Polar bear–human interactions in Canadian national parks,1986–2000

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Abstract: Interactions between polar bears (*Ursus maritimus*) and humans in 6 national parks in the Canadian Arctic from 1986 to 2000 were examined ($n = 53$). No human fatalities and only 1 injury occurred. Bears were killed in only 4% of interactions, a much lower rate than in other studies, possibly because of the availability of deterrents. Interactions occurred mainly in summer in parks where bears are forced ashore by melting sea ice. Unlike interactions between humans and grizzly bears (*U. arctos*), the frequency of interactions appeared unrelated to park visitation and may have been influenced by sea ice availability. Rates of interactions without human injury varied widely among parks: 2 parks had no interactions and 2 were comparable to the rates for other species of bears in some other parks in North America; Wapusk National Park was much higher than any other. Data were insufficient to test predictions that nutritional stress on bears due to early sea ice breakup would increase the rate of bear–human interactions.

Key words: bear–human conflict, Canada, national park, polar bear, *Ursus maritimus*

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Polar bears are found throughout the circumpolar Arctic wherever there is suitable sea ice habitat for hunting seals (DeMaster and Stirling 1981). In Canada, polar bears are found throughout the Arctic Archipelago, Beaufort Sea, Hudson and James bays, and along the Labrador coast. In some areas of their range, such as Foxe Basin, Baffin Bay, and Hudson and James bays, polar bears spend part or all of summer and autumn ashore fasting after the sea ice melts (Harington 1968, Jonkel et al. 1976, Stirling et al. 1977, Ferguson et al. 1997). Pregnant females usually spend the winter in dens on shore where they give birth (Harington 1968, Ramsay and Stirling 1986). Polar bears are almost exclusively predatory, and most of their diet consists of ringed (*Phoca hispida*) and bearded seals (*Erignathus barbatus*; DeMaster and Stirling 1981).

Relatively few people live within the range of polar bears, and these are mostly indigenous people, industrial workers, and researchers. These groups have developed techniques for protecting themselves from polar bears (Fleck and Herrero 1988, Carpenter 1989, Kearney 1989). However, human populations throughout the circumpolar north are increasing (Knapp 2000), as is interest in the Arctic as a tourist destination (Ross 2000). Given that bear–human conflicts are considered to be a function both of human density and bear density (Martinka 1982, Herrero and Fleck 1990), polar bear–human conflicts may increase as more people, including those less experienced with Arctic travel and polar bears, live and travel in polar bear habitat. Stirling and Derocher (1993) and Stirling et al. (1999) predicted that climate change may also increase conflicts between polar bears and humans as reduced sea ice forces bears to spend more time on shore.

Overall, injuries to humans caused by bears of any species are rare, though such events are often well publicized (Herrero 1985, Middaugh 1987, Herrero and Fleck 1990, Floyd 1999). Conflicts between people and American black (*U. americanus*) and grizzly bears are well documented, and effective management policies have been built on understanding bear biology and the causes of conflicts (Bromley 1989). Understanding and management of polar bear–human conflicts, however, are not as advanced. Part of this problem is that such conflicts are few and often poorly documented, so it is difficult to collect sufficient information to draw reliable conclusions. Also, many people in the north carry firearms, so interactions often result in the death of the bear. Polar bears seem to come into conflict with people for substantially the same reasons as other species of bears do: attraction to human food and garbage, surprise,

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Fig. 1. Canadian national parks within the range of polar bears, 2001.

defense of their young, and because, at times, humans may be viewed as prey (Herrero 1970, Herrero 1985, Gilbert 1989, Herrero and Fleck 1990).

The system of national parks is expanding in the Canadian Arctic. With existing national parks (Fig. 1) and currently proposed parks, up to 10 national parks may soon exist where polar bears are found (Parks Canada 2000). National parks are protected areas, but their mandate and policies result in increased visitation and use (Parks Canada 1994). Parks Canada has a responsibility to both minimize the risk of injury to park visitors, recreational and otherwise, and to protect polar bears within national parks (Fleck and Herrero 1988, Herrero and Herrero 1999). Given this, park managers need to assess the risk from polar bears to visitors in national parks and to implement policies and plans to reduce that risk. This has begun in some parks (Herrero and Herrero 1997, 1999), but the most comprehensive assessment remains Fleck and Herrero's (1988) investigation of polar bear–human conflicts from 1965–85. Here, I update some aspects of their analysis and suggest directions for future research to better understand polar bear–human interactions.

