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Factors contributing to human injuries and fatalities inflicted by brown bears (Ursus arctos) in Russia, 1932-2017

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Preface

This study was conducted at the Faculty of Environmental Sciences and Natural Resource Management at the Norwegian University of Life Sciences (NMBU).

I wish to express my warmest gratitude to my supervisors Jon Swenson and Andrés Ordiz for making this study happen. I appreciate their support of this terrifying thesis, which remains as captivating as the species studied. I have been fortunate to have their supervision and guidance through this process. They have graciously allowed me the opportunity to present a poster on this research at the 26th International Conference on Bear Research and Management. I would also like to thank IBA Travel Grants Committee for providing a travel grant to attend this conference.

I wish to thank Leonid Baskin for providing valuable information on brown bear ecology, human-bear conflict in Russia, hunters' surveys on bear encounters, as well as for the feedback that has improved the manuscript. Many thanks to Svetalna Barysheva for sharing the dataset on brown bear attacks.

I am also grateful to: Mahdieh Tourani, Richard Bischof, and Ross Wetherbee for valuable tips about data analysis and visualization, as well as to the staff at the NBMU Library for ordering literature from abroad and helping me with editing Russian references.

Ås, 05.12.2018

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Abstract

In this thesis, I have compiled, summarized, and reviewed 322 cases of people killed and injured by brown bears (*Ursus arctos*) in Russia from 1932 to 2017. The focus was primarily on 256 bear-induced human casualties recorded between 1991 and 2017, because data availability varied between the Soviet and post-Soviet periods. I found that the annual number of human-bear incidents was positively associated with the area of forests burned annually and with the increase in the brown bear population, despite varying estimates of the bear population size during the study period. Between 1991 and 2017, bear-caused injuries and fatalities occurred more frequently on the Russian Pacific Coast (111 incidents) and in Siberia (104 incidents) than in European Russia (41 incidents), which had higher human density and fewer bears. Single bears were involved in most of the incidents (73%). Casualties occurred mainly during daytime and especially in summer and autumn. Human activities appeared to lead, directly or indirectly, to bear-caused human injuries and fatalities; in 182 incidents with documented probable causes bears most often attacked when provoked (41%), surprised (18%), and when bears preyed or attempted to prey upon humans (17%). During 1932-1990, hunters and outdoor workers were the main categories attacked by bears. Between 1991 and 2017, people who gathered wild resources and hiked were injured or killed more frequently in bear attacks. I emphasize the importance of educational programs where people can learn about bear biology and habits, better management of human activities in bear country, systematical collection of data on bear population dynamics, and preservation of bear habitat in order to minimize human-bear conflicts in Russia and elsewhere.

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Introduction

Human-carnivore conflicts have been a part of the history and evolution of both humans and carnivores (Camarós et al., 2016) and are still common across the globe, particularly in Asia and Africa (Kruuk, 2002; Thirgood et al., 2005). Habitat loss, ecosystem degradation (Miquelle et al., 2010; Murphy & Macdonald, 2010), and human population growth and encroachment into previously inaccessible locations (Herrero et al., 2011) have led to more frequent human-carnivore encounters. People´s attitudes towards large carnivores are complex and the intensity of human-large carnivore conflicts is dependent on a variety of environmental, social, and personal factors (Swenson et al., 1995; Røskaft et al., 2003; Dickman, 2010). Large carnivore attacks on livestock (Zimmermann et al., 2005; IUCN, 2006; Jackson et al., 2010) and humans (Thirgood et al., 2005; Dhanwatey et al., 2013), as well as competition for prey with human hunters (Graham et al., 2005), elicit intrinsic biophobic responses among people (Røskaft et al., 2003; Schwartz et al., 2003), which in turn jeopardize carnivore management and conservation incentives (Kojola et al., 2018). Even rare incidents (Knight, 2000) can enhance the antipathy and hyper-awareness towards large carnivores among the general public and often lead to serious declines in carnivore populations (Woodroffe et al., 2005; Dickman, 2010; Dickman & Hazzah, 2016).

The dramatic nature of human-carnivore conflicts has formed tenuous human relationships with potentially dangerous carnivores, like the brown bear (*Ursus arctos*) (Graf et al., 1992; Swenson et al., 1999; Herrero, 2002). Moreover, the great interest in bear attacks, demonstrated by the media, has amplified the negative perception of them and consequently threatens bear conservation (Craighead & Craighead Jr, 1971; Smith et al., 2012). Numerous studies have analyzed human-bear incidents in North America (Shelton, 1994; Herrero & Higgins, 2003; Penteriani et al., 2016; Smith & Herrero, 2018) and Europe (Swenson et al., 1999; De Giorgio et al., 2007; Støen et al., 2018), describing factors involved in incidents and their prevention.

Increased numbers of human-bear incidents have occurred, because of rising bear abundance combined with growing numbers of people engaging in outdoor activities, hunting, and human risk-enhancing behaviors in bear country (Penteriani et al., 2016; Smith & Herrero, 2018; Støen et al., 2018). Inappropriate food and garbage storage (Herrero, 2002; Herrero & Higgins, 2003) and predatory behavior demonstrated by some bears (Shelton, 1994) are factors that have also been mentioned, primarily in North America. Støen et al. (2018)

concluded that in Scandinavia the annual number or people injured or killed by bears increased in association with the increasing bear population size during the last four decades, but this relation was only true for hunters. The increase in the bear population size did not correlate with the number of incidents affecting unarmed people (Støen et al., 2018).

Geographical variation in bear behavior has been reported in Russia, with higher rates of bear-caused fatalities in Siberia and on the Pacific Coast than in European Russia (Vaisfeld, 1993; Swenson, 1996), and a few studies focusing on potential factors contributing to human-bear conflicts (Baskin, 2006; Baskin & Barysheva, 2016). Both the brown bear population size and the number of casualties have been reported to be growing in Russia, negatively affecting human-bear coexistence and potentially undermining bear protection efforts (Baskin & Barysheva, 2016). Previous studies in Russia, have found that people were injured more often when cubs were present and bears were wounded and/or followed by hunters than by single and nonwounded bears (Bobyr, 1987; Baskin, 1996). Other studies in Russia from the 1980s-1990s concluded that inefficient hunting management, unsustainable logging (Yudin, 1993), large-scale forest fires (Ustinov, 1993), and increased human disturbance resulted in bear-human interactions (Suvorov, 1991; Revenko, 1993; Revenko, 1994). Reducing these negative factors and eliminating food-conditioned and habituated bears were thus recommended in order to avoid economic damage and for human safety reasons (Krechmar, 1986; Bobyr, 1987; Pazhetnov, 1990).

