted most (68%, 49 of 72) serious or fatal injuries (Table 1). Grizzly and black bears were responsible for equal numbers of fatal injuries. The number of serious and fatal injuries inflicted by bears increased each decade from the 1960s to the 1990s (Fig. 1). While the number of serious injuries and fatalities varied from year-to-year, the overall trend for 1960–97 was up, as shown by a 3-year running average (Fig. 2). The injury rate from both species of bears combined (the mean number of residents of B.C./bear-inflicted injury) increased during the 1980s and 1990s (Table 2). The rate of increase in injuries significantly exceeded the rate of human population increase during the 1990s (Fig. 2). All differences are significant because we are describing populations of events, not samples.

Serious injuries and fatalities were clustered from May–October, with the peak in August (Fig. 3). There were no serious injuries or fatalities recorded in the months of February, March, April, or December.

For incidents where the time of the attack was known, 85% (33 of 39; $G_1 = 20.3$, $P = 0.000$) that involved grizzly bears, and 94% (17 of 18; $G_1 = 16.8$, $P = 0.000$) that involved black bears, occurred during the daytime (between 0600 and 1800). One grizzly bear and no black bear incidents occurred between midnight and 0600.

The percent of serious injuries or fatalities that occurred in the national parks in B.C. declined since the 1970s (Table 3). Grizzly bears inflicted all serious injuries or fatalities that occurred within the national parks from 1960–97.

Consistent with 1980–85 rates (Herrero and Fleck 1990), the injury rates for front or back-country visitors to the national parks in B.C. from 1986–93 were low (Tables 4 and 5). While the back-country injury rate for Yoho National Park increased 1986–93 compared to 1980–85, the injury rate for front-country visitors declined for the same periods. The small number of injuries for any individual park can make the injury rates quite variable, reducing the validity of trends in these rates. Back-country visitors were significantly more likely to be injured by a bear than were front-country visitors.

Gwaii Haanas National Park, a new park in the Queen Charlotte Islands off the northwest coast of B.C., was established in early 1996. Prior to this it had varying degrees of protection from resource extraction and hunting. Only black bears occur in this area, and no serious or fatal bear-inflicted injuries were reported during 1985–