Methods

I requested the numbers of visitors and visitor-nights/year, the numbers and details of polar bear observations, and any details of interactions between people and polar bears from each of the 6 national parks in Canada containing polar bears. From these figures I calculated mean numbers of interactions per 100 visitors and per 1000 visitor-nights for each park. The latter figure permits better comparison with wilderness areas in more southern parks with other species of bears (Floyd 1999). Of the 6 parks, only Auyuittuq existed in 1986. The years in which operations started in the other parks are given in Table 1; data were available from the first year

Table 1. Visitation and rates of perceived aggressive interactions with polar bears in Canadian national parks, 1986–2000.

Park	First year of park operation	Annual mean visitors	Annual mean visitor nights	Perceived aggressive interactions	Mean interactions/ 100 visitors	Mean interactions/ 1,000 visitor nights
Aulavik	1994	73	632	0	—	—
Auyuittuq	1986	434	1825	4[a]	0.06	0.15
Ivvavik	1988	196	1928	1	0.04	0.04
Quttinirpaaq	1987	209	1478	0	—	—
Sirmilik	2000	37	460	1	2.70	2.17
Wapusk	1998	56	1164	46	25.00	13.33

[a]Includes 1 injury, 2000. See text.

of park operation until 2000. Researchers are included in these figures in all parks, as they were in Fleck and Herrero (1988). These data were not complete for traditional aboriginal and local park users, and for some years only estimates of visitor and visitor-night figures were available from Ivvavik and Auyuittuq.

I used the term "perceived aggressive interactions" to describe encounters in which polar bears were perceived to have posed a threat or to have acted aggressively toward people but people were not injured. This categorization was based on peoples' perceptions of situations and their reactions and did not necessarily mean that the bears involved were in fact aggressive. This distinction is important because polar bears are often described as inquisitive, and such behavior can intimidate people even if the bear had no aggressive intent. Because the age and sex class of bears involved were not consistently documented among these interactions, their influences on interactions were not investigated. To examine whether the number of interactions was a function of park visitation, mean annual numbers of visitors and visitor-nights were regressed separately against the mean annual numbers of perceived aggressive interactions. Analysis of variance (Zar 1984) was used to test the significance of the regressions, with $\alpha = 0.05$.

Visitors to Wapusk National Park were categorized (staff, researchers, recreational visitors, and local users) to examine whether interaction rates differed among them. The latter 2 groups were combined because their numbers were only estimated, and recreational visitors and local users often travel together, usually by snowmobile or dogsled. A χ^2 test corrected for continuity (Zar 1984) was used to compare proportions of polar bears observed at and away from research camps which were involved in interactions. People traveling on tundra vehicles in Wapusk to view polar bears were excluded from these analyses because the numerous interactions at these vehicles were largely deliberate.

Several limited sources of data were available to look for potential effects from the length of bears' time on shore on the rate of interactions in and around Wapusk, but a comprehensive analysis of this relationship is outside the aim of this paper. Simple linear regression (Zar 1984) was used to compare the number of perceived aggressive interactions within the park to dates of the first observation of bears at the La Perouse Bay research camp in Wapusk each year from 1998–2000. The numbers of bears captured to mitigate bear–human interactions in and around the nearby town of Churchill for those same years were similarly compared to those dates.

Results

I documented 52 perceived aggressive interactions and 1 interaction that resulted in human injury (Table 1). In September 2000 a lone hiker in Auyuittuq was reported injured by a bear biting through his tent (K. Lassen, Parks Canada, Pangnirtung, NT, Canada, personal communication, 2001). The victim did not see the bear, but Park Wardens found tracks of a lone young bear at the site. Two interactions resulted in bears being killed, both single bears in Auyuittuq National Park in separate incidents in September 1991 (sex and age data were unavailable). Two parks had no interactions (Aulavik and Quttinirpaaq), and 46 (87%) took place in Wapusk National Park. There was no significant relationship between the mean annual number of visitors to the parks and the rates of perceived aggressive interactions ($r^2 = 0.09$, $F = 0.40$, $P = 0.56$) or between mean annual visitor nights and interactions ($r^2 < 0.01$, $F < 0.01$, $P = 0.96$).

In Wapusk during 1998–2000, researchers accounted for 65% of all visitors annually (37 of 56), 93% of visitor-nights (1083 of 1164), and were involved in 95% (44 of 46) of all interactions. Park staff accounted for an average of 6 visitors (11%) and 53 visitor nights (5%) per year, and local users and recreational visitors accounted

for 12 visitors (21%) and 28 visitor nights (2%). One interaction occurred among each of those user groups. Of the polar bears observed by researchers, 34 of 72 observed from camps became involved in interactions, whereas only 10 of 101 bears observed away from camps interacted with the researchers ($\chi^2_c = 30.864$, 1 df, $P < 0.0001$).