The objective of this study was to investigate the factors influencing brown bear-caused casualties that resulted in human injury or death in Russia. This is warranted, because, although about half of the world's brown bears live in Russia (McLellan, 2017), only 4% of the scientific publications about brown bears in the world came from Russia (n=4,553, based on a search in ISI, the Web of Knowledge, as of September 27, 2018, when using the search term "brown bear"), and only 3% were published in English.

I investigated the period between 1932 and 2017, with a particular focus after 1991, when the sources of information seemed to be more reliable and bear incidents were more likely to be reported both in areas with both low (European Russia) and high (Siberia and the Pacific Coast) bear numbers. The first hypothesis was that both natural factors, e.g., brown bear population size, season, and fluctuating productivity of bear food items, and anthropogenic factors, e.g., level of human disturbance in bear habitat due to road construction, geological exploration, logging, hunting, and recreation, were involved in the number of bear casualties in recent decades. The second hypothesis was that the above-mentioned factors varied among areas, with a greater proportion of lethal cases towards the Pacific Coast. Hence, the overall goal was to understand which factors are involved in the bear-caused casualties in Russia and how the pattern might vary across different areas of this huge country, which has potential implications for the conservation-oriented management of brown bears at the worldwide scale, given the percentage of bears that inhabit Russia.

Methods

Study area

The Russian Federation occupies an area of 17.1 million km^2 with total human population estimated to be 146,804,400 (Federal State Statistics Service, 2017). I classified administrative regions into three main areas – European Russia, Siberia, and the Pacific Coast (Fig.1), which differ in their densities of bears, paved roads, and humans, levels of human disturbance, abundance of food items, and percentage of forest cover (Table 1). The study area as a whole covered 14 biomes, including tundra, taiga, deciduous and mountainous forests, alpine tundra and meadows (see Table S1 for further details). Between 1932 and 2017, bear casualties have been recorded in 40 of the 83 administrative regions in the country (Table S2).

Study species

The brown bear population in Russia consisted of an estimated 132,000 individuals in 1992 (Chestin, 1997). According to the Ministry of Environment and Natural Resources of Russian Federation, the brown bear population has increased rapidly, reaching 245,100 individuals in 2017. In contrast, another state agency reported a decrease in brown bear numbers, from 225,100 in 2015 to 143,000 in 2017 (The Prosecutor General´s Office of the Russian Federation, 2018). Bragina et al. (2015) suggested that the reportedly increased bear abundance in recent decades was a result of changes in bear monitoring methods, which included annual aerial surveys, surveys on established plots and oat fields, as well as written surveys completed by hunters (Komissarov & Gubar, 2013). Nevertheless, officially reported population numbers should be treated with caution; the International Union for Conservation of Nature (IUCN) recently estimated that about 100,000 brown bears were found in Russia (McLellan, 2017), i.e., the IUCN estimation is barely half of the Russian estimates of the bear population size.

Fig 1: Main areas of Russia – European Russia, Siberia, and the Pacific Coast, used in this study

	European Russia		**Siberia**		**Pacific Coast**	
Human population	104,623,542	±866,900	32,995,342	±808,664	5,577,621	±866,900
Brown bear population	51,569	±7,780	64,150	±13,857	43,574	±10,658
Paved road density	189 km/1,000km^2	±63	46 km/1,000km^2	±15	20 km/1,000km^2	±5
Forest cover	65 %	±11	47 %	±1,2	51 %	±0.41
Forested area burned/year	56,632 ha	±67,083	1,196,161 ha	±719,606	390,032 ha	±266,593
Protected area	8.4 %	±6.3	9.7 %	±7.1	9.3 %	±3.1
Biomass of berry species	4 kg/ha	±2.9	5.4 kg/ha	±3.4	2.2 kg/ha	±1.3

Table 1: Differences among main areas within Russia (European Russia, Siberia, and the Pacific Coast) in average human population, brown bear population, paved road density, forest cover, forested area burned/year, percentage of area protected, and biomass of berry species between 1991 and 2017.

As the bear population in Russia apparently almost doubled from 1992 to 2015, the legal harvest increased by 50% (Federal Agency of State Statistics, 2018). However, the number of issued hunting licenses remained low in recent years (Suvorov & Smirnov, 2006; Zyryanov, 2011). At the same time, the pressure of illegal hunting (mainly for bear gall bladders and paws) was estimated to exceed the legal bear harvest (Komissarov & Gubar, 2013).

Data collection and data processing

I used the term "casualty" for bear-caused human injuries or fatalities and "incident" to describe a case when a human-bear encounter led to one or more casualties. Casualties resulting in both minor and major injuries have been included into the dataset, but I have not evaluated the severity of the injuries, due to the lack of data on medical examinations in the collected reports.

Data about bear-caused casualties have been collected from various sources, including a dataset created and shared by Russian scientists, scientific publications devoted to human-bear conflicts, as well as from Russian media reports accessed over the Internet. In total, I have checked 6 books (only one book contained chapter summaries in English), 17 scientific publications (3 in English, the rest in Russian), and at least 520 media reports. I used methods consistent with those of Smith and Herrero (2018) and accepted all my collected reports as true, as far as they included a minimum amount of information. Reports (n=23) that lacked essential information, e.g., location, date, primary human activity, etc., were discarded from the dataset. Online searches in Yandex (the Russian equivalent of the Google service) of human-bear incidents included the term "bear" combined with the following words when searched for incidents – "нападения медведей" ("bear attacks");"медведь напал" ("bear attacked"); "медведь-шатун" ("vagabond bear"); "медведь набросился" ("bear pounced"); "медведь растерзал" ("bear mauled"); and "медведь убил" ("bear killed"). The Russian dataset included the incidents recorded during 1950-2015, and I gathered additional details about them from the Internet.

Totally, I included 322 incidents involving brown bears that caused human injuries or deaths from 1932 to 2017 in the dataset. I focused on the 256 cases recorded during 1991-2017 for further analyses of trends and geographical variation in the frequency of incidents, because data availability varied between the Soviet and post-Soviet periods. In addition, during the Soviet times, bear incidents were more likely to be reported in regions with lower bear population densities (European Russia) than in areas with high bear densities (like the Pacific Coast).