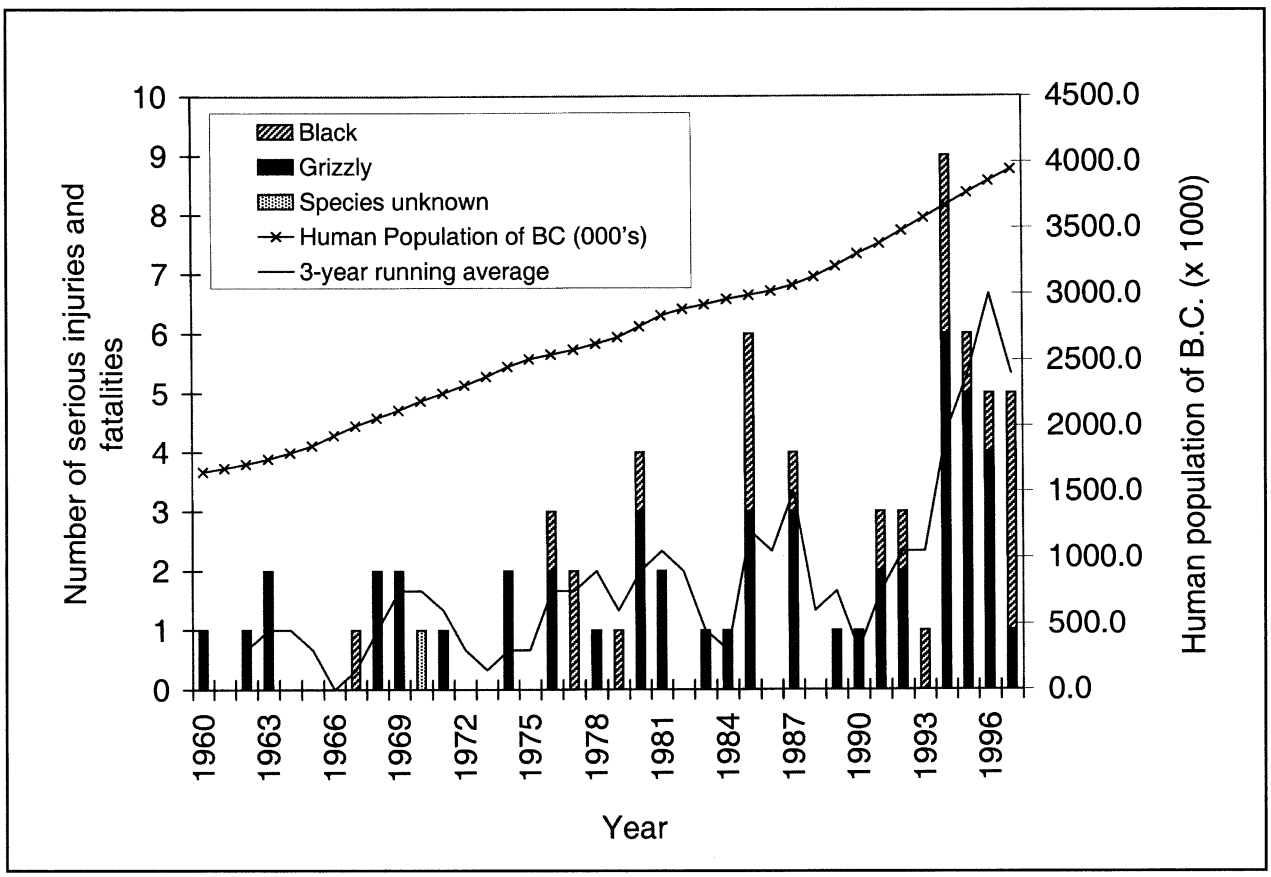

Fig. 2. Bear-inflicted serious injuries and fatalities and human population, 1960–97, British Columbia, Canada.

Table 2 Combined injury rates for grizzly and black bears, 1960–97, British Columbia, Canada.

Decade	Number of serious or fatal injuries	Average human population	Annual injury rate (per person)
1960s	9	1,855,470	1/2,061,630
1970s	11	2,452,250	1/2,229,320
1980s	19	2,977,090	1/1,566,890
1990s	33	3,620,440	1/877,680

97. Visitation was low, averaging less than 5,000 people/year.

Bear Harvest Numbers.—Grizzly bear harvest numbers declined from the 1960s to 1990s, and this declining trend seemed inversely related to the grizzly bear-inflicted injury rate, although there was year-to-year variability (Fig. 4). The black bear harvest increased during the 1960s and 1970s and leveled off during the 1980s and 1990s (Fig. 4). The number of injuries inflicted by black bears was not strongly correlated with harvest.

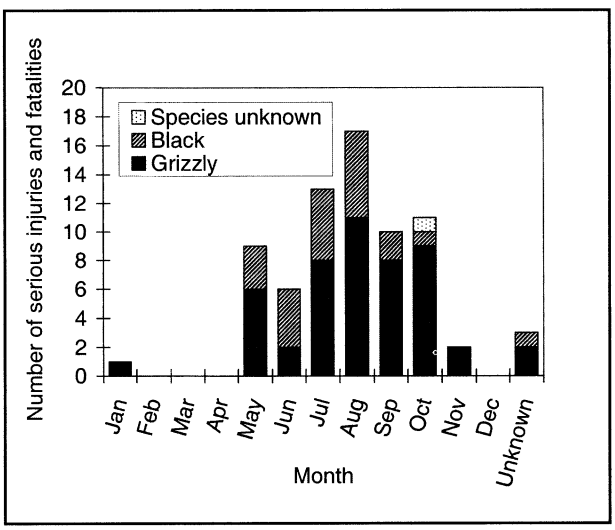

Fig. 3. Monthly distribution of serious injuries and fatalities inflicted by bears, 1960–97, British Columbia, Canada.

People and Parties Injured

In 81% (35 of 43) of incidents involving grizzly bears the injured groups consisted of 1 or 2 people. These small groups were more likely to be injured by a grizzly bear than larger groups ($G_1 = 18.1$, $P = 0.000$), but we do not know the relative proportions of different group sizes for the hiking population as a whole. In 69% (11 of 16)

Table 3. Bear-inflicted serious injuries and fatalities by decade, for national parks and areas outside national parks, 1960–97, British Columbia, 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	9	8	1 (11)
1970–79	11	8	3 (27)
1980–89	19	18	1 (5)
1990–97	33	31	2 (6)
Total	72	65	7 (10)

Table 4. Rate of injurious interactions between park visitors and black or grizzly bears for national parks in British Columbia, Canada, 1980–93.