In Wapusk there were 23 interactions in 1998, 21 in 1999, and 2 in 2000. The number of bears captured in and around Churchill was 105 in 1998, 87 in 1999, and 38 in 2000 (Polar Bear Technical Committee 1999, 2000, 2001). The first observations of bears on shore at the La Perouse Bay research camp were 2 July 1998; 23 June 1999 and between 1–5 August 2000 (P. Matulonis, Hudson Bay Project, New York, New York, USA, personal communication, 2001). The number of interactions in Wapusk appeared to increase in years with earlier on-shore dates, as did the number of bears captured in and around Churchill, but due to small sample size these relationships were not statistically significant ($r^2 = 0.91$, $F = 10.96$, $P = 0.19$ and $r^2 = 0.79$, $F = 3.82$, $P = 0.30$, respectively).

Discussion

The human injury rate of 2% reported here is less than Fleck and Herrero's (1988) documented rate of 5%, but samples are too small to test for statistical significance. Both findings demonstrate that most interactions do not result in human injury. The rate of 0.035 injuries/1000 visitor-nights for Auyuittuq National Park is lower than some other parks, ranking below Kluane National Park of Canada (0.043/1000 visitor nights), Yoho National Park of Canada (0.063), Glacier National Park, USA (0.107), and Waterton Lakes National Park of Canada (0.176; Herrero and Fleck 1990). In terms of visitor-nights without human injury, Auyuittuq, which has remained remarkably constant over time, and Ivvavik are comparable to other parks including Yellowstone (0.20/1,000 visitor nights), Mt. Revelstoke/Glacier national parks of Canada (0.12), and Jasper (0.076) and Nahanni (0.04) national parks of Canada (Herrero and Fleck 1990). Sirmilik's rate appears high but is difficult to judge because the interaction rate is based on only a single interaction and low visitation, and represents just the first year of park operations.

Interaction rates are high in Wapusk compared to all other parks. Wapusk is occupied by most of the western Hudson Bay population of polar bears from July–November, estimated by Lunn et al. (1997) at 1,199 bears (95% CI: 948–1450). Polar bears are particularly numerous along the coast (Derocher and Stirling 1990), where 2 permanent fenced research camps are occupied from May–early August. Based on the results of Derocher and Stirling (1990), Herrero and Herrero (1999) estimated that bear densities on the coast of Wapusk may have been as much as 5 times higher than in high-quality grizzly habitat in national parks in the Canadian Rocky Mountains. The high number of interactions in Wapusk is not surprising given the spatial and temporal overlap of people with such a high number of bears.

Comparisons with other areas involve situations in which the types of polar bear–human interactions are defined differently—and possibly reported at different rates and according to different criteria—so they must be made with caution. However, in both Canada and Svalbard polar bear deaths are recorded relatively accurately, so at least preliminary comparison of those results is possible. The reported killing of bears in only 4% of perceived aggressive interactions was much less than in 61% of interactions documented by Fleck and Herrero (1988), most of which took place outside parks, where firearms were present and where there were fewer sanctions against killing bears. Similarly, bears were killed in 92% of "serious confrontations" recorded in Svalbard (Gjertz and Persen 1987) where, in contrast to Canadian parks, people are encouraged to carry firearms for defense from polar bears (IUCN/SSC Polar Bear Specialist Group 1998). Mattson et al. (1996*a*, *b*) concluded that the presence of firearms is a key determinant in the spatial distribution of grizzly bear deaths in the northwestern USA, which are lower in national parks than outside. Their demonstration of differential human lethality to grizzly bears among jurisdictions resembles the pattern for polar bears, but more detailed investigation of polar bear mortality is required to understand this situation and determine if direct comparison with grizzly bear mortality patterns is valid.

Most interactions documented here took place at the 2 research camps in Wapusk. These camps have operated for over 30 years each, have formalized bear response procedures, and use an array of deterrent devices (e.g. fences, cracker shells). In neither camp has anyone ever been injured by a bear, and only 1 bear has been killed in defense during their history. Preparation, planning, experience, and the frequent use of non-lethal deterrents may have reduced any perceived need to kill bears to end interactions, and the relative roles of each of these factors would be worth examination. These camps represent a unique situation both in terms of the high number of interactions and in their apparent success at managing polar bear–human interactions. The use of deterrent

devices against polar bears has been examined empirically (Fleck and Herrero 1988, Leonard 1989) as well as experimentally (Stenhouse and Cattet 1984). Polar bears were successfully deterred during 1 interaction in Auyuittuq (with pepper spray) and 1 in Sirmilik (with a rubber slug). Although there is insufficient evidence to evaluate the effectiveness of different deterrents, they appear to have benefits by giving people options and possibly reducing the killing of bears. Continued documentation of interactions involving deterrent attempts as well as realistic experimental trials would be useful to further understand the value of deterrents against polar bears.

