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Original article

Problem brown bears *Ursus arctos* in Finland in relation to bear feeding for tourism purposes and the density of bears and humans

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The practice of feeding brown bears *Ursus arctos* for recreational purposes is common in the easternmost areas of Finland, but this may, however, result in human-habituated bears. From 1995 to 2008, 3% of all bears killed by humans (N = 1,108 bears) in Finland represented incidents where bears were either killed for reasons of human safety under a license issued by the police or as a result of actual emergency situations where bears were shot in self defence. We constructed binary logistic regression models for comparing bears shot under police license and in self defence with bears killed in regular sport hunting by using the sex of the bear, human density, bear observation density and the distance from the nearest feeding site as independent variables. High human density was the most important factor differentiating bears shot under a license issued by police from bears killed in sport hunting. The difference in human density was largest for places located far from feeding sites. Increasing distance from feeding sites differentiated bears shot under police license and in self defence from sport hunted bears. The sex of the bears and the density of bear observation were more weakly associated with the category of shooting. Our study did not provide evidence that bear feeding for recreational purposes is associated with the nuisance-bear problem in Finland. Nevertheless, some risks for human safety might be associated with artificial bear feeding for tourism purposes. If the practice of feeding bears continues to be accepted by Finnish legislation, game management should include an action plan for occasions when bears visiting feeding sites will lose their wariness of humans.

Key words: bear density, bear feeding, brown bear, human density, problem bears, tourism, Ursus arctos

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Areas used by large carnivores and humans will often overlap extensively, and detailed and active management is required to reduce the potential risk of human-large carnivore conflicts (Linnell et al. 2001, Rondinini & Boitani 2007). Brown bear *Ursus arctos* populations have increased and expanded during recent decades in Scandinavia and Finland. Although the European brown bear is not particularly dangerous (Swenson 1999, Swenson et al. 1999), fatal attacks by bears on humans have recently been reported (Nyholm 1998, J.E. Swenson, unpubl. data).

Feeding may shape the behaviour of bears toward humans by reducing their wariness and thereby increasing the risk of attacks on humans (Swenson 1999, Løe & Røskaft 2004, Penteriani et al. 2010). The first symptom of reduced wariness is often a growing number of nuisance bears, i.e. bears that intrude on human settlements looking for food that has been unintentionally provided by humans (e.g. Peine 2001). Habituation to people also involves risks to human safety (Herrero & Fleck 1990, Herrero et al. 2005). Attracting brown bears by means of feeding is a common practice in wildlife tourism at the Finnish-Russian border. Each year, about 4,000 visitors come to watch bears, spending on average 3-4 nights in a blind during their visit (Eskelinen 2009, L. Rautiainen, unpubl. data). In the public debate in Finland, the greatest concern has

been human safety (Pohja-Mykrä & Kurki 2009), as bears repeatedly and regularly visiting feeding sites may become accustomed to human presence and less wary of humans (see for example Craighead et al. 1995 for bears fed at garbage sites in the Yellowstone National Park, USA). So far, no empirical evidence of feeding bears for reasons of recreational tourism has been published. The most likely reason for this is that this is not a widespread practice in countries other than Finland. However, since there is a heavy demand, and since this business is profitable (Eskelinen 2009), this kind of bear tourism may also excite attention and interest in other parts of the world.

In this study, we examined whether any unwary behaviour of brown bears in Finland may be associated with the feeding of bears at the Finnish-Russian border. Our examination was based on a comparison of the geographic distances between problem bears shot at the responsibility of police officers and the distances between bears shot in self defence, respectively, and sites where bears had been shot in sport hunting. Furthermore, we studied the effects of bear density and human density by investigating whether the bear-observation density and the human density differed between the different categories of bear shooting.

Material and methods

Our study was based on statistics on the number of brown bears shot in Finland during 1995-2008 (N = 1,108 bears) on five locations (i.e. Kuntivaara, Martinselkonen, Vartius, Viiksimo and Kivikiekki) where the feeding of bears for tourism purposes was most extensive (Fig. 1), on the human density in each municipality where a bear had been shot and, finally, on the number of bear observations made within a 50 × 50 km area in a given year. We recorded bear observations with the aid of local contact persons, totalling about 1,700 people who detailed their observations on special forms and maps. Because our network of contacts was sparse in the northernmost third of Finland, we excluded this area from our examination of the bear-observation density. As no bear-observation data were available from 1995-1998, we used the 1999 figures for these years.