	Mean number visitors/year		Mean number of visitors per injury from					
			Black bear		Grizzly bear[a]		Total bears	
Park	1980–85	1986–93	1980–85	1986–93	1980–85	1986–93	1980–85	1986–93
Kootenay	1,913,773[b]	1,572,003[c]	–[d]	–	–	12,576,024	–	12,576,024
Mt. Revelstoke-Glacier	3,899,154	4,783,819[e]	–	–	–	–	–	–
Pacific Rim[f]	677,247	790,313	–	–	*	*	–	–
Yoho	1,137,956	2,624,375[g]	–	20,995,000	6,693,859	20,995,000	6,693,859	10,497,500

[a] * Species does not occur in park.
[b] Total visitation for Kootenay are for 1980–83 inclusive.
[c] Mean number of visitors excludes 1986 (no data available).
[d] – Indicates no injuries or deaths by this species for the period noted.
[e] Mean number of visitors excludes 1986 and portions of 1987–89 (no data available).
[f] Pacific Rim total visitation is for Long Beach Unit only.
[g] Mean number of visitors excludes 1986, 1987, and portions of 1988 and 1993 (no data available).

of incidents involving black bears where the size of the group was known, the groups consisted of 1 or 2 people ($G_1 = 2.2$, $P = 0.135$). There were no recorded injuries inflicted by a bear to groups of 6 or more people.

Seventy-seven percent (17 of 22) of persons injured by black bears were hiking, watching the bear, working, or recreating (Table 6). Eighty-eight percent (43 of 49) of persons injured by grizzly bears were hunting, hiking, or involved in work (Table 6). Eight percent of grizzly bear-inflicted injuries (4 of 49) occurred while the person was in camp.

Eighty-one percent (58 of 72) 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 (5:1 and 2.7:1, respectively).

Twelve of the 18 (67%) victims of potentially predatory black bear attacks were adults, 5 (28%) were youths (age 10–19) and 1 (6%) was a child (<10 years old). Three of the 5 victims of potentially predatory grizzly bear attacks were adults and 2 were youths.

Table 5. Rate of injurious interactions between humans and black or grizzly bears in backcountry areas of national parks in British Columbia, Canada, 1980–93.

	Mean number backcountry user nights/year		Mean number of backcountry user nights per backcountry injury from					
			Black bear		Grizzly bear		Total bears	
Park	1980–85	1986–93	1980–85	1986–93	1980–85	1986–93	1980–85	1986–93
Kootenay	3,146[b]	3,383[b]	-[c]	–	–	27,064	–	27,064
Mt. Revelstoke–Glacier	1,351	no data	–	–	–	–	–	–
Pacific Rim	22,791	33,346[d]	–	–	*	*	–	–
Yoho	2,703	2,786	–	22,288	15,900	22,288	15,900	11,144

[a] * Species does not occur in park
[b] Average backcountry visitation for Kootenay excludes 1985, 1986, 1991 (no data available)
[c] – No injuries or deaths by this species for the periodd
[a] Average backcountry visitation results for Pacific Rim excludes 1980 (no data available). All Pacific Rim backcountry use results are for the West Coast Trail Unit.