To identify the factors contributing to incidents, I analyzed year, date, time of the day, bear-related (number and sex of bears, bear activity, and probable cause of attack), environmental (geographical location, biome, regional percentages of forested and protected areas, susceptibility to forest fires, paved road and human densities, biomass of berries and stone pine species seeds), and human-related variables (number, age, gender, and primary activity of the affected people) on a regional scale. Human population size, bear population size, annual data on legally harvested bears, number forest fires, percentage of forested area, and percentage of forested area burned were also summarized at the national scale.

The location of each recorded casualty was used to assign it to one of 14 biomes with the purpose of estimating the habitat type where the incident occurred. Data about biomes, regional susceptibility to forest fires, and biomass of berries (*Vaccinium vitis-idaea*, *V. uliginosum*, *V. myrtillus*, *V. oxycoccos*, *Rubus idaeus*, and *R. chamaemorus*) and seeds of stone pines (*Pinus sibirica, P. pumila,* and *P. koraiensis*) species within the administrative regions have been obtained from the National Atlas of Russian Federation (Federal Agency of Geodetics and Cartography, 2007). Identified geographical coordinates also helped to estimate the regional biomass of berry and stone pine species fruits and seeds (Federal Agency of Geodetics and Cartography, 2007), the main food sources for bears during hyperphagia (Pazhetnov, 1990; Dahle et al., 1998; Bojarska & Selva, 2012). I did not consider fish stocks (mainly *Salmonidae*) in this study. Open source web tool Datawrapper GmbH (2018) was used for creating the maps of main areas of Russia and spatial distribution of total incidents.

Bear population size and density have been taken from national (Komissarov & Gubar, 2013; Gorlova, 2017; Russian Nature, 2018) and regional reports and databases (see Table S3). The number of forest fires, annual forested area burned, percentage of forested and protected areas within administrative regions, human population size, and paved road density were obtained from ecological reports (Federal Center of Geo-Ecological Systems, 2013; Federal Center of Geo-Ecological Systems, 2014), the website of the Ministry of Natural Resources and Environment of the Russian Federation (http://mnr.gov.ru/opendata/), Statistical Yearbooks, and open statistical data available online on the Federal State Statistics Service official websites (www.gks.ru and www.fedstat.ru).

I distinguished the following probable causes of bear casualties: food defense; cub defense; people provoking the bear (e.g., when people approached a bear at a close distance while it was in a den or during hunting or photographing); surprise (sudden encounter); and predatory behavior, which included predation or attempted predation, i.e., when bears searched, stalked, attacked, killed/dragged a person, and sometimes fed upon a person (Graf et al., 1992; Hopkins III et al., 2010). I also took into account special circumstances associated with casualties that could help to better understand the causes of bear aggressiveness: whether a bear was reported as sick/old/nuisance; whether a bear had been wounded by people attacked by the bear; or wounded, but not by the people attacked by the bear.

Age of the injured or killed people was assigned to the following groups: children (0-13 years), teenagers (14-19 years), adults (20-64 years), and seniors (>65 years). The primary human activities encompassed: hunting bears, hunting other species, fishing, livestock herding, hiking, professional outdoor activities (e.g., logging, geological exploration, or working at oil and gas fields), and gathering wild resources (e.g., berry or mushroom picking). I also sorted casualties that occurred outside the bear habitat into two separate categories – “in settlement” and “inside a house, hunting cabin, or car”. Time of the casualty referred to either nighttime or daytime, because the precise information was lacking in most of the documented cases.

Data analysis

I used generalized linear models to test whether bear population size, annual forested area burned, and paved road density were related to the number of incidents annually in all of Russia during 1991-2017. Human population size and percentage of forested area have been omitted from the final models, because these variables changed little over the years and the former also had an overwhelming impact on the model outcomes, due to its large magnitude. Furthermore, other variables were correlated with them, which reduced the number of variables included in the models. To account for the differing estimates of bear population size in Russia during recent years, I ran the same sets of models with three datasets containing different bear population estimates; one that reported a continuous increase in bear numbers (Gorlova, 2017; Federal State Statistics Service, 2018b); one that reported decreasing numbers since 2015 (The Prosecutor General´s Office of the Russian Federation, 2018); and a dataset reflecting the IUCN estimation of bear population in Russia (McLellan, 2017).

I selected the most parsimonious model based on the corrected Akaike's information criteria (AICc) (Zuur et al., 2009), and the importance of parameters retained in final models was interpreted with 95% confidence intervals (CI). Pearson's product-moment correlation threshold level of 0.6 was used to identify collinearity among model variables. As a consequence, the number of forest fires and paved road density were excluded from the models, because they both were highly correlated with area of annually burned forest (r=-0.76 and r=0.66, respectively). I tested the models for overdispersion and corrected it by using a quasi-Poisson link function (Zuur et al., 2009).

I also investigated whether the percentage of fatalities per total number of incidents within each of the three areas was different and, if so, which factors could explain the observed differences. For this analysis, I analyzed whether the outcome of an incident between 1991 and 2017, i.e., nonlethal (0) or lethal (1), depended on season, human activity, area, fire susceptibility, percentage of protected area, or bear density within the administrative regions. The open-source statistical software RStudio version 1.1.453 (R Development Core Team, 2018) was used to carry out all statistical analyses.

Results

Descriptive statistics

Geographical and temporal distributions of bear incidents

The collected data spanned 85 years (1932-2017) and included 322 incidents with at least 367 persons involved. Between 1991 and 2017, bear incidents occurred more frequently on the Pacific Coast (n=111) and Siberia (104) than in European Russia (41), which has higher human and road densities in the bear distributional range (Fig. 2). Most cases occurred in the mountainous, middle, and southern taiga biomes that are typical for Siberia and the Pacific Coast; 117, 35, and 31 cases, respectively (Fig. 3).

Bear incidents occurred mainly in summer and autumn (Fig.4, 5) and during daytime (n=135). However, there were also incidents during nighttime (n=36). Recorded cases that occurred during nighttime were unevenly distributed among the areas; 11% of all incidents in European Russia, 36% on the Pacific Coast, and 53% in Siberia. Bears that were considered as human-food conditioned in the reports caused injuries/fatalities during nighttime only in Siberia (n=8) and on the Pacific Coast (n=5).

Characteristics of bears involved

Single bears were involved in most of the incidents (73%). Bears mostly attacked people that were unaware of the bear's presence (n=90) or following a sudden encounter (n=33). In 25 incidents after detection by people, the bears approached or chased and then attacked the people. Yet, in 66 cases, details about the bear's behavior at the time of attack remained unknown, except that the bears had not being hunted and initiated the attacks. Bears attacked most often after people had provoked (n=75) or surprised them (n=33), and when bears demonstrated predatory behavior (n=30). Comparatively few bears attacked people when defending their food (n=19) or cubs (n=16) and when being hunted (n=9). In 74 incidents, the primary cause of bear attacks was not reported. Bears were reported to be old/nuisance/sick in 40 incidents, wounded by the people whom the bears attacked (n=15), or had been wounded, but not by the people they later attacked (n=4).

Bears classified as "vagabond" (sometimes referred to as "hanging bears" or *shatuns* in Russian) in the reports were involved in 15 incidents, which resulted in 5 injuries and 10 fatalities. Vagabond bears, as described in Russian literature, are bears that fail to fatten up

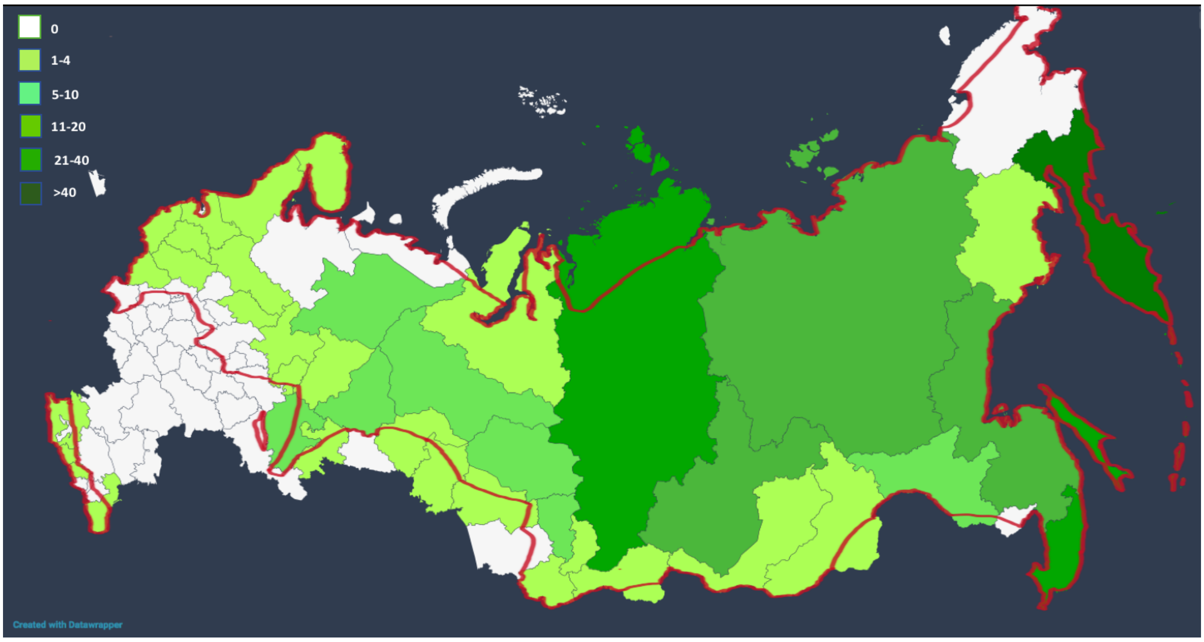

Fig 2: Spatial distribution (administrative regions) of human casualties caused by brown bears in Russia, 1991-2017. White color shows the regions without bear-caused casualties. Different shades of green colors code for the frequency of casualties within the administrative regions during the study period, with darker shades indicating higher frequencies. The red line indicates the approximate border of the brown bear distribution within the country.

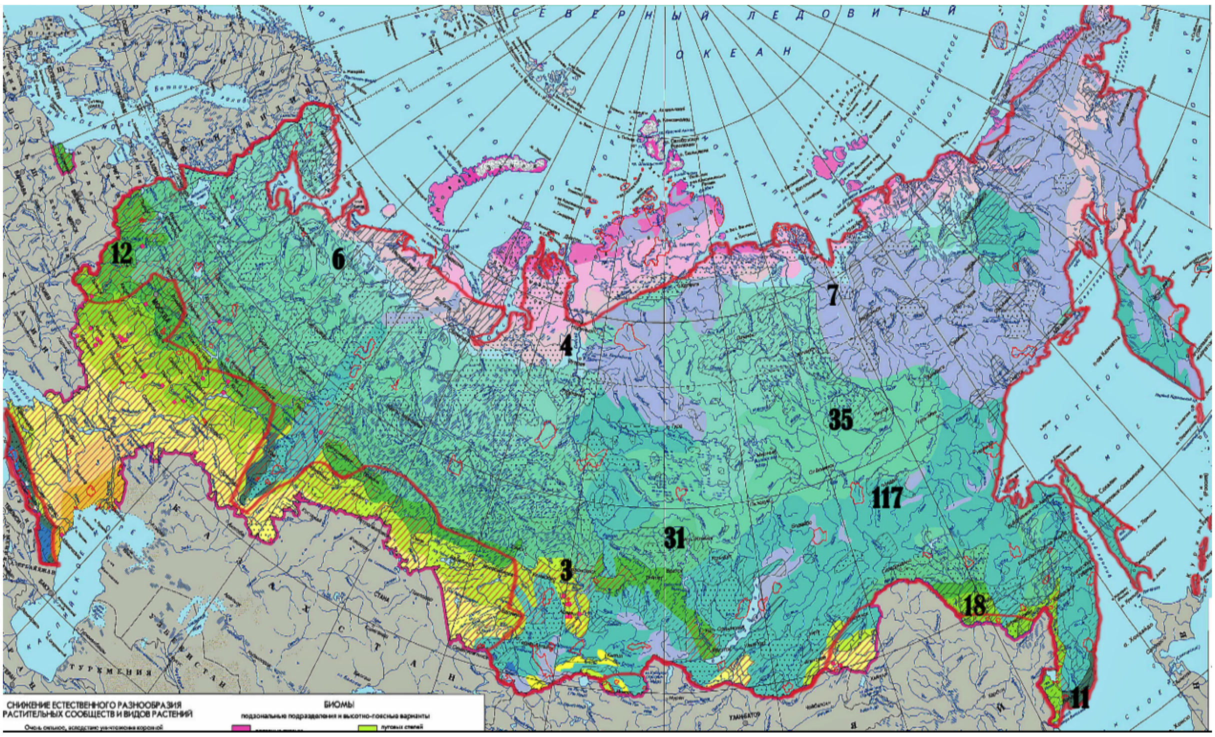

Fig 3: Distribution of human casualties caused by brown bears in different biomes in Russia, 1991-2017. The red line indicates the approximate border of the brown bear distribution within the country. Map from http://национальныйатлас.рф/cd2/356-358/356-358.html

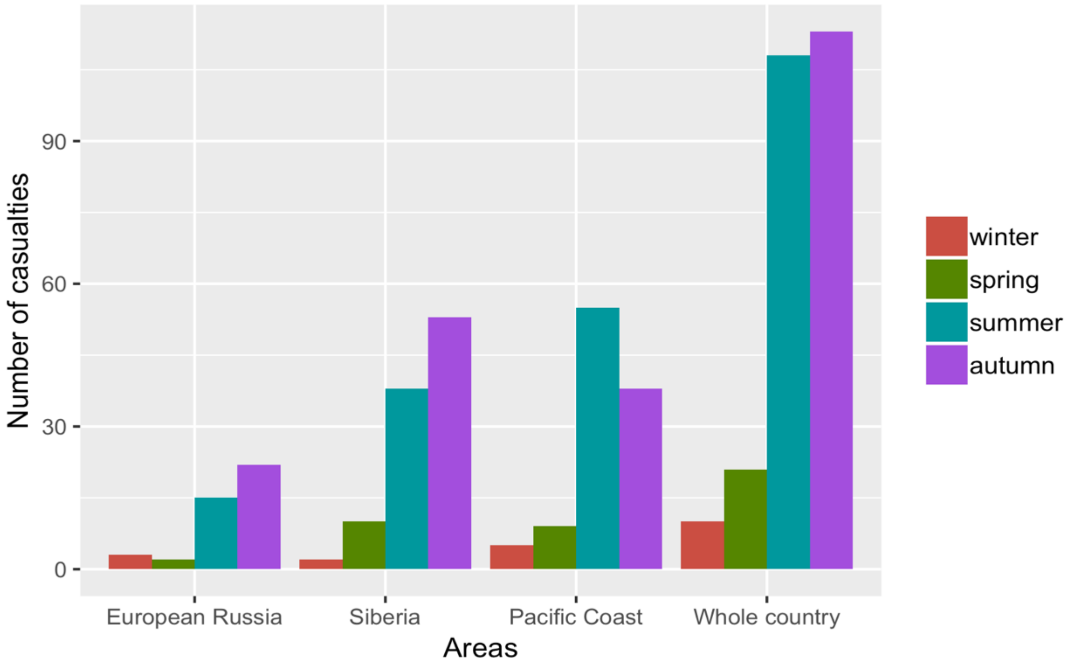

Fig 4: Seasonal distribution of brown bear-caused human casualties in Russia, 1991-2017.

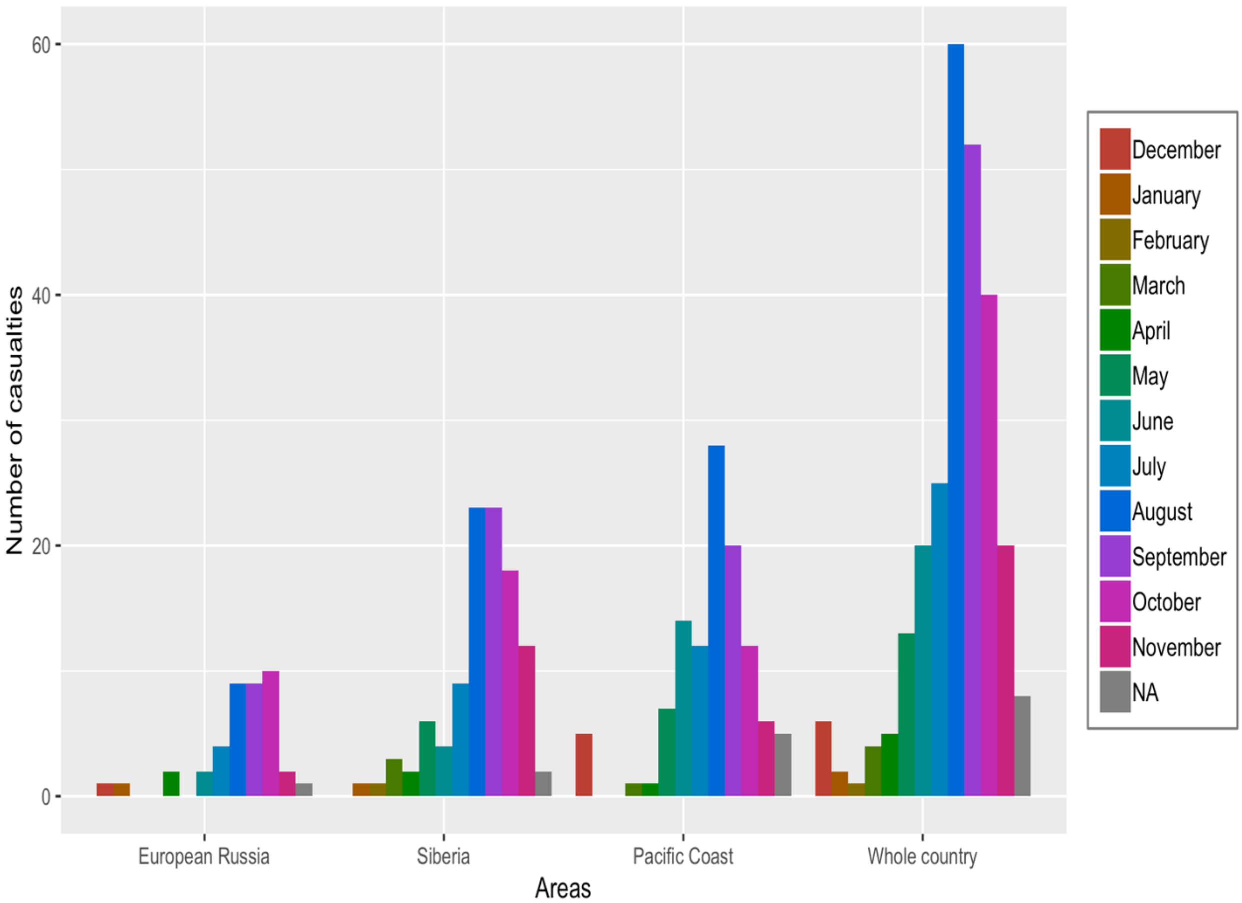

Fig 5: Monthly distribution of brown bear-caused human casualties in Russia, 1991-2017.

during the pre-denning period, as a result of internal (sickness, injury) or external (poor harvests of main food items) constraints and thus behave abnormally. However, in our dataset only four of the 10 fatalities apparently caused by vagabond bears occurred during the years with known poor berry or/and stone pines species seed production (see Table S4 for further details). In 59 fatalities, the bears consumed or moved the persons whom they initially hunted (n=20), in some cases after being provoked by humans (n=9), or when bears defended either their food (n=6) or cubs (n=4). In 20 cases when bears consumed/moved their victims, the causes of bear attacks were unknown. For bears involved in casualties with a known outcome for bears (n=190), 110 survived and 80 were eliminated by hunting managers or the police (n=44), or by people whom the bears had attacked or who accompanied people attacked by the bears.

Characteristics of humans involved

The majority of people injured or killed by bears were adults (n=119 and n=94, respectively). Senior-aged persons (14 injured and 16 killed) and children/teenagers (6 injured and 3 killed) were also involved in casualties. Totally, 210 men and 43 women were injured or died in bear-caused casualties. In 12 incidents gender was not documented. All injured/killed hunters and livestock herders were men. The great majority of persons involved in other activities were also men – 77% of injured and 82% of killed. Of 275 people injured or killed by bears, 142 were alone and 136 were in groups of 2-5 persons. In 24 cases the group size was not reported.

During 1932-1990, hunters were more often attacked by bears than any other group (39% of the injured cases and 35% of the killed) (see Fig.6.1-2; Table S5). Other incidents involved professional outdoor workers (13% injured and 22% killed), people gathering wild resources (13% and 8%), hikers (6% and 14%), or anglers (3% and 5%). After 1991, fewer records reported bear-caused casualties of hunters and people involved in professional outdoor activities. Casualties with people gathering wild resources and hiking, which included walks near human settlements, on the contrary, were documented more frequently between 1991 and 2017 (Fig. 6.3-4; Table S5). Bears injured/killed people in settlements in 36 cases, of which 33% were in Siberia and 58% on the Pacific Coast, and even when people were inside their houses, hunting cabins, or cars (n=4; 3 incidents were in Siberia). In those cases, bears did not seem to have been directly provoked by the humans they attacked, but demonstrated predatory behavior towards people.

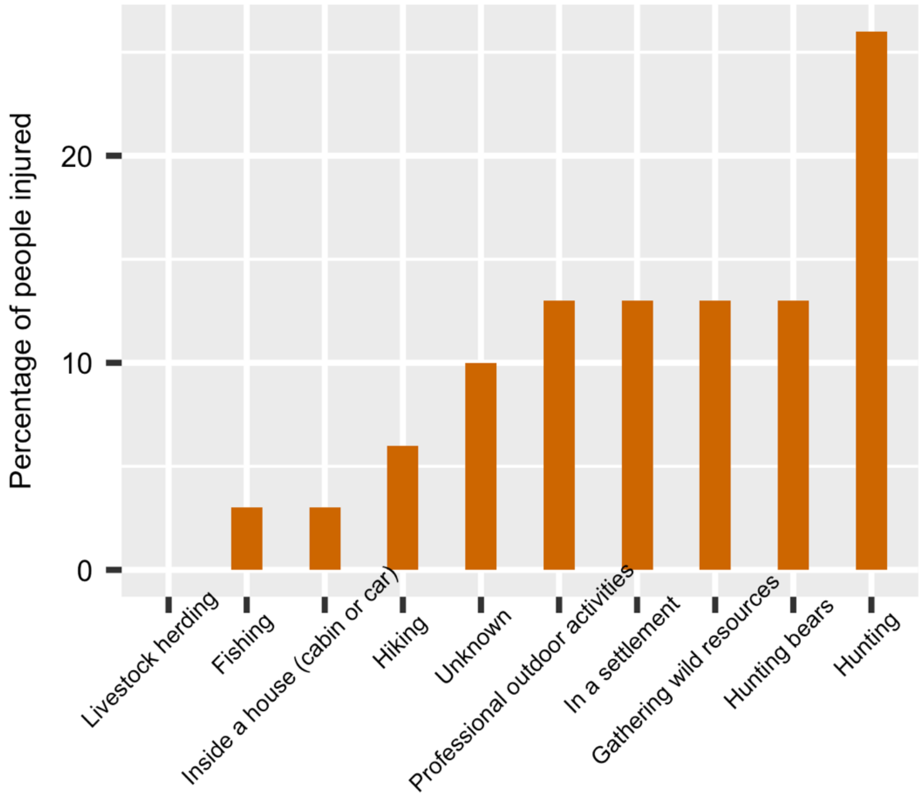

Fig 6.1: Primary activity of people injured in brown bear casualties in Russia, 1932-1990

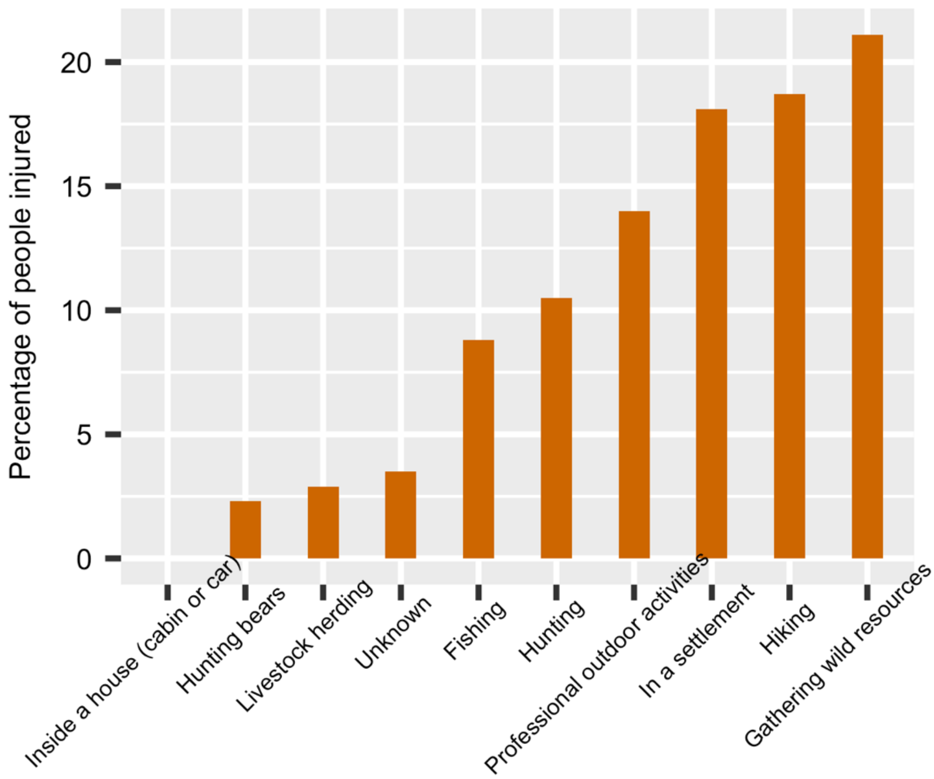

Fig 6.2: Primary activity of people injured in brown bear casualties in Russia, 1991-2017.

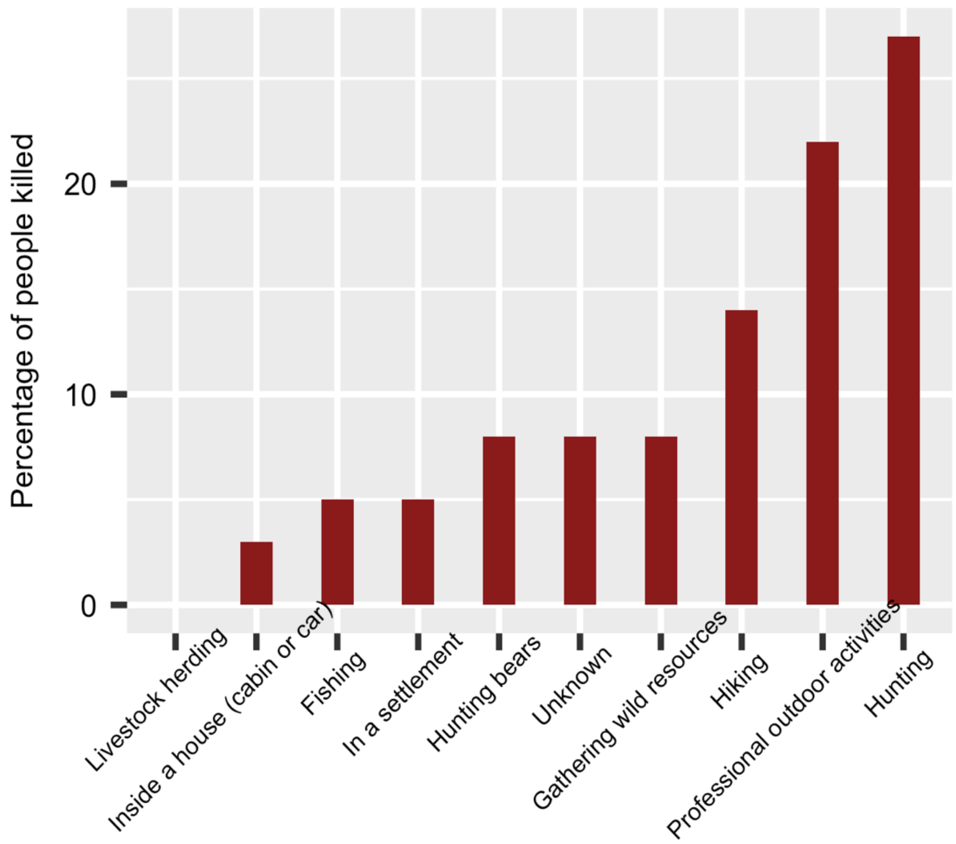

Fig 6.3: Primary activity of people killed in brown bear casualties in Russia, 1932-1990

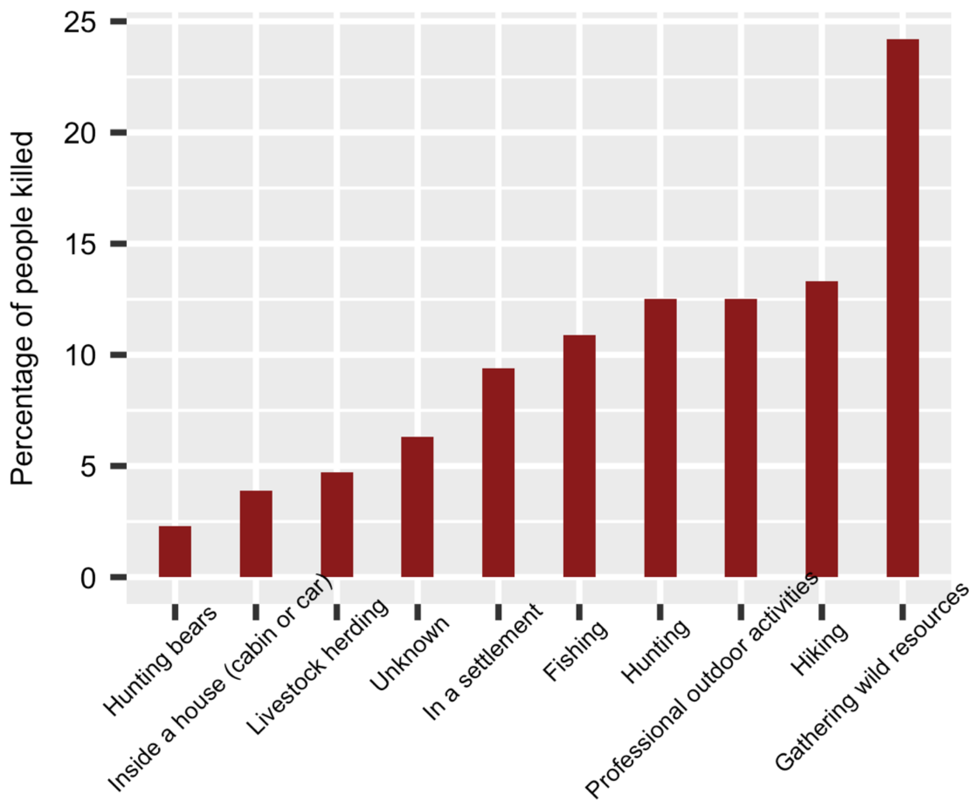

Fig 6.4: Primary activity of people killed in brown bear casualties in Russia, 1991-2017

Model results

For 1991-2017, the annual number of bear incidents increased with the increase in the bear population (ß=1.1e-05; 95% CI: 2.06e-06 – 2.003e-05) and with the forested area burned (ß=4.9e-07; 95% CI: 9.81e-08 – 9.04e-07). The alternative models, including the null model, had no support (Table 2). Importantly, the alternative bear population estimates did not change these results (Tables S6-7).

Model structure	ß	LL	UL	AICc	Delta	Weighted AICc	φ
Incidents ~ bear population size, forested area burned				158.8	0.00	99.7	2.37
(Intercept)	-0.7	-1.39	-8.98e-04				
Parameter: bear population size	1.1e-05	5.17e-06	1.69e-05				
Parameter: forested area burned	4.9e-07	2.33e-07	7.57e-07				
Incidents ~ bear population size				170.7	11.93	0.3	2.91
(Intercept)	-1.44	-2.06	-0.85				
Parameter: bear population size	2.07e-05	1.77e-05	2.38e-05				
Incidents ~ forested area burned				176.9	18.13	0.00	3.00
(Intercept)	3.890e-01	0.04	0.72				
Parameter: forested area burned	9.33e-07	8.01e-07	1.07e-06				
Null model				380.0	221.26	0.00	

Table 2.1: Results from generalized linear models (GLM) using Poisson link function explaining the annual number of people injured/killed by brown bears in Russia, 1991-2017 (Russian brown bear population estimate with an increasing trend).
ßs indicate parameter estimates, LL=lower limit of the 95% confidence interval, UL=upper limit of the 95% confidence interval, φ=dispersion parameter

Model structure	ß	LL	UL
Incidents ~ bear population size, forested area burned			
(Intercept)	-0.68	-1.79	0.35
Parameter: forested area burned	4.9e-07	9.81e-08	9.04e-07
Parameter: bear population size	1.1e-05	2.06e-06	2.003e-05

Table 2.2: Results from the most parsimonious GLM using quasi-Poisson link function explaining the annual number of people injured/killed by brown bears in Russia, 1991-2017 (Russian brown bear population estimate with an increasing trend).
ßs indicate parameter estimates, LL=lower limit of the 95% confidence interval, UL=upper limit of the 95% confidence interval.

The models suggested that the proportion of fatalities was related to season (more lethal cases in autumn than in the rest of the year) and area (Table 3). About half of the incidents were lethal on the Pacific Coast (52%), 47% incidents resulted in fatalities in Siberia, and 39% in European Russia during 1991-2017. Nevertheless, none of the variables I included in the models were clearly explanatory of the lethal or non-lethal outcome of an incident, because the null model was equally supported and the 95% CI of the estimates of the parameters included in the best model overlapped 0.

Model structure	**ß**	**LL**	**UL**	**AICc**	**Delta**	**Weighted AICc**
Human killed ~ season				316.6	0.00	0.35
(Intercept)	-1.04	-2.03	-0.07			
Parameter: season	0.36	-0.02	0.75			
Human killed ~ season + area				317.4	0.81	0.24
(Intercept)	-1.59	-3.01	-0.22			
Parameter: season	0.37	-0.01	0.77			
Parameter: area	0.22	-0.17	0.61			
Null model				317.9	1.33	0.18

Table 3: Results from generalized linear models (GLM) using binomial link function on the lethal or non-lethal outcome of incidents between brown bears and people in Russia, 1991-2017. See Table S8 for comparison of all competing models.
ßs indicate parameter estimates, LL=lower limit of the 95% confidence interval, UL=upper limit of the 95% confidence interval.

Discussion

I found that both natural and anthropogenic factors directly or indirectly contributed to the occurrence of brown bear-inflicted injuries and fatalities. Study results showed that the annual number of bear-human incidents in 1991-2017 was related to an increase in the bear population size, and this was in accordance with observed trends in North America (Smith & Herrero, 2018) and in Europe (Vougiouklakis, 2006; De Giorgio et al., 2007; Ambarli & Bilgin, 2008), although this relationship was only found for hunters in Scandinavia (Støen et al., 2018). The results showing the relation between bear population size and annual number of incidents held for all sets of models that used the alternative bear population estimates, i.e., the IUCN and Russian estimates that reported a continuous increase in the bear numbers in 1991-2017, and the Russian estimate that suggested a drastic bear population decline in the most recent years, after 2015 (Tables S6-7).

Importantly, the results also highlighted that large-scale drought, measured with the proxy of forested area burned per year, had a positive effect on the number of brown bear-inflicted casualties in Russia. Forest fire susceptibility is higher in drought years, which in turn results in poor forage production and apparently escalates the human-bear conflicts (Gillin et al., 1997). Human activity causes 46-60% of forest fires in Russia (Unified Interdepartemantal Information and Statistical System (EMISS), 2018a), which illustrates a link between human-caused habitat change and, according to our results, increased human-bear conflicts in Russia.

Like in Scandinavia, casualties involving hunters peaked in October and November (61%), at the end of the hyperphagia period in autumn. Within that period, bears may respond aggressively to disturbance, because of reduced activity levels that are associated to prehibernation behavior (Sahlén et al., 2015a). Despite the growing number of licensed hunters in Russia (Federal Agency of State Statistics, 2018; Unified Interdepartemantal Information and Statistical System (EMISS), 2018b), I observed a shift in the human activities associated with bear casualties since 1991. After 1991, hunters were no longer the main group facing the highest risk of a bear casualty, as they were earlier in the 20th century. Gathering wild resources and hiking have become the most common human primary activities involved in brown bear-inflicted injuries and fatalities, providing additional evidence and supporting results from the studies that documented similar trends in Slovakia (Rigg, 2018) and Alaska (Smith & Herrero, 2018).

I also identified spatial differentiation in the distribution of bear casualties in Russia. However, I could not detect the factors strongly related to changing severity of bear incidents among areas. Within Russia, lethal cases were more numerous in Siberia and on the Pacific Coast, which could be related to geographical variation in bear aggressiveness, which I could not control in the models (Table 4). According to some surveys of hunters (n=487), bears in Siberia and on the Pacific Coast demonstrated aggression more often during human-bear encounters (in 12% of 127 meetings, compared to 7% of 360 meetings in European Russia). Bears might more often display aggressive behavior towards people in Siberia and on the Pacific Coast, where human density is lower, than in European Russia, where bears exhibit more wary and elusive behaviors after longer-term coexistence with people.

Historically, brown bears in the European Russia have experienced heavy hunting pressure, similar to bears inhabiting Western Europe (Swenson et al., 1995; Zedrosser et al., 2011), which may have influenced them to avoid people when possible (Pazhetnov, 1990; Vaisfeld, 1993), whereas bears in Siberia and on the Pacific Coast, which have being hunted for a shorter period, attacked people more often (Cherkasov, 1884; Zavatskiy, 1993; Baskin, 1996). Moreover, the bear population increase