We divided the bear shootings into the following three categories: 1) bears shot by a police officer or under a license issued by the police (N = 19), 2) bears shot in self defence (N = 14) and 3) bears killed in regular sport hunting (N = 1,075). The hunting season lasts from 20 August to 31 October. The maximum number of bears allowed to be shot in regular hunting is determined by an annual quota issued by the Finnish Ministry of Agriculture and Forestry. During 1995-2008, the mean harvest rate was 8% of the pre-harvest population estimate. We determined the geographical distances between the sites where bears had been shot and the five locations where the feeding of bears for tourism purposes has been most widespread and where most of the bears visiting such places are concentrated. Feeding is intense; food is delivered so regularly that it is available throughout the season in which the bears are active. The other feeding sites were smaller and located near (< 10 km) the closest of the five primary feeding places. We examined the differences between the three abovementioned categories of bears in 1) distance to sites

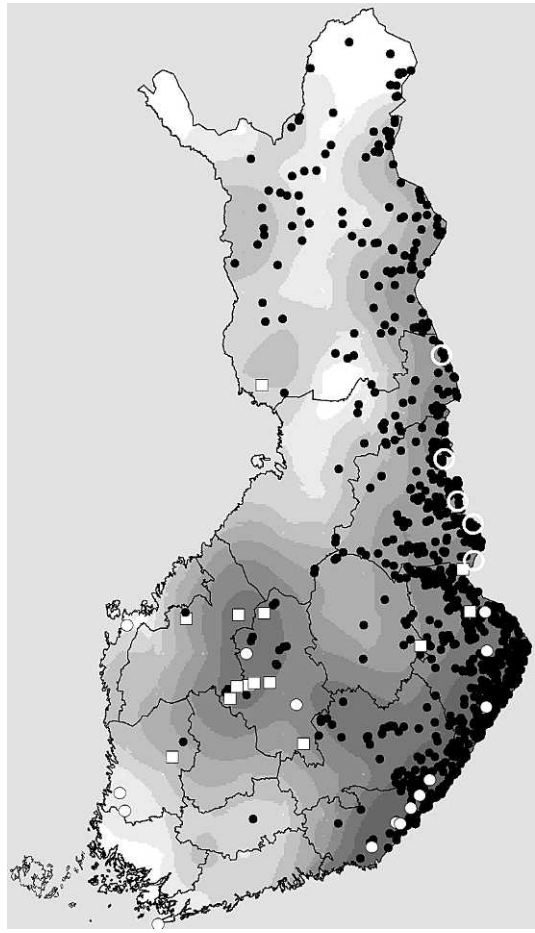

Figure 1. Locations of artificial bear-feeding sites (white rings), bears killed under a police-issued license (white dots), bears killed in self defence (white squares) and sport hunted bears (black dots) in Finland during 1995-2008.

Table 1. Sex ratio of bears, density of bear observations, human density and distance from the nearest feeding site for the different categories of bear shooting.

Parameter	Police licence (N = 19)	Self defence (N = 14)	Sport hunting (N = 1075)
Sex ratio (% males)	78.95	50.00	66.98
Bear-observation density (observation/km^2, mean ± SD)	0.79 ± 0.92	0.474 ± 0.393	1.13 ± 2.27
Human density (individuals/km^2, mean ± SD)	69.80 ± 98.46	5.66 ± 5.84	5.39 ± 7.09
Distance (km ± SD)	304.89 ± 141.14	257.96 ± 111.99	137.01 ± 95.44

where bears were fed, 2) the human density in the given municipality and 3) the density of the bear observations recorded as sights or signs/km^2 land area within 50 × 50 km squares. When an observation square was partially located outside Finnish territory, only the Finnish segment was used in the calculation of the observation density.

In statistical analysis we first log-transformed continuous independent variables and checked for any autocorrelation between them. The Pearson correlation coefficient between human density and bear-observation density was 0.488 and 0.251 between human density and distance to the nearest feeding site, respectively. The coefficient between bear-observation density and distance was 0.340. We constructed two sets of binary logistic regression models; i.e. one for bears shot under police license, and one for bears shot in self defence. The two models compared bears shot under police license with bears shot in sport hunting (Table 1) and bears shot in self defence with bears shot during sport hunting (Table 2). We ranked the models using ΔAIC values that compare values of AIC (Akaike's information criterion) with the most fit model (Burnham & Anderson 2002). Human density and bear-observation density were not approved to the same model owing to relatively strong autocorrelations. We performed statistical treatments using SYSTAT 13.0 software.

Results

The mean bear-observation density, the human density and distance from the nearest feeding site and the sex ratio of bears for the different categories of shooting are listed in Table 1. The sex of the bears was

Table 2. Logistic regression model for differences between bears shot under police license and in sport hunting in Finland, during 1995-2008. Continuous independent variables were log-transformed, and the models have been ranked by their AIC values. ΔAIC represents the difference from the most fit model, and K represents the number of parameters in the given model (including the constant).

Rank	Model	AIC	ΔAIC	K
1	Human density+distance+human density*distance	132.116		4
2	Sex+human density+distance+human density*distance	132.272	0.156	5
3	Sex+human density+distance	139.139	7.023	4
4	Human density+distance	139.295	7.179	3
5	Sex+human density	145.140	13.024	3
6	Human density	145.408	13.292	2
7	Sex+human density+sex*human density	147.092	14.976	4
8	Bear-observation density+distance	158.681	26.565	3
9	Sex+bear-observation density+distance	159.057	26.941	4
10	Sex+distance+sex*distance	159.373	27.257	4
11	Bear-observation density+distance+bear-observation density*distance	160.634	28.518	4
12	Distance	160.988	28.872	2
13	Sex+distance	161.005	28.889	3
14	Sex+bear-observation density+distance+bear-observation density*distance	161.015	28.899	5
15	Constant+bear-observation density	191.451	59.335	2
16	Constant+sex	193.052	60.936	2
17	Constant	193.088	60.972	1
18	Constant+sex+bear-observation density	194.186	62.070	3
19	Constant+sex+bear-observation density+sex*bear-observation density	195.044	62.928	4

not significantly linked with the category of shooting. There was, however, a trend towards a less male-biased sex ratio among bears shot in self defence ($\chi^2 = 3.039$, $df = 1$, $P = 0.081$ for the difference between bears killed in self defence and in regular sport hunting).

Logistic regression models for bears killed under police license showed human density to be the most important factor as all models incorporating this parameter provided a remarkably better fit (AIC $\geq$ 11.589; see Burnham & Anderson 2002) as compared with the best model without human density which was an additive model with bear-observation density and distance from the nearest feeding site constituting independent variables (calculated on the basis of the figures shown in Table 2). The two best models included interaction terms between human density and the distance from the feeding site (see Table 2). This interaction was due to differences in human density between sport hunted bears and bears killed under police license being higher for places that took place further than 305 km from the nearest feeding site which was a median for bears shot under police licence. Using this distance as a divisor, we had means of 5.2 and 28.9 humans/km^2 for shorter distances and 8.7 and 106.5 humans/km^2 for longer distances, respectively. Increasing distance from the feeding site improved the fit but not as strongly as the human density. The sex of the bear and bear-observation density were not associated with bears shot under police license (see Table 2).

The best model for bears killed under police license included the interaction terms between human density and the distance from the feeding site, giving a better fit (AIC $\geq$ 6.867) than the most fit model exclusive of this interaction (see Table 2). The Neglekerke R-Square of the models inclusive and exclusive of the interaction terms were 0.371 and 0.321, respectively.

For bears shot in self defence, increasing distance from the nearest feeding site was the key factor. Models excluding distance terms were less fit than the models including distance (Table 3). The minimum difference in the AIC value between a model with distance (sex+human density+distance) and a model without distance (sex+bear-observation density+sex*bear-observation density) was 5.944 which indicates a remarkable difference in the fit of these models (see Burnham & Anderson 2002). The two best models, namely (sex+bear-observation density+distance) and (bear-observation density+distance), were almost equally fit (see Table 3). R-squares for these models were relatively low (0.115 and 0.114, respectively).

Table 3. Logistic regression model for differences between bears shot in self defence and in sport hunting in Finland, during 1995-2008. Continuous independent variables were log-transformed, and the models have been ranked by their AIC values. ΔAIC represents the difference from the most fit model, and K represents the number of parameters in the given model (including the constant).

Rank	Model	AIC	ΔAIC	K
1	Sex+bear-observation density+distance	135.612		4
2	Bear-observation density+distance	135.622	0.010	3
3	Bear-observation density+distance+bear-observation density*distance	137.321	1.709	4
4	Sex+bear-observation density+distance+bear-observation density*distance	137.401	1.789	5
5	Distance	139.899	4.287	2
6	Sex+distance	140.847	5.000	3
7	Human density+distance+human density*distance	141.748	6.136	4
8	Human density+distance	141.865	6.253	3
9	Sex+distance+sex*distance	142.234	6.622	4
10	Sex+human density+human density*distance	142.553	6.941	4
11	Sex+human density+distance	142.818	7.206	4
12	Sex+bear-observation density+sex*bear observation density	148.762	13.150	4
13	Sex+bear-observation density	149.767	14.155	3
14	Bear-observation density	150.137	14.525	2
15	Constant	151.339	15.727	1
15	Sex	151.588	15.976	2
17	Human density	152.762	17.150	2
18	Sex+human density+sex*human density	154.730	19.118	4
19	Sex+human density	158.088	22.476	3

Discussion

We demonstrated that the geographical distance from bear-feeding sites to locations in which bears were shot during the ordinary autumn hunting was shorter than the distance to locations in which bears were shot under a police license and in self defence. In the logistic regression models for bears shot under police license and in self defence, the increasing distance to the nearest feeding site was the only parameter associated with the category of bear killing. Therefore, our data provide no evidence that bear tourism based on bear feeding is a cause of nuisance-bear cases in Finland.

Incidents where bears were killed under police-issued licenses or killed in self defence were different. Police-licensed removals mainly concern bears moving in either suburbs or villages, while bears shot in self defence are most frequently shot by moose hunters. This is also the case in Sweden (J.E. Swenson, pers. comm.). The larger difference in human density at locations far from feeding sites is due to a higher mean density of humans in the urban areas of southern Finland. In cases of self defence, many shootings are preceded by provocation by a hunter's dog, and by the bear chasing the dog towards the hunter (I. Kojola, S. Heikkinen & S. Ronkainen, unpubl. data). The reason for such incidents being most common in regions where the bear densities are not highest might be ascribed to the recent westwards expansion of the bear population in southern Finland. The sport hunting of bears has been maintained in the easternmost of Finland as bears have never become extinct in this region, whereas bears were practically absent from the west and south of Finland for most of the 20th century (ca 1900-1980). The bear densities have also been gradually increasing in the west, but hunters here are still less used to bear encounters and might therefore shoot more readily than hunters in the east where, although encounters are probably more frequent, hunters will have more experience in living with bears.

Although our data provided no evidence that bear feeding for tourism purposes has exerted an impact on human safety, it is still premature to make any accurate predictions for the future, and the consideration for risks to human safety still prevail. The bear-feeding practice is expanding, and although the Finnish National Board of Forestry, in charge of the management of state-owned land, does not permit the establishment of new bear-baiting sites (J. Bisi, The National Board of Forestry in Finland, pers.comm.), it is possible to obtain permission from private landowners. It is crucial that enterprises running such tourism operations minimise the safety risks. However, baiting as such will probably not constitute the most critical factor, as this practise has been a part of bear hunting in many countries, as for instance in Sweden until 2001 (Bischof et al. 2008). In the North American states Virginia and Washington, bear feeding of the black bear *Ursus americanus* has been investigated as a means to reduce forestry damage caused by bears (Nolte et al. 2001, Gray et al. 2004, Ziegltrum 2008). However, feeding for tourism purposes is essentially different, because in this case bears are baited to feed at a distance of a few metres from blinds that will only provide a thin wooden partition for the protection of humans from bears (I. Kojola, pers. obs.). We believe that bears visiting such places can sense the humans in the blinds and thus become inured to human presence.

Management implications

Because it is not known how bears that regularly visit baiting sites behave in relation to human contact elsewhere, the behaviour of bears frequently visiting such places should be experimentally investigated using GPS transmitters with mobile interfaces recording locations at very short intervals (*cf*. Sundell et al. 2007). It seems evident that the watching and photographing of bears is likely to remain an important element of nature-based tourism in the easternmost regions of Finland. However, if the Finnish legislators continue to consent to the practice of feeding bears, then police officials and game management should have a joint action plan for occasions where bears will lose their wariness of humans at feeding sites. The underlying points of departure differ distinctively from mainstream human-large carnivore conflicts because, in this case, the beneficiaries of bear tourism are private enterprises not entitled to remove fearless bears, as this is a role reserved for the public game management. In any case, it is necessary to specify responsibilities and practices in order that problem-bear incidents may be readily resolved.

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