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Bear attacks on people in Slovakia in 2000 - 2016

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Abstract

Human-wildlife conflicts worldwide involve both herbivore and carnivore species. Conflicts often result in negative consequences on both sides. Large carnivores, including bear species, are often involved. Brown bears (*Ursus arctos*) usually avoid interactions with humans, but on rare occasions may attack during encounters. There are about 1000 – 1500 brown bears in Slovakia with a female-biased sex ratio. Only direct contacts or injuries caused by brown bears were considered as attacks. During the period 2000 – 2016, bears caused human injuries (but no fatalities) in 54 recorded incidents. The highest number of attacks occurred in 2014 (8) and 2007 (7). Attacks peaked in June and occurred significantly more often during weekends than on weekdays. Hunting and gathering were activities most related to brown bear attacks in Slovakia while unaccompanied people were more exposed to attacks than those in groups. Females bears carried out significantly more attacks (20 of 24) compared to male bears where sex of the bear was confirmed. Habituated or food-conditioned bears were involved in 11% (6/54) attacks on people. On average, victims first time spotted bears from approximately 12 m and those who initially stayed still spent less time in hospital than people who tried to run away. Dense vegetation along with low visibility of surroundings were two common risk factors. The presence of a dog usually aggravated situations while carrying a gun did not guarantee safety. None of the victims was carrying bear spray, which is an effective bear deterrent. Raising awareness of the general public and particular interest groups most often present in bear country could be key for better understanding between the two species: human and bear.

Key words: *Brown bear, Ursus arctos, bear attacks, human injuries, behaviour.*

Content

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1 Introduction

Human-wildlife conflicts are defined as situations that involve any negative interactions between humans and wildlife (Messmer 2009). The occurrence of human-wildlife conflicts has increased as a consequence of higher numbers of people moving onto less land compared to the past (Conover 2002). There are several different sources for human-wildlife conflicts, for example when ungulates damage crops (Wagner et al. 1997, Irby et al. 1996), carnivores depredate on domestic livestock (Treves et al. 2002, Odden et al. 2002) or when humans are injured or killed by wildlife (Zinn et al. 1998, Conover et al. 1995). However, human-wildlife conflicts usually have negative consequences for both sides involved, because they often result in retaliation killing or lethal control of the individual animals involved in such incidents (Treves et al. 2002, Zinn et al. 1998). The wildlife species most involved in human-wildlife conflicts are large herbivores and carnivores (Redpath et al. 2014). For example, African and Indian elephants (*Loxodonta africana, Elephas maximus*) are large herbivore species commonly involved in human wildlife conflicts resulting in economic damage but also human fatalities (Williams et al. 2001, Venkataraman et al. 2005).

Large carnivore species, such as Asiatic lion (*Panthera leo persica*) and Sumatran tiger (*Panthera tigris sumatrae*), are also commonly involved in human-wildlife conflicts that result in property damages, human injuries or fatalities (Saberwall et al. 1994, Nyhus and Tilson 2004). However, many large carnivore species are species of conservation concern and are commonly protected by special legislation (Kellert et al. 1996, Weber and Rabinowitz 1996). Large carnivores are currently recovering in many parts of the world, especially Europe (Chapron et al. 2014).

Ursids are a taxonomic group commonly involved in human-wildlife conflicts (Nyhus 2016). Eight bear species exist worldwide (Waits 1999). The bear species most often involved in attacks and human injuries and fatalities are American black bears

(Ursus americanus) and brown bears (*Ursus arctos*) in North America (Herrero 2002), brown bears in Eurasia (Swenson et al. 1999b, De Giorgio et al. 2007), polar bears (*Ursus maritimus*) in Arctic regions (Herrero and Fleck 1990) and sloth bears (*Melursus Ursinus*) on the Indian subcontinent (Bargali et al. 2005).

In general, bears avoid or flee when encountering humans. However, some factors can increase the likelihood of an attack, such as the presence of dependent offspring, presence of a carcass, a surprise encounter, a bear in a den, or the presence of a dog (Swenson et al. 2000). Hunters that wound a bear are especially at risk of being attacked (Swenson et al. 1999b). The outcomes of human-bear encounters are also influenced by human reactions (Herrero 1985). Some human-bear interactions and close encounters can result in aggressive behaviour by bears which can lead to injuries or, rarely, even death (Gunther & Hoekstra 1998, Herrero 2002, Naves et al. 2016).

Human-bear conflicts may affect the public perception of bears, which in turn can undermine support for conservation measures (Wechselberger et al. 2005, Rigg & Adamec 2007). Human-bear incidents, especially interactions that result in human injuries or fatalities, raise a lot of attention in the media (Røskaft 2007, Fernández-Gil et al. 2016). However, these incidents are often presented inaccurately, and it is often difficult to understand precisely the circumstances of attacks. For example, according to hunting statistics in Slovakia from 2007 to 2014, in 91% of 406 recorded bear-human encounters, attacks did not occur (Rigg 2016).

Slovakia hosts about 1000-1500 brown bears (Paule et al. 2015) which are part of the large Carpathian bear population (Hartl and Hell 1994). Hunting brown bears was banned in Slovakia from 1932 to 1962, which resulted in recovery of the population from a low in the 1930s. Nowadays much of the previous range is re-occupied (Paule et al. 2015). However, poor garbage management and feeding of bears with human-derived foods as tourist attractions is common. Šebo (2004) examined the causes of 33 bear

attacks on humans in Slovakia based on questionnaires sent to hunting organizations. However, the attacks were not verified in the field or by talking to affected persons. Only one fatality caused by a brown bear is recorded in Slovakia: a young shepherd was killed in 1927 while defending his sheep from a depredating bear. The female bear involved in this case was later shot near the village of Ždiar (Lenko 2014).

The main aim of this study is to carry out an objective survey of human-bear encounters resulting in injuries to humans in Slovakia, to better understand the factors associated with these incidents and to provide a knowledgebase for recommendations to reduce the risk of bear attacks. I aimed to gather and validate data on all known bear attacks on humans in Slovakia in 2000 – 2016. I specifically investigated the spatial distribution of attacks in relation to the core of the bear population in Slovakia, if there were differences in the numbers of bear attacks between days, months, seasons and years as well as the trend over time. I focused on activities of people in bear habitat during attacks, their behaviour, and the presence of a dog, gun or female bear. My goal was to measure all possible variables in the field in order to search for relationships between them and bear attacks and to evaluate the behaviour of people and bears before and during such incidents in order to identify the most common risk factors associated with aggression.

2 Materials and Methods

2.1 Study area

The study was carried out in Slovakia (approximately 48°66′N, 19°69′E) in 2015 – 2018. Slovakia is located in central Europe and is characterized by a mountainous landscape in the north and lowlands in the south. It is located in the northern temperate climate zone with a regular alternation of four seasons and variable weather with a relatively even distribution of precipitation during the year (www.shmu.sk, accessed on 16.8.2018). Approximately 40% of Slovakia is forested (www.forestportal.sk, accessed on 3.9.2018).