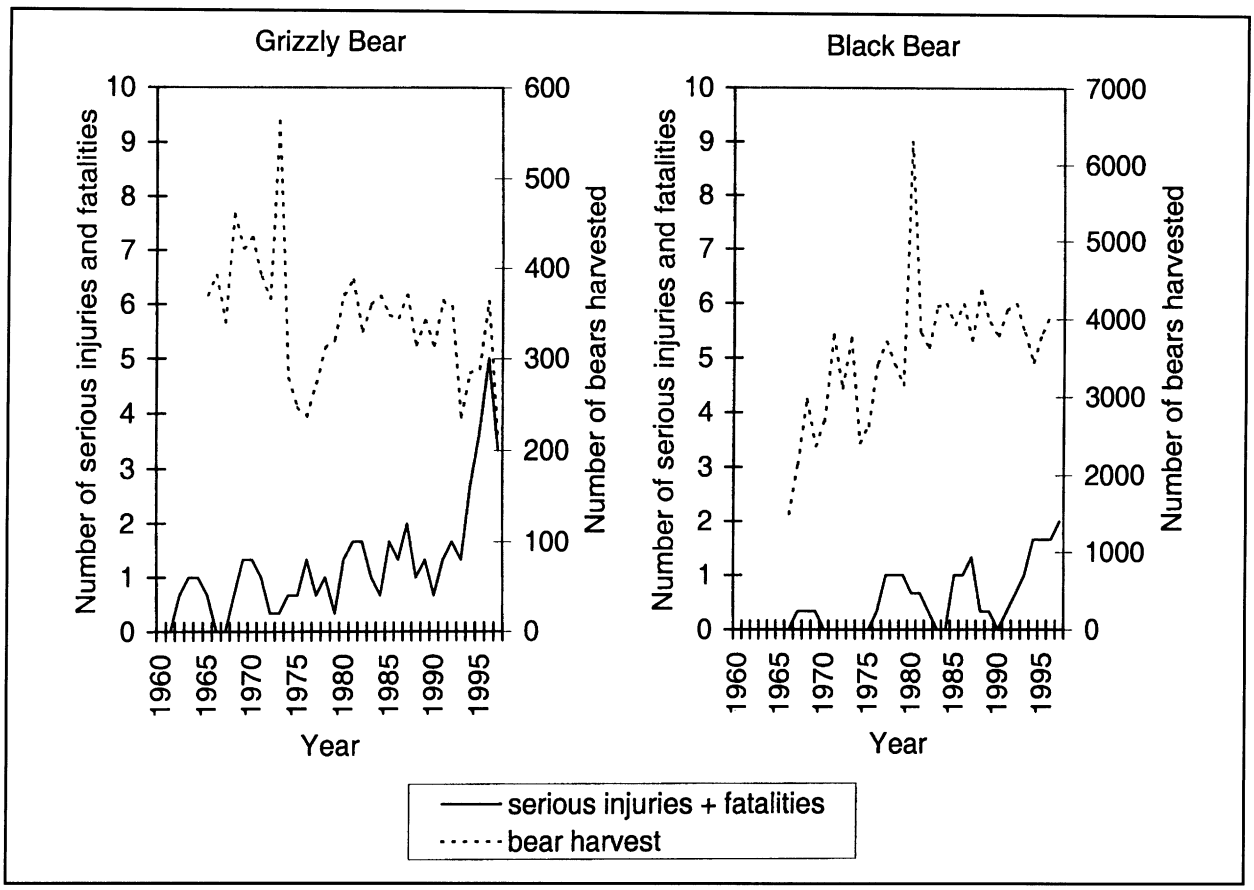

Fig. 4. Bear-inflicted serious injuries and fatalities (3-year running average) and bears harvested, 1960–97, British Columbia, Canada.

Bears that Inflicted Injury

In all but 1 of the 64 incidents studied, only 1 bear was actively involved in the attack. In the incident in which 2 bears were involved, a grizzly bear sow was the most aggressive bear, but her cub participated by biting the person's arm and dragging him.

In incidents involving grizzly bears ($N = 44$), the bear was identified as female in 74% (23 of 31) of the incidents where the sex of the bear was known ($G_1 = 7.4$, $P = 0.006$; Table 7). The bear was an adult in 88% (28 of 32) of the incidents where the age class of the bear was known ($G_1 = 19.9$, $P = 0.000$). The adult female cohort was responsible for 79% (22 of 28) of the incidents where the age and sex class of the bear were known ($G_1 = 9.5$, $P = 0.002$).

In incidents involving black bears ($N = 19$), the bear was male in all (13 of 13) of the incidents where the sex of the bear was known (Table 7). The bear was an adult in 50% (7 of 14) of the incidents and subadult in another 50% (7 of 14) where the age class of a black bear was known. Five of the 15 black bears involved in potentially predatory attacks were adult males, 5 were subadult males, 2 were males of an unknown age class, 2 were adults of unknown sex, and 1 was an unknown sex and age class (Table 7).

In 3 of the 19 incidents involving black bears, the bear was judged to have had low body weight by inspecting B.C. Conservation Officers. Possible predation was the inferred motivation of all 3 bears. These 3 incidents represented 6 serious or fatal injuries. In 1 case, the B.C. wildlife officers who necropsied the bear observed "almost no body fat".

In 3 of 44 incidents involving grizzly bears, poor physical condition of the bear was identified by inspecting B.C. Conservation Officers. Body weights of 2 bears were judged to be low. These bears were reported to have had little fat and generally poor body condition. The inferred motivation in 1 of the attacks was a female acting in defense of her cubs. The second incident involved a male bear, and the inferred motivation was a bear attempting to claim a hunter's kill. The third case involved an adult male bear who, when autopsied, had apparently normal fat reserves but infected teeth. The bear was not in hibernation in January at the time of the attack. The in-

Table 6. Activities of victims prior to injury by bears in British Columbia, Canada, 1960–97.

	Activity (number incidents)					
	Hunting	Hiking	Working	Camping	Other or unknown	Total
Grizzly bear victims	Hunting (14) Cleaning animals (3)	Walking (5) Hiking, noise level unknown (4) Hiking, quietly (4) Hiking, noisily (2) Hiking, with dog (1)	Forestry (7) Geological exploration (3)	Backcountry (2) Frontcountry (1) In a tent (1)	2	
Grizzly bear total	17	16	10	4	2	49
Black bear victims	Fishing 1 Cycling 1 Playing 1	Walking (2) Hiking, noise level unknown (1) Hiking, quietly (4)	Forestry (2) Geological exploration (1)	Backcountry (1)	Watching bear (4) Other (3) Unknown (1)	
Black bear total	3	7	3	1	8	22

ferred motivation of this incident was possible predation.

Bear Attacks — Associated Variables

In 16 of 22 (73%) grizzly bear attacks where the duration of attack was known, the attack lasted <2 minutes, (G_1 = 4.6, P 0.032). For 5 black bear attacks the duration was: <2 min (1), 10–30 min (3), and 1–2 hours (1).

In 2 of the 19 incidents involving black bears, human food or garbage was noted within 100 m of the attack site; a known history of feeding on human food or garbage was noted in 3 incidents, the bear was judged to be "searching for food and garbage" in 2 incidents, and we judged the trigger for aggression to be food odors in 1 incident. In 3 of 44 incidents involving grizzly bears, human food or garbage was noted within 100 m of the attack site; the bear had a known history of feeding on human food or garbage in 3 incidents; the bear was "searching for food and garbage" in 2 incidents; and the trigger for the aggression was judged to be food odors in 1 incident. Five incidents (resulting in 5 injuries) involved grizzly bears defending animal carcasses. Three other incidents (resulting in 3 fatalities and 1 serious injury) involved grizzly bears attempting to claim hunters' kills as the hunters were cleaning or carrying their kills.

In 23 of 37 (62%) incidents involving grizzly bears, where the bear's motivation could be inferred, the motivation was "startled" (G_1 = 2.1, P = 0.140). In 76% (16 of 21) of these incidents where the bear's motivation was "startled," the initial encounter distance was <50 m in 76% (16 of 21) (G_1= 5.9, P = 0.015); in 2 incidents the distance was >100 m. Only 11% (4 of 37) of the grizzly bear incidents were attributed to "possible predation" (G_1 = 25.6, P = 0.000), whereas 83% (15 of 18) of black bear incidents were judged to be predatory (G_1 8.5, P = 0.004). There were no incidents involving black bears where the inferred motivation was "startled."

Twenty-seven of 34 (79%) incidents involving grizzly bears, where the location with respect to development was known, occurred in back-country locations, while 7 of 34 (21%) occurred in front-country (G_1 = 12.4, P = 0.000). In 16 incidents involving black bears where proximity to development was known, 38% (6 of 16) occurred in back-country locations and 62% (10 of 16) occurred in front-country (G_1 = 1.0, P = 0.322).

DISCUSSION

Even though there were an estimated 12 times as many black as grizzly bears in B.C. during 1960–97 (BC Bear Facts, undated publication, Ministry of Environment,

Table 7 Sex and age classes of grizzly and black bears involved in serious injury or fatal incidents in British Columbia, Canada, 1960–97.

Sex	Age class	Grizzly bear	Black bear
Male	Adult	5	5
	Sub-adult	0	6
	Cub	0	0
	Unknown	3	2
Female			
	Adult	22	0
	Sub-adult	0	0
	Cub	1	0
	Unknown	0	0
Unknown			
	Adult	1	2
	Sub-adult	3	1
	Cub	0	0
	Unknown	9	3
Total		44	19

Lands and Parks, Victoria, British Columbia, Canada) grizzly bears inflicted about 3 times as many serious injuries and the same number of fatalities as black bears. This is consistent with, but more quantitative than previous findings regarding the relative aggressiveness of the 2 species (Herrero 1972, 1985; Middaugh 1987; Miller and Tutterow This Volume).

The average number of serious and fatal injuries inflicted by bears each year increased significantly per decade from the 1960s and 1990s. The rate of increase exceeded the rate of increase in the total population of B.C. during the 1990s. The causes for the increases in number of injuries and rate of injury are not apparent from available data, but may be explained by people's increased use of bear habitat, an increase in the bear population, changes in bear behavior, or a complex interaction of some or all factors.

While bear populations probably increased in a few areas, they decreased in others. Increases in recreational and occupational uses of bear habitat seem likely to account for most of the increase in injuries, although one type of recreation, ungulate hunting, declined (M. Austin, Wildlife Division, Government of B.C., Victoria, Canada, personal communication, 1998). The decline in ungulate hunting paralleled a decreasing trend in grizzly bear harvest. The black bear harvest, which rose during the 1970s, has remained stable since the 1980s. While grizzly bear harvest was inversely related to the number of grizzly bear-inflicted injuries, changing black bear harvest was not correlated with changes in average number of injuries/year/decade.

We do not have data to directly evaluate whether the rising number of injuries by grizzly bears was due to less hunting of grizzlies or to increased use of bear habitat. In B.C., relatively few injuries occurred in national parks where bears were not hunted. In Yellowstone National Park, Wyoming, even with back-country use, grizzly bear-inflicted injuries are now few (Gunther 1994). We found peaks in the average number of bear-inflicted injuries during July and August, when outdoor recreation is greatest in B.C. This supports the idea that bear-inflicted injuries are related to levels of human use, a finding previously reported in Glacier National Park, Montana (Martinka 1982, Gniadek and Kendall 1998).

Bears that were accustomed to feeding on people's food or garbage were associated with about 10–15% of injuries. This contrasts with the situation in national parks during the 1950s through the mid-1980s, when food-conditioned and habituated grizzly bears were responsible for most serious and fatal injuries (Herrero 1970*a*,*b*, 1985, 1989; Gunther 1994; Gniadek and Kendall 1998). Food-conditioned bears inflicted few injuries in B.C. despite extensive feeding at dumps by both bear species as recently as the 1990s. The low number of injuries in this context may be explained by hunting, management removals, and, perhaps, poaching, all activities that select against bears that approach people or campsites. Even the relatively few injuries by food-conditioned bears of both species could have been avoided with better garbage management.

Consistent with previous findings (Herrero 1970*a*,*b*, 1985), most injuries occurred to people in groups of 1 or 2. Although we do not know the frequency of different sizes of groups active in bear habitat in B.C., small groups may be at higher risk of attack because we believe they tend to be quieter and appear less intimidating to bears than larger groups.

Attacks by grizzly bears and black bears occurred primarily during daytime hours and were preceded by a variety of outdoor activities. In 88% of grizzly bear-inflicted injuries, the victim was actively hunting, hiking, or working.

Hunting was the activity most commonly associated with grizzly bear attacks (N = 17), which suggests the potential for competition between hunters (especially ungulate hunters) and grizzly bears. There were 5 serious or fatal injuries involving a grizzly bear defending a carcass and 3 other incidents involving a grizzly bear apparently attempting to claim a hunter's kill as the hunter was cleaning or carrying it. None of the black bear-inflicted injuries were preceded by hunting or involved carcasses, which confirms previous findings (Herrero 1985) and further highlights behavioral differences between the species.

Most grizzly bear-inflicted injuries occurred in back-country areas, whereas most injuries inflicted by black bears occurred in front-country areas nearer to developments. These data are consistent with the notion that grizzly bears avoid developed areas more than black bears do (Herrero 1985). They also suggest that persons traveling in the back-country are probably in greater danger of surprising a grizzly bear.

There were dramatic differences between grizzly and black bears regarding the nature of injurious incidents and the gender of bears involved in incidents. As reported in earlier studies (Herrero 1985, Herrero and Higgins 1995), almost all serious or fatal injuries inflicted by black bears involved possible or actual predatory attacks by males. Although data were limited, predatory incidents tended to last 10–30 minutes, further suggesting the intent and persistence of the bear (Herrero 1985, Herrero and Higgins 1995). Female black bears rarely attack when startled and in defense of young (Herrero 1985), as confirmed by the total absence of such inci-

dents in the B.C. database. Males have a different adaptive strategy than females, perhaps taking more chances to acquire the resources needed to fatten and compete with other males (Herrero 1985). People were rarely chosen as prey. In most areas of B.C., large numbers of black bears have coexisted with people without serious or fatal injuries.

Adult females with dependent young inflicted most injuries by grizzly bears. These incidents were usually of short duration and occurred when the attacking bear appeared to be startled at close range. This agrees with previous findings regarding the sometimes aggressive defensive behavior of grizzly bear females with young (Herrero 1970*a*, 1972, 1985). Since grizzly bear hunting in B.C. is structured so that about 2 males are killed for each female, reducing the risk of grizzly bear-inflicted injury through hunting would require increased female harvest, which would probably put populations into decline. While we recorded only 4 serious injuries or fatalities in which a grizzly bear's behavior was thought to be predatory on people, we cannot conclude that predation is more likely in black bears because B.C. has approximately 12 times as many black bears as grizzly bears. In the 1 predatory grizzly bear incident where the bear's gender was known, it was male.

Given the number of people and bears in B.C., the number of injuries is a very small fraction of the total number of times bears and people interact in B.C.

MANAGEMENT IMPLICATIONS

Current management policies and actions regarding bear hunting in B.C. do not appear to be responsible for increasing numbers of injuries inflicted by bears; however, this possibility cannot be completely rejected, especially with regard to grizzly bear-inflicted injuries. We suggest more in depth studies to better understand the complex relationships between grizzly bear and human densities, human food attractant management, and hunting intensity.

Assuming that increases in injuries are primarily related to increases in various human activities in grizzly bear habitat, management of bear attack risk should focus on people's behavior in bear habitat. Improved food and garbage management practices decrease the risk of bear-inflicted injuries and should be encouraged, using laws and their enforcement if necessary (Herrero 1985, Gunther 1994). There are science-based strategies for decreasing the risk of surprise encounters with grizzly bears and deterring potentially predatory attacks by either bear species (Herrero 1985, Herrero and Higgins 1995).

In a few incidents involving both species of bears, the bear was starving or diseased. This suggests that food stress or disease occasionally may predispose a few bears to attacks on people. This is not typical, however, because years of bear food crop failure often result in bear depredation problems, especially for black bears, but only seldom in human injury (Herrero 1985). Managers may want to consider removing bears that have significantly less than normal fat reserves or diseased animals should they be captured as a result of displaying unusual aggression toward people. However, in most incidents, including predatory ones, the attacking bear appeared to be healthy and of normal body weight.

Educational and interpretive efforts aimed at decreasing risk of bear attack should focus on individuals and groups at risk, particularly ungulate hunters, hikers, campers, forest industry workers, geologists, and oil and gas industry employees. Worker's compensation regulations in B.C. require bear safety training for persons working in bear habitat. Such programs could be expanded to include other risk groups. B.C. Forest Service and other government divisions have produced good-quality videos and pamphlets explaining safety in bear country. There is understanding of how people's behavior can avoid or deter most potential bear attacks (Herrero 1985). Red pepper spray (with capsaicin as the active ingredient) appears to be an effective deterrent for most aggressive grizzly bears (Herrero and Higgins 1998). For people trained in using firearms to shoot erratically moving targets and where firearms are legal and feasible to carry, they can offer a significant, but not complete, degree of safety. Trails and public facilities can be located to minimize the risk of sudden confrontations between people and grizzly bears (Herrero et al. 1986). This approach has been used extensively in B.C. provincial parks (McCrory et al. 1989). The final responsibility for safety in bear country should come from a partnership between land and wildlife management agencies and individuals.

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