In Wapusk, a much higher proportion of the bears observed from camps became involved in interactions than was the case away from camps, suggesting several possible interpretations. Bears approaching camps may have been perceived as a greater threat and more vigorous responses may have been used. Alternatively, attractants present at camps (food, garbage, odors) may have motivated bears to investigate or display other behavior which people perceived as aggressive or threatening. Attractants clearly motivate other species of bears into conflicts with people (Herrero 1985, Middaugh 1987), and Fleck and Herrero (1988) documented that attractants were present in 96% of non-injurious aggressive interactions between polar bears and humans. Also, for at least 20 years, polar bears in that area have regularly received human food from tourism operations near those camps (Watts and Ratson 1989, Herrero and Herrero 1997). Such food conditioning and human habituation (Gilbert 1989) could have caused some bears to act more aggressively around camps than they might have otherwise. In addition, knowledge of the general relationship between food conditioning, habituation, and bear behavior might have influenced the responses of people in the camps during interactions regardless of whether individual bears displayed such characteristics. Further investigation into the effects of habituation and food conditioning on polar bear behavior would be particularly important to develop sound guidelines for human responses during interactions with polar bears.

All interactions took place on land, and all but 1 took place during the summer or fall, similar to others' findings (Gjertz and Persen 1987, Fleck and Herrero 1988, Stenhouse et al. 1988, Gjertz et al. 1993, Gjertz and Scheie 1998). The parks where no interactions occurred, Aulavik and Quttinirpaaq, are in areas where sea ice was generally available to bears year-round. Polar bears prefer to remain on sea ice because they cannot effectively hunt seals from shore or in open water (DeMaster and Stirling 1981) and because most visitors to Arctic parks stay on or very near land (D. Clark, unpublished data). This spatial and temporal separation of people and bears appears to provide a margin of safety. Seasonal melting of sea ice forces bears onto land where they are more likely to interact with people simply due to their proximity, especially in areas such as Wapusk where large numbers of bears concentrate. Conversely, changing visitor use patterns or choice of recreational activities that alter human use of sea ice might also increase the chances for interaction. When polar bears are on shore they subsist largely on stored fat reserves (Stirling et al. 1977, Ramsay and Stirling 1988), suggesting another mechanism by which sea ice availability might influence polar bear–human interactions. As bears on shore deplete their fat reserves they may seek alternative food sources (Lunn and Stirling 1985), increasing the likelihood of interacting with people. The need for bears to seek supplemental food may increase during longer periods of time spent on shore and may also be related to the amount of fat which individual bears accumulate before coming ashore (Fleck and Herrero 1988), each of which can be influenced by numerous ecological and behavioral factors (Stirling and Lunn 1997, Stirling et al. 1999). Whatever the mechanisms, an effect of sea ice availability on polar bear–human interactions might explain the lack of a significant relationship between rates of interaction and park visitation.

Although the data presented here are consistent with the hypothesis that longer ice-free periods increase the number of polar bear–human interactions, for several reasons they are insufficient to test it. First, they cover only a very limited number of years, and sea-ice dynamics are highly variable from year to year in western Hudson Bay (Stirling et al. 1999). Second, few visitors are in Wapusk past early August, largely because of the high numbers of bears. One would expect that, in any given year, the likelihood of interactions would increase over time in the on-shore season as bears use up their fat reserves. In such a situation numbers of interactions in the park would not reflect this effect, which would be better assessed by data on interactions in and around the town of Churchill. Considerable data exists to do so (e.g. Kearney 1989, Herrero and Herrero 1999, Stirling et al. 1999), and such an analysis would be extremely useful. Third, although an investigation including the spatial distribution of interactions would probably be illuminating (Mattson et al. 1996*b*), such an investigation must be larger in scope than an individual park to capture events outside the park's boundaries which are relevant to the population of bears under consideration. For example, in early July 1999 after an early ice breakup, a bear killed

a person and injured 2 others several hundred km north of Wapusk (Winnipeg Sun 1999). However, this happened well within the range of the western Hudson Bay polar bear population, which uses both the park and a much larger surrounding area (Stirling et al. 1977). Investigating interactions using polar bear populations rather than parks as study units, while probably more complex, might be more ecologically revealing. Despite shortcomings, these data do illustrate that numbers of interactions in a given area can vary widely among years, and park managers planning for visitor safety must take this variation into account. It would be important to investigate further the relationships between sea ice, polar bear nutrition, and polar bear–human interactions, especially given the trend toward longer ice-free periods in western Hudson Bay (Stirling et al. 1999).

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