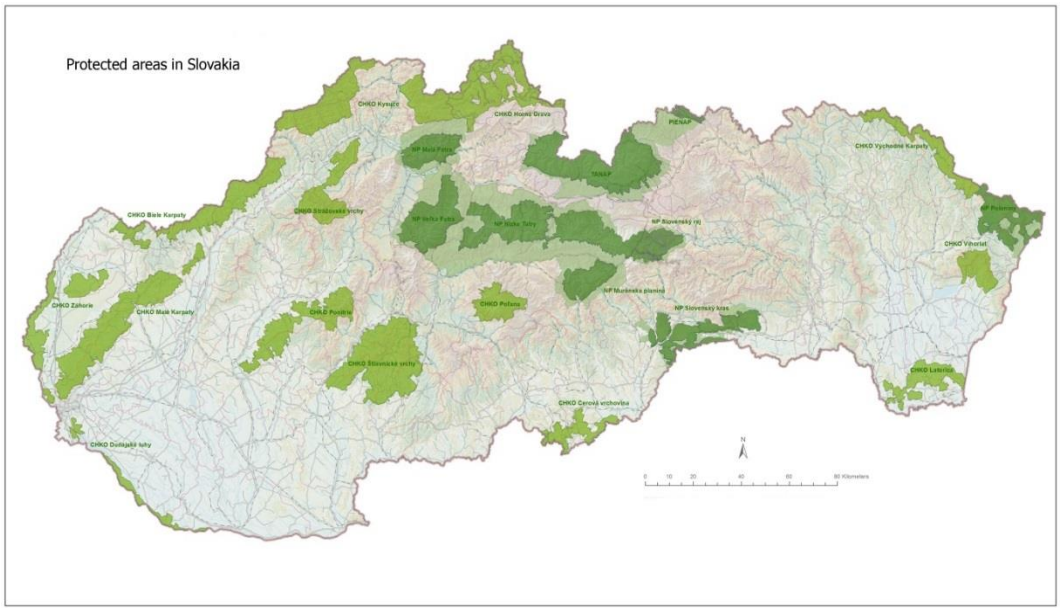

Figure 1: The distribution of protected areas in Slovakia. These areas consist of 9 national parks (dark green; 6.48% of Slovakia), buffer zones around national parks (lighter green; 5.36% of Slovakia) and 14 Protected Landscape Areas (light green; 10.66% of Slovakia) (Source: State Nature Conservancy, Banská Bystrica http://www.sopsr.sk/cinnost/doc/Mapka_VCHU.jpg)

2.2 Population status of brown bears in Slovakia

The brown bear in Slovakia is a game species according to §19 and later amendments of the Hunting Act (no. 23/1962). However, according to Decree no. 172/1975 by the Ministry of Agriculture and later amendments on the timing, method and conditions for hunting certain game species, there is no open season for bear hunting in Slovakia. Exceptions from the law on nature and landscape protection issued by the Ministry of the Environment to allow population control as well as the removal of problem bears (Rigg & Adamec 2007). The distribution of bears in Slovakia is closely linked to forest cover (Koreň et al. 2011). The core of the population is in central Slovakia with lower numbers in the northeast (Figure 2) and very few bears present in the west or south. The population size was estimated at 1256 bears (1023 - 1489 95% CI) in 2013 and 2014 (Paule 2015). This number includes all bears killed during this period (hunting n = 40 and traffic n = 21) but does not include cubs born in 2014. The sex ratio was found to be skewed towards females (59.9% females, 40.1% males) (Paule 2015).

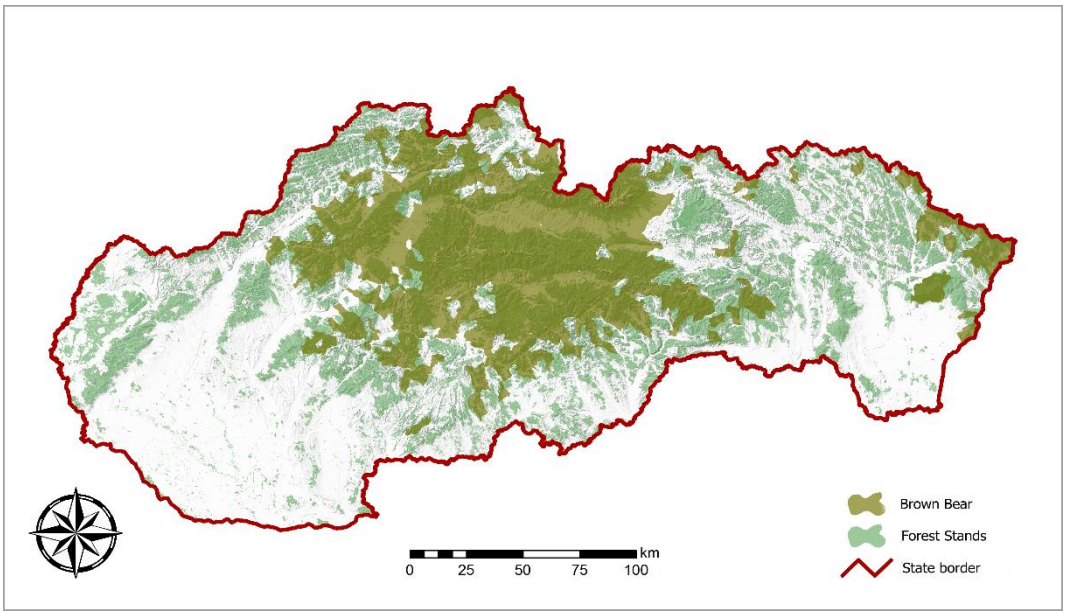

Figure 2: The distribution of brown bears in Slovakia in 2016 (Source: State Forestry Center – NLC, Zvolen, 2016)

2.3 Fieldwork and data collection

I created three datasets for further analysis. The definitions used in this thesis are presented in Table 1.

Dataset 1 - The Slovak Wildlife Society created a data base of 51 bear attacks on humans in Slovakia during the period 2000 – 2015 based on official reports by authorities and reports obtained from the media, internet, and newspaper articles (R. Rigg, unpublished data). I investigated and verified every attack in this data base through consultation with responsible authorities and other sources (National Park services, rangers, district officials, forestry offices, police, medical services, etc.). I was not able to verify several cases from the original data base, i.e. these cases were wrong and accordingly removed them from the data base. However, several new cases were found and added to the data base.

After this step, Dataset 1 contained only confirmed bear attacks (bear attack: direct physical contact or injury of a person caused by a bear; see Table 1) on people which resulted in human injuries or fatalities (n=54). For every confirmed attack, I collected data on the location (administrative district), date, number of people involved, the activity of people at time of attack (see also Appendix 1), and if possible, the age, sex and reproductive status of the bear involved. The sex of a bear was verified by the presence of cubs, when the bear was killed after the attack, of by confirmation from National Parks (also approved if bear was habituated of food-conditioned) and Forestry Service.

Dataset 2 – I used Dataset 1 to contact 20 victims of bear attacks and interviewed them face-to-face to obtain as detailed information as possible on the circumstances and conditions under which attacks occurred. Data collected from past events that are reliant on subjective memory and opinions can be biased. However, I tried to minimize biases by comparing interview data with data from official reports to account for differences in the official version and the version of the attacked person. I aimed at collecting data

describing the behavior of the victim as well as of the bear before, during and after the attack. The following data were collected for every attack (see also Appendix 1): time of day (day, twilight – morning and evening depending on season and victim report, night), exact time of attack, weather conditions, presence of a dog, presence of a gun, was the bear shot at, distance between person and bear before the attack, duration of attack (estimate), defensive behavior of victim (active or passive), initial focus of attack (i.e., which part of the human body was injured first), initial response of person, length of hospitalization and/or absence from work (Table 1).

Table 1. Definitions of terms for human-bear conflicts applied to a dataset on bear attacks in Slovakia 2000-2016.

Definitions
Encounter/Interaction: A person and bear notice each other. The outcome of such an encounter can differ, depending on the situation (Rigg 2016).
Incident: Interaction with a person where bear reacts aggressively (Rigg 2016).
Attack: Direct physical contact or injury of a person caused by a bear (Hopkins 2010).
Active defense: Describes the reaction of an attacked person, that is actively fighting back against the bear during an attack; for example, by hitting the bear with bare hands or a stick, shooting at the bear, etc.
Passive defense: Describes the reaction of an attacked person, that is passively responding the attack, for example by lying still on the ground, remaining silent, etc.
Defensive attack: Responsive attack by bear in self-defense that may be a public safety concern during sudden encounter or surprised bear (Hopkins et al. 2010)
Predatory attack: A bear is actively preying on a person (Herrero and Higgins 2003).
Habituated bear: A bear that shows little to no overt reaction to people as a result of being repeatedly exposed to anthropogenic stimuli without negative consequences (Herrero et al. 2005).
Food-conditioned bear: Bear that learned to associate people, human activities, human-use areas, or food storage with anthropogenic food (Herrero et al. 2005)

Dataset 3 – I visited the exact locations of 20 bear attacks, whenever possible together with the victim. I selected cases where the habitat characteristics of the site had not significantly changed since the attack; for example, attack sites that were in the forest but have since been clear cut were excluded from the analysis. Because the exact habitat characteristics and conditions at the time of the attack could not be replicated, I tried to compare the relative characteristics of the attack site to the same habitat variables collected at a random site 200 m from the attack site. A distance of 200m was selected based on the maximum distance (150m) from which a bear was reported to have charged at a person in Slovakia (Šebo 2004). A random direction to obtain a location for the random site was derived from a random number generator from a Smartphone application. This approach resulted in a paired data set where every attack site can be directly compared to a random site in the vicinity.

At each of the attack and random sites the following habitat characteristics were assessed: altitude, predominant habitat type within a radius of 100m; the habitat types were identified based on the National Forestry Center maps (gis.nlcsk.org) under Slovak Ministry of Agriculture. Main habitat types were meadows and forest. The habitat category 'forest' was subdivided into 4 categories, based on stage of succession, canopy cover, understory, and ground cover. In addition, data on the presence and type of water bodies, and sound of water were collected, as well as human infrastructure (roads, houses, urban areas), distance to nearest hiking trail, vehicle track, road, ungulate feeding site, and to the nearest hunting tower (see also Appendix 2). The potential presence of anthropogenic (garbage), or natural bear foods (carcass, fruit/berries, mast/nuts, insects) at the time of the attacks was collected based on the information from authorities, the victim, or the presence of such foods during the visit for data collection.

In addition, I tried to evaluate the relative minimum and maximum visibility at the attack site compared to the random site. For this purpose, I created a cardboard model

of a life-sized standing brown bear (dimensions of the model: 90 cm high, 105 cm wide; see also Appendix 3). I measured the minimum and maximum sighting distance, which was defined as the shortest and longest distance from which the model was still visible with the naked eye; these distances were measured with a tape measure, or alternatively derived from exact GPS coordinates on the Slovak TOPO map®.

2.4 Statistical analysis

Parametric and non-parametric statistics were used to evaluate the research questions presented in the introduction. The statistical software Minitab 18 (Minitab Inc. 2010) and R 3.4.3 (R Core Team 2017) were used, and p-values ≤ 0.05 were considered as significant, and p-values >0.05 but <0.1 were considered as suggestive.

3 Results

3.1 General results

Overall, I was able to verify 54 cases of bear attacks on humans in Slovakia during the years 2000 – 2016 (mean number of attacks per year = 3.18 ± 2.555 (SD), median = 3, range (0 – 8)). All attacks resulted in contact or injuries of victims, but no human fatalities were recorded during the study period. Attacks were documented in 15 administrative districts and most (76%) occurred in 6 districts within the core area of the bear population (Figure 3). I found that 47 attacks happened within or close to protected areas.

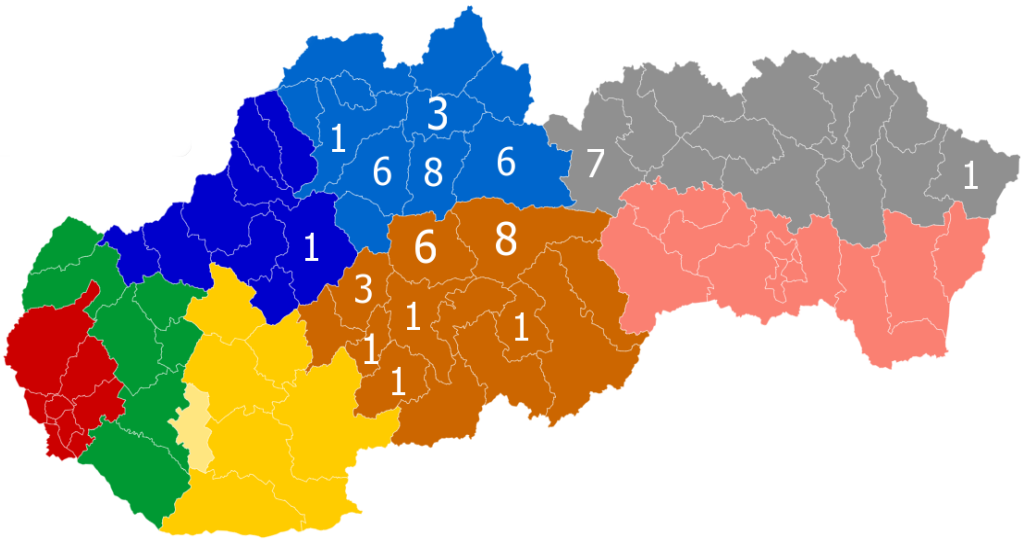

Figure 3: Number of brown bear attacks on humans per administrative district in Slovakia in 2000 – 2016. (Source for map of districts: www.sodbtn.sk).

The highest number of attacks occurred in June (n=8), and significantly more attacks happened during the period when bears are usually active compared to the hibernating season (Chi-Square Goodness-of-Fit test: $\chi 2 = 25{,}8302$, df = 53, $P \leq 0.001$);

active season mean = 5.625 ± 1.188 (SD), median = 5.500, range (4 – 8); hibernating season mean = 2.000 ± 0.816, median = 2.000, range (1 - 3) (Figure 4).

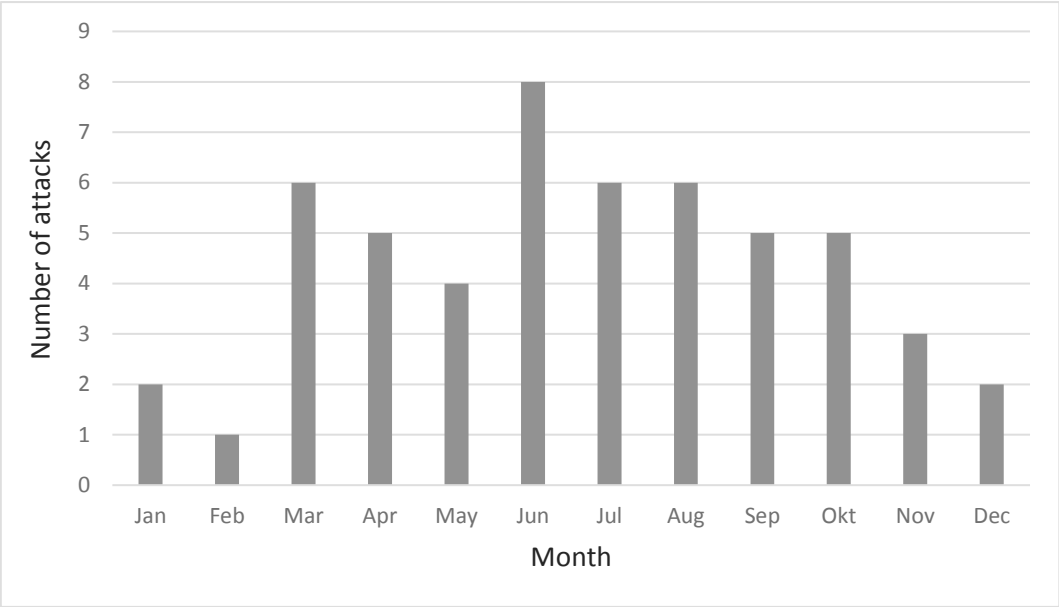

Figure 4: Number of brown bear attacks on humans per month in Slovakia in 2000 – 2016.

The number of bear attacks varied significantly among years (Chi-Square Goodness-of-Fit test: $\chi 2 = 32.8889$, df = 16, P = 0.008). Most attacks happened in the years 2014 (8 cases) and 2007 (7) (Figure 5).

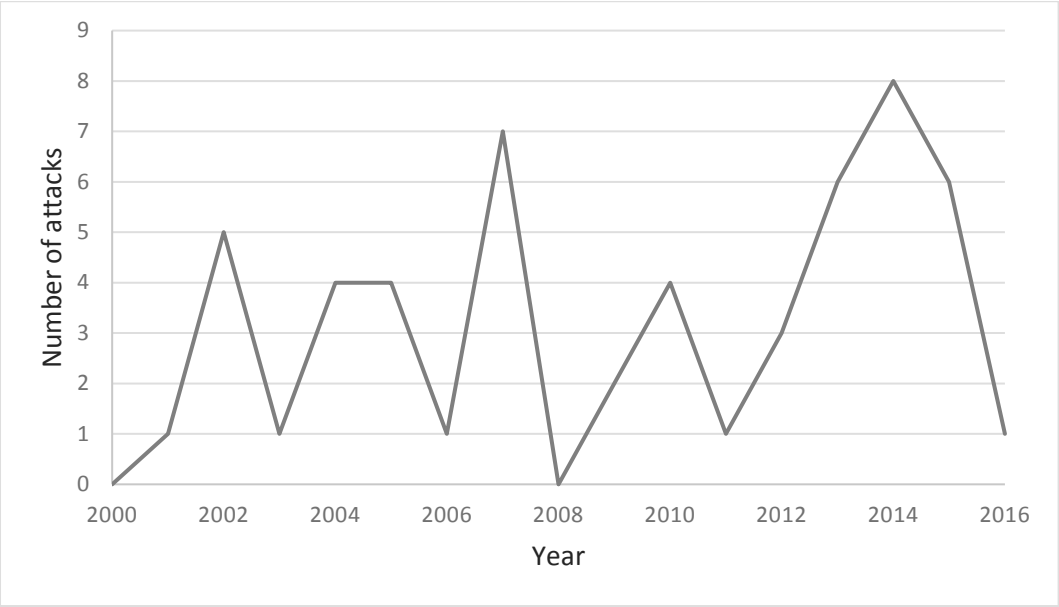

Figure 5: The number of brown bear attacks on humans per year in Slovakia from 2000 to 2016.

In 43 cases for which exact dates were confirmed, significantly more (51%) occurred during the weekend (Saturday, Sunday) compared to weekdays (Monday-Friday; Chi-Square Goodness-of-Fit test: $\chi 2 = 16.4186$, df = 6, P = 0.012) (Figure 6).

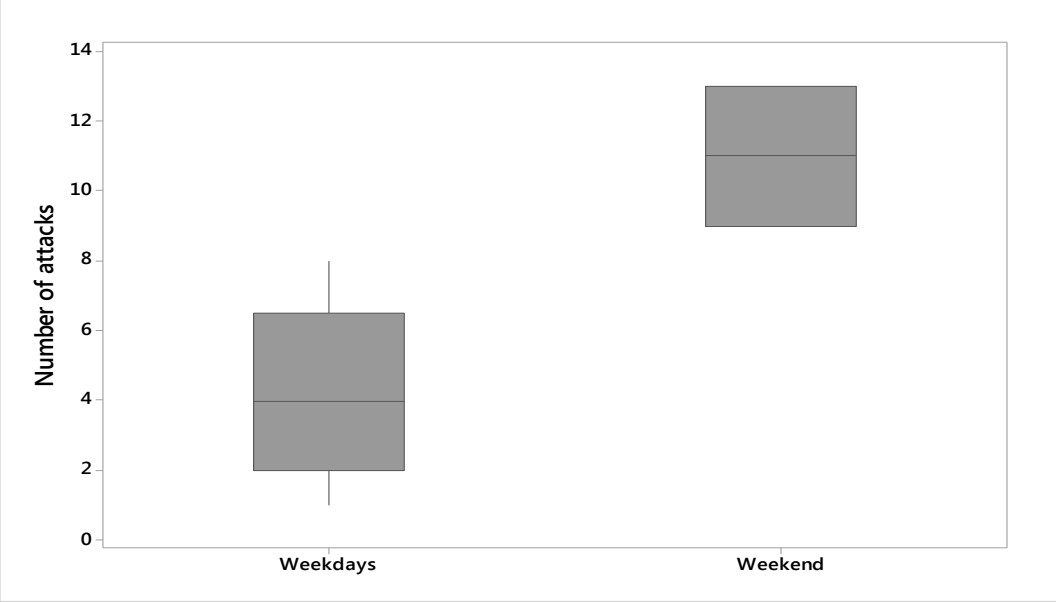

Figure 6: Median number of brown bear attacks on humans during weekdays and weekends in Slovakia in 2000 - 2016.

The sex of attacking bears was confirmed in 24 cases. Females carried out significantly more attacks (83%) compared to male bears (Chi-Square test: $\chi 2 = 10.6667$, df = 1, P = 0.001). From 20 cases where bear females were involved, majority (70%) was with presence of cubs ($\chi 2 = 3.2000$, df = 1, P = 0.074).

An unaccompanied person was significantly more often attacked by a bear than a person in a group (Chi-Square test: $\chi 2 = 116.074$, df = 6, $P \leq 0.001$) (Figure 7). I was able to confirm the activities that people carried out before a bear attack in 49 cases. People carrying out activities related to hunting and gathering (29%) were significantly more often involved in bear attacks than people carrying out other activities, such as recreation - hiking, camping, (20%, n = 10), forestry work (16%, n = 8) or other (6%, n = 3) (n = 49, $\chi 2 = 26.8571$, df = 6, $P \leq 0.001$) (Figure 8).

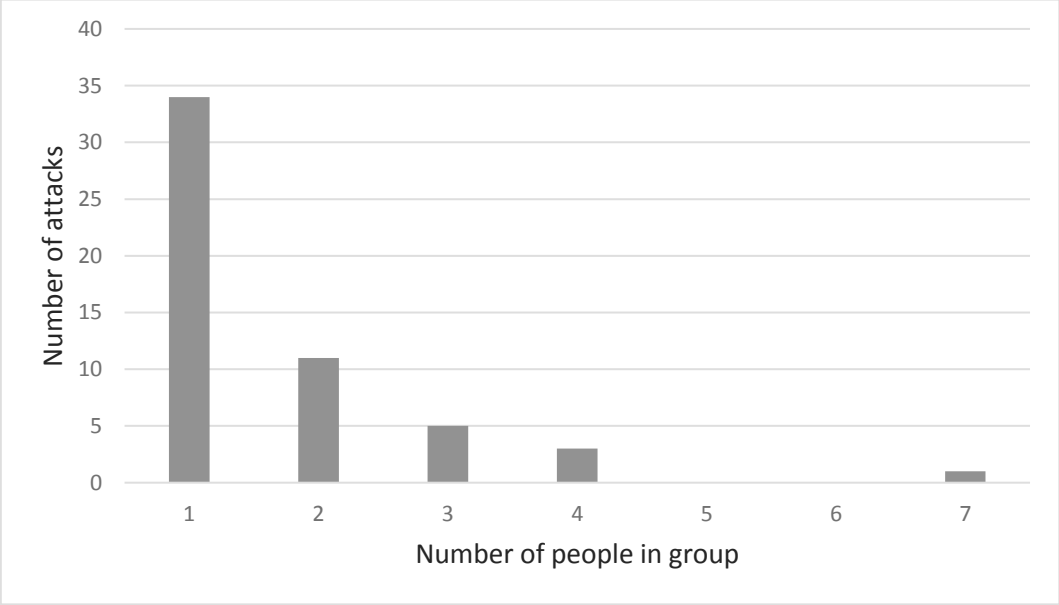

Figure 7: Number of brown bear attacks on humans in relation to group size in Slovakia.

In 48 cases (89%), bear behavior was evaluated as defensive and in 6 cases (11%) habituated or food-conditioned bears attacked people. None of the bear attacks was considered as predatory. There were no cases in which injuries were caused by more than 1 bear.

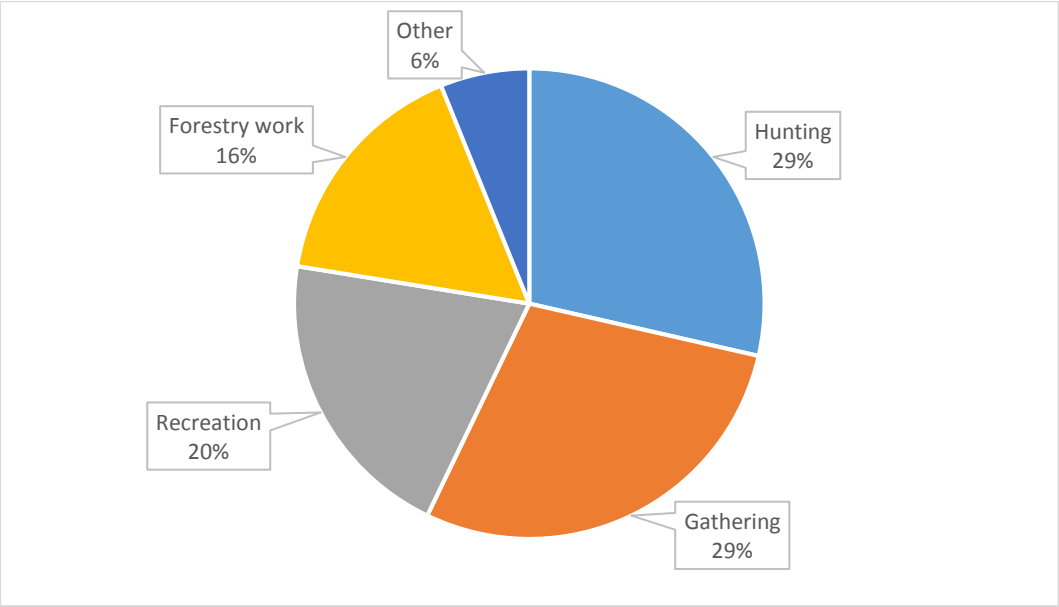

Figure 8: Activities that people carried out before being attacked by a bear in Slovakia in 2000-2016.

3.2 Interviews with victims

Dataset 2 was compiled from interviews with 20 victims. The majority (80%) of attacks occurred during the day, with peaks around 10:00 and 14:00. Three (15%) occurred during twilight and 1 (5%) during the night ($n = 20$, $\chi 2 = 19.9000$, $df = 2$, $P \leq 0.001$).

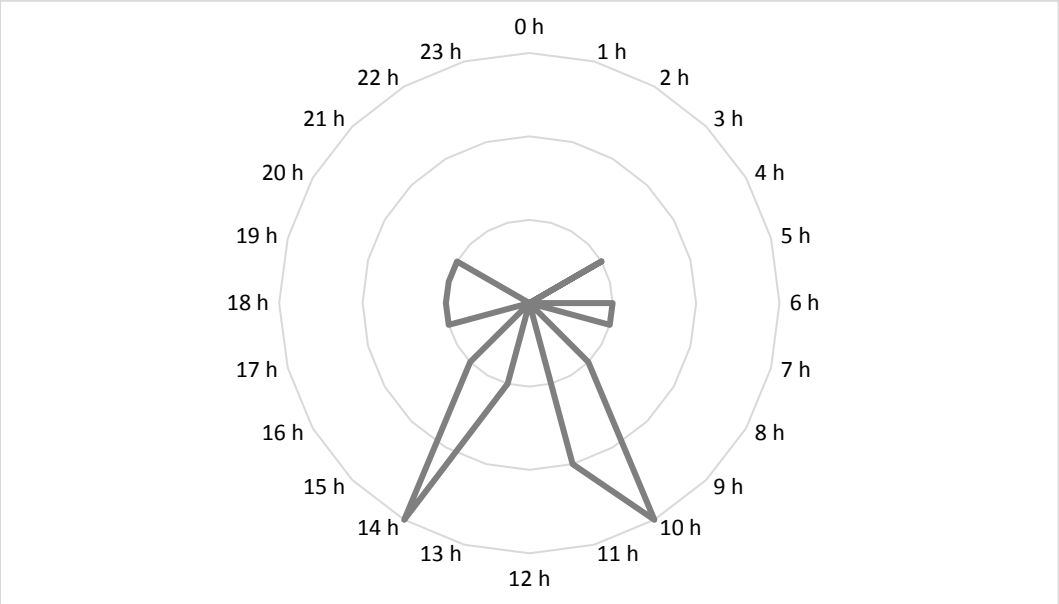

Figure 9: Time of day when bear attacks occurred.

In 15 cases (75%) victims reported that the weather was fair, i.e. clear sky, sun and good weather conditions.

A dog was present in 5 cases (25%). A gun was present in 5 cases (25%) and in 2 cases victims shot at the bear but did not hit, wound or kill bear.

The distance at which a person first observation of bear before being attacked was on average 11.94 ± 12.716, median = 5 (0 – 40) (n = 18; Figure 10). Most attacks initially focused on the victim's legs (58% of 19 cases analysed), arms (26%), body (11%) or dog (5%).

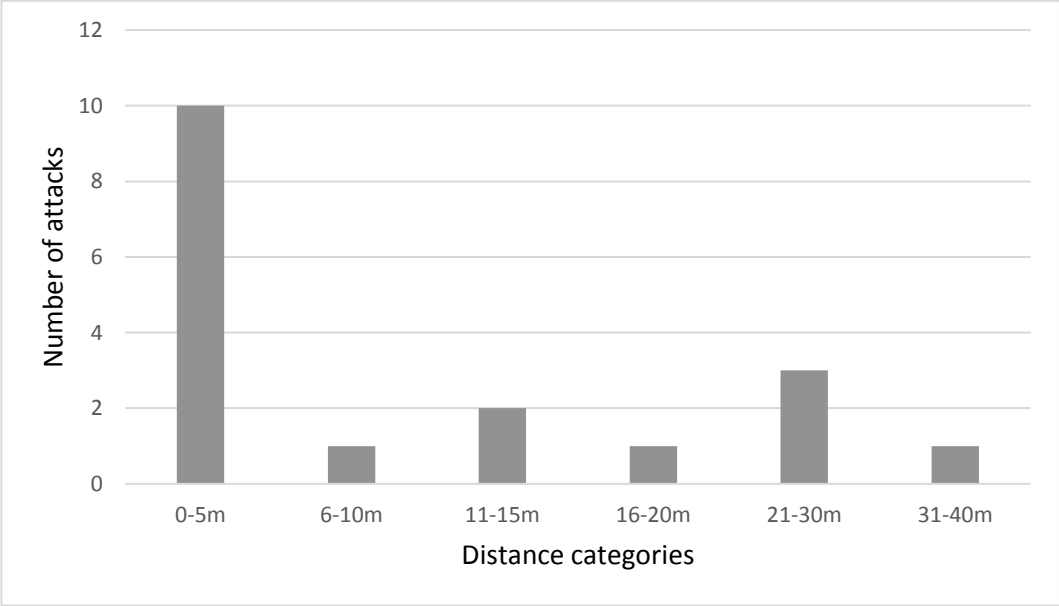

Figure 10: Distance (m) at which victims first observed bears prior to being attacked.

In most cases (15/20) people defended themselves actively against the attacking bear, while the remainder responded passively, i.e. they did not resist physically. The mean hospitalization after bear attacks was 8.7 ± 10.178 days for active defense and 7 ± 0.000 for passive defense, $\chi 2 = 10.387$, df = 3, P = 0.016.

People who tried to run away from a bear (9 of 19 cases) were hospitalized on average 8.8 days ± 5.630, median = 10 days (0 – 14), whereas people who remained still

(5 cases) were hospitalized on average 6 days ± 2.777, median = 7 days (1 – 9) $\chi 2$ = 17.098, df = 4, P = 0.002. The mean number of days of work absence after being attacked by a bear was 92.73, median = 52 and range from 0 to 465.

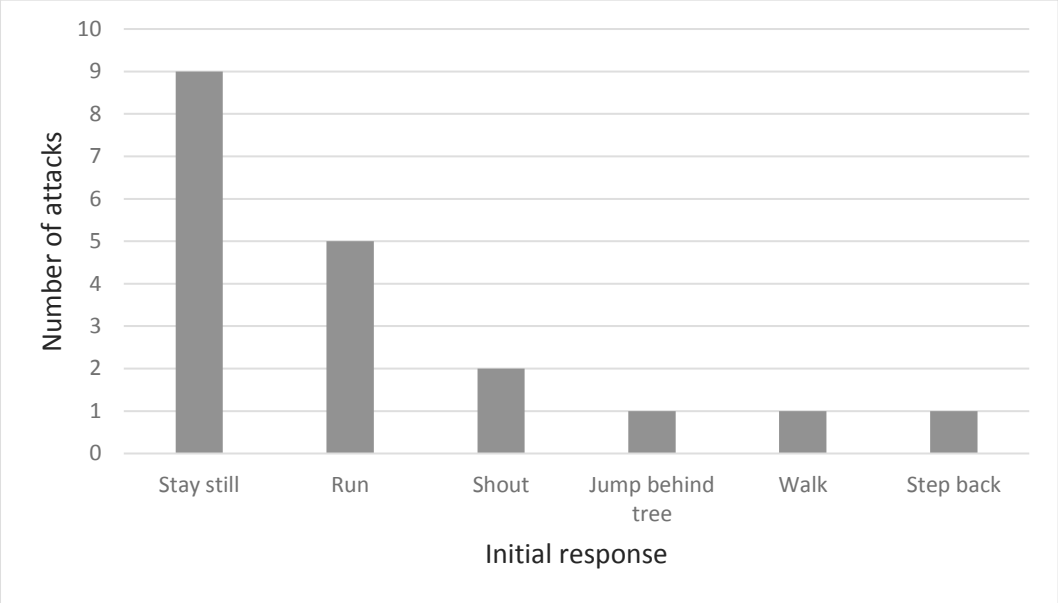

Figure 11: Initial response of victims to brown bear attacks in Slovakia in 2000 - 2016.

3.3 Attack sites vs random sites, paired design

Attack site – The majority (85%, from an overall sample size = 20) of attacks occurred in forest habitats (paired t-test, t = -0.10, df = 36, P = 0.924). In 85% (n = 17) attacks happened in closed canopy cover, and 55% (n = 11) in dense understory (Table 2). In 50% (n = 10) of the cases were victims travelling off trail (paired t-test, t = 0.39, df = 33, P = 0.698). None of the attack occurred on marked tourist trails. Mast/nuts (70%) and fruits/berries (45%) were found as natural bear food within 100 meters around attack sites (paired t-test, t = 0.46, df = 1, P = 0.723).

The only significant difference between habitat variables measured at both attack and random sites was the mean maximum sighting distance of the bear model (Table 2). The mean maximum sighting distance was significantly shorter at attack sites (56.2 ±

66.0m) compared to random sites (77.0 ± 73.9m) (paired t-test, t = -3.48, df = 19, P = 0.002). All other pairwise comparisons were non-significant (Table 2).

Table 2. Pairwise comparison of habitat variables at attack sites and random sites in 20 cases of bear attacks on people in Slovakia from 2000-2016. "Variable" describes the habitat variable measured, "Attack site" shows the mean ± SD of the habitat variable at the attack site, and "Random site" shows the mean ± SD of the habitat variable at the random site. Significance gives the p-value of a paired t-test comparing a given habitat variable at an attack site vs a random site. P-values <0.05 were considered significant.

Variable	Attack site	Random site	Significance
Altitude (m)	827±312	811±792.5	0.052
Building (m)	962±944	982±942	0.582
Path (m)	67±146	88±128	0.379
Road (m)	1307±978	1321±1008	0.672
Urban area (m)	1530±1208	1529±1219	0.977
Vehicle track (m)	357±493	310±528	0.293
Minimum visibility (m)	9±6.4	10.5±11.2	0.661
Maximum visibility (m)	56±66	77±74	0.002
Stage of succession (rank)	3±1	3±1	0.334
Canopy (rank)	2.5±0.5	2.2±0.6	0.164
Understory (rank)	1.7±0.7	1.6±0.7	0.334
Ground cover (rank)	1.5±0.8	1.7±0.9	0.610

4 Discussion

During the period 2000 – 2016, 54 attacks by brown bears occurred in Slovakia. Most attacks happened within the core area of the bear population, in or near protected areas and during the summer. People walking alone or with a dog were more exposed to attack than people in larger groups. Dense vegetation with reduced visibility was a significant risk factor. Attacks were more likely to happen during weekends than weekdays and the most risky activities were hunting and mushroom/berry picking. In contrast to Scandinavia (Sahlén 2013) and Romania (Linnel et al. 2002a, b, Domokos et al. 2006), no human fatalities caused by brown bear attacks were reported in Slovakia during my study period. The last known bear-caused human fatality in Slovakia happened in 1927 (Lenko 2014). Most bear attacks occurred in districts with the highest bear densities, similar to what has been found in Scandinavia (Sahlén 2013).

Brown bear attacks in Slovakia peaked during the summer months, which is similar to results from Alberta, Canada, where the peak for brown bear attacks was in September and for American black bear attacks in August (Herrero and Higgins 2003). Attacks by bears on humans during summer months are likely related to the fact that many people spend more time on outdoors activities (Penteriani et al. 2016). In addition, especially in the later summer months, bears are more active feeding to build up fat reserves for hibernation.

Bear attacks during the winter/non-active period of bears can likely be related to disturbance of bears at or close to den sites. Attacks which happened during winter in 2007, 2014 and 2015 may be related to reported warmer years in general (www.shmu.sk, accessed on 16.8.2018), which may have caused some bears to leave their dens or not hibernate at all (Nores et al. 2010).

An increased number of interactions between people and bears during weekends can be associated with more people spending time in bear habitat for recreational purposes.

More than two thirds of the recorded attacks were carried out by female bears, which supports findings from Scandinavia (Swenson et al. 2000) that the presence of dependent offspring increases the risk of being attacked during an encounter with a bear. The number of people in a group has been suggested to be an important factor for attacks by large carnivores (Penteriani et al. 2016). Results from my study showed that single people or very small groups of people were attacked more often. This is similar to results from North America, where the same group size (1 or 2 persons) represented 87% of people injured by bears in Yellowstone National Park (Gunther & Hoekstra 1998). In Alberta, 90% of groups involved in bear attacks consisted of 1, 2 or 3 people, and 91% of black bear incidents involved a group size of 1 or 2 persons (Herrero and Higgins 2003). Larger groups of people tend to make more noise than single persons or small groups of people, which increases the probability to be discovered by a bear in time and thereby decreases the probability for an attack.

Outdoor activities in bear habitat, such as hunting, gathering (berries, mushrooms), hiking and camping are very popular in Slovakia. Hunting and gathering are the two outdoor activities most exposed to bear attacks followed by activities related to forestry work. One bear attack happened on an Alpine skiing slope where a ski rail worker was inspecting work by other colleagues when he slipped and fell downhill in very foggy conditions and collided with a bear, which briefly attacked him.

In Europe, brown bears have been classified as nocturnal-crepuscular animals (Kaczensky et al. 2006, Moe et al. 2007). According to interviews with victims, most of the attacks occurred during the daytime and support findings from a North American study that both people and bears have diurnal activity preferences (Herrero 1985). This is

likely related to most people being active in bear habitat during daylight hours, and that bears are disturbed in their day beds during these activities. Brown bears prefer daybeds in dense vegetation cover with the opportunity to avoid detection (Ordiz et al. 2011). While I do not have data on day bed selection in Slovakia, the result that the visibility of the bear model was on average lower at attack sites compared to random sites suggests that bear attacks occur mainly in habitats with dense vegetation cover and poor visibility.

I determined, that weather conditions are likely not strong factors in conjunction with brown bear attacks. As most of the victims reported generally good weather and clear sky during attacks with bears, beliefs about association between bad weather conditions and the chance of being attacked by a bear are not supported by this study.

The presence of a dog has been defined as a major factor associated with an increased probability of being attacked during an encounter with a bear (Swenson et al. 2000, Sahlén 2013). The observed cases in Slovakia where a dog was present during a bear attack indicate that this was a stressful situation for the bear. In all 4 incidents with dog presence, the victims reported that the dog and the bear had noticed each other just before the attack. Three victims reported that their dog ran into dense vegetation cover and then returned immediately followed by a disturbed bear, which suddenly switched its focus from the dog to the person. In one case with dog presence, the dog was not present during the initial attack, but was attracted by the noise of the attack and defended the attacked person.

Guns were present at 5 attacks, but fired only in two cases, and both times the bear was missed and not injured. Victims were actively hunting during attacks or walking and patrolling hunting territory. All victims of such attacks reported that the bear was very close and the attack happened very quickly. The average distance during these attacks was estimated at 12m, and the average visibility at these sites was 9m.

Attacks where people remained passive and did not engage in physical confrontation with the bear during the attack resulted in shorter hospital stays. This suggests that the most appropriate reaction if attacked by a bear is to remain passive rather than running away or fighting back. This is similar to the findings of a study in Yellowstone National Park, USA, where in most cases running, attempting to climb a tree, or resisting an attack did not appear to be good strategies during an encounter with a bear (Gunther & Hoekstra 1998).

The significant difference in the visibility distance of the model bear between attack sites and random sites shows that dense canopy cover and understory growth in bear habitat combined with short visibility provides more opportunities for surprises and sudden encounters with bears (Herrero and Higgins 2003).

Many studies on bear-human interactions have described that habituated and food-conditioned bears are more likely to be involved in attacks on people (Herrero 1970a, 1985, 1989, Gunther 1994). In Slovakia, people commonly feed bears and this undesirable behavior of both people and bears can turn problematic (Hell & Slamečka 1999). Although 89% of the bears in this study were not known to be food-conditioned or human-habituated, this issue could become more serious in future. Garbage management in areas with bears is still very poor in Slovakia, which may result in injuries caused by food-conditioned brown bears.

5 Conclusion and management recommendations

The absence of a validated and centralized database and record keeping about bear attacks on people in Slovakia was a major hindrance to this study. I had to personally visit victims to ask them about their experiences, which turned out to be a stressful discussion for some of the people I visited. Data based on personal memories of such an event must be interpreted carefully.

In areas where bears and people use the same habitat, there will always be potential for conflicts including the possibility of attack and injury (Conover 2002). According to researchers and managers, many bear attacks could be prevented and avoided with appropriate knowledge of bear behavior and ecology (Herrero 1970a, 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 1999). One of the most important recommendations from this study for people in Slovakia to avoid meetings with bears is that people should travel in groups, or alternatively, make noise when travelling alone in bear habitat. Remaining silent or moving very quietly through areas with restricted visibility increases the risk of a sudden encounter with brown bear. This is related particularly to hunting and mushroom/berry picking, which are activities that are usually carried out off marked tourist trails. Avoiding dense vegetation with limited visibility to surroundings is also important advice arising from this study. People should be made aware that being accompanied by a dog may increase the risk of bear attacks. If a brown bear attack happens, there are indications that remaining silent and passive (if possible) results in less severe injuries.

None of the victims was carrying bear spray, which has proven to be very effective to avert bear attacks (Smith et al. 2008). In addition to working effectively, such spray also has a psychological aspect, in that it reduces the excessive fear of bears in humans in general (Majić Skrbinšek & Krofel 2014). Bear spray has been available for sale in Slovakia since 2008 (www.medvede.sk) and is slowly becoming more commonly carried, but knowledge and awareness is still low among the general public. A rise in the awareness of the general public and other groups which spend time in bear country could be key for better coexistence between two species: humans and bears.

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Appendix

List of appendix:

Appendix 1: Interview with victims.

Appendix 2: Standardized protocol for data collection at attack sites.

Appendix 3: Brown bear model for minimum and maximum visibility measurements.

Appendix 4: Examples of signs to alert people of potential bear presence in Slovakia.

Appendix 1: Questionnaire

Slovak Wildlife Society (SWS)
Spoločnosť pre výskum, vzdelávanie a spolužitie s prírodou
P.O. Box 72, Liptovský Hrádok 033 01.
Tel.: +421-907-446714 | email: info@slovakwildlife.org
www.slovakwildlife.org | www.medvede.sk

QUESTIONNAIRE

Analysis of encounters and attacks by bears on people

The aim is to objectively determine in which circumstances attacks occur and, on the basis of the results obtained, to make recommendations for authorities and the public about how to reduce risks. We therefore need detailed and accurate information. Please respond to all questions (use a separate sheet for each case) by filling in or circling answers or indicating where the answer is unknown or not applicable.

First name, surname: _____

Organization, address: _____

Position: _____

Tel./mob.: _____ email: _____

Relation to victim: _____

Information about the attack came from:

a) interview with victim b) site investigation c) official records

d) media: _____

e) other: _____

When and where the attack occurred

1. Date: _____
2. Day of the week: _____
3. Time: _____
4. Mountain range: _____
5. District: _____
6. Municipality: _____
7. Location (GPS coordinates): _____ (name): _____
8. Weather during attack: _____
9. Level of nature protection at the site: 1 2 3 4 5
10. Place where the victim was immediately before attack (e.g. on forest road): _____
11. Description of surrounding habitat (e.g. young spruce forest): _____

Description of the victim(s)

12. How many people were attacked? _____

13. Sex of first victim: male / female 13.1. Sex of second victim: male / female

14. Age of first victim: _____ years 14.1. Age of second victim: _____ years

15. Activity at time of attack:
a) hunting: _____
b) forestry: _____
c) agriculture: _____
d) mushroom collecting e) forest fruit collection
f) hiking g) camping
h) at cottage / hotel i) emptying refuse or compost
j) other: _____

Description of the attacking bear

16. Sex: male / female / unknown

17. Age: _____ years (17.1. measured or estimated?)

18. Mass: _____ kg. (18.1. measured or estimated?)

19. If cubs were present – how many: _____ and what age: _____

20. Was the bear already known? (e.g. observed repeatedly, unwary etc.) yes / no / I don't know

21. If yes, please explain: _____

Circumstances of the attack

22. How many people were in the group with the victim? _____

23. Was there a dog? yes / no / I don't know

24. Did the victim have a gun during the attack? yes / no / I don't know

25. What was the victim doing immediately before encountering the bear? _____

26. What was the bear doing before the encounter? _____

27. Was there a lot of activity and/or people in the area? yes / no / I don't know

Reactions and their effects

28. When the victim first noticed the bear, what was the distance between them? _____ m.

29. What alerted the victim to the presence of the bear? _____

30. Was the bear aware of the person in that moment? yes / no / I don't know

31. What was the first reaction of the victim on noticing the bear? _____
_____

32. What effect did this reaction have on the situation? _____
_____

33. When the bear first noticed the person, what was the distance between them? _____ m.

34. What was the first reaction of the bear on noticing the person? _____
_____

35. What effect did the reaction of the bear have on the situation? _____

_____

36. If physical contact occurred, what did the victim do?

a) defended him/herself (how: _____) b) played dead c) other: _____

37. Did someone try to help the victim while the bear was still present? yes / no / I don't know

38. If yes, in what way and what effect did this have on the situation? _____

_____

39. How long did the attack last? _____ s.

40. How did the attack end? a) bear was chased off (how: _____) b) victim escaped

c) bear escaped d) bear was shot e) other: _____

Outcomes

41. After the attack, the victim was: a) uninjured b) lightly injured c) seriously injured

42. Description of injuries: _____

_____

43. If the victim was hospitalized, for how many days? _____

44. What treatments were administered? _____

_____

45. For how many days was the victim unable to work? _____

46. Did the victim suffer long-term consequences? yes / no / I don't know

Interventions

47. Was there a site investigation? yes / no / I don't know

48. If yes, after how many days? _____

49. Was there an application to remove the bear? yes / no / I don't know

50. For what reason? _____

51. Was the application approved? yes / no / I don't know

52. For what reason? _____

53. If it was approved, was the bear removed? yes / no / I don't know

54. Was there a request to compensate medical costs? yes / no / I don't know

55. If yes, was it approved? yes / no / I don't know

Please return the completed questionnaire by email (info@slovakwildlife.org) or send it to:
Slovak Wildlife Society, P.O. Box 72, 033 01 Liptovský Hrádok.

Please feel free to add any additional comments in the space below.

Appendix 2: Standardized protocol

Bear attack site protocol

Case ID:	Date of visit:
Name of observer:	Time of visit:
Assisted by:	Weather during visit:
Interviewee (if present) and contact (mobile no.):	

Name of location:	GPS coordinates:
Nearest town/village:	Altitude:
District (*okres*):	Level of protection (1–5):

Date of attack (dd/mm/yy):	Attack was at: 1-twilight, 2-day, 3-night
Initial distance from victim to bear: m	Time of attack (if known):
Weather during attack: 1-fog, 2-rain, 3-sun, 4-cloud, 5-wind, 6-snow, 7-other (specify)	

Predominant habitat within 100m radius of attack site*:	1-arable field (specify crop) 2-pasture 3-meadow 4-alpine/subalpine 5-scrub 6-forest 7-urbanised (specify) 8-other (specify)
• If forest – what type? (forest GIS)	
– stage of succession:	1-clearfell, 2-saplings, 3-young forest, 4-mature
– canopy (tree species, height and density; state if logged):	1-open, 2-semi-open, 3-closed Description:
– understory (shrubs, young trees):	1-absent/sporadic, 2-semi-open, 3-dense Description:
– ground cover (herb layer):	1-<20cm, 2-20–40, 3-40–60, 4-60–80, 5-80–100, 6->100cm Description:
• If meadow – height of vegetation:	1-<20cm, 2-20–40, 3-40–60, 4-60–80, 5-80–100, 6->100cm Description:
*Specific details (e.g. if attack site was forest clearing or edge, details of forestry work prior to attack, was meadow mown prior to attack, etc.):	
Changes in habitat since attack (describe):	

Visibility of model bear from attack site:	Minimum: m Maximum: m
Was the victim on a trail when attacked?	1-paved road 2-unpaved vehicle track 3-marked footpath 4-unmarked footpath (e.g. hunting path) 5-game trail 6-off trail
Water within 100m of attack site:	1-river, 2-stream, 3-lake, 4-pond, 5-other
Sound of flowing water heard at attack site:	1-none, 2-quiet, 3-medium, 4-loud
Natural food within 100m at time of attack:	1-carcass 2-fruit/berries 3-mast/nuts 4-insects (specify) 5-grass 6-other (specify)
Anthropogenic food within 100m:	1-agricultural crops (specify) 2-livestock (specify) 3-game feeding site 4-hunting bait 5-fruit trees 6-beehives 7-trash 8-other (specify)
Human infrastructure within 100m:	1-village/town 2-isolated building (permanent use - specify) 3-cabin e.g. hunters' (specify) 4-permanent camp site 5-seasonal camp site 6-forestry workers' camp 7-agricultural workers' camp (e.g. *salaš*) 8-other (specify)
Distance to nearest:	Footpath: m Vehicle track: m Public road: m Hunters' feeding site: m Hunting tower: m Isolated building (specify type): m Urban area: m
Other factors likely to be significant: (e.g. presence of bear den, human disturbance of bear, history of bear feeding by people, etc.)	
Notes: - outcome of attack, - identity and management of the bear, - unusual circumstances, - inconsistency/contradiction of information from media/victim, etc.	

Appendix 3: Bear model

Appendix 4: Bear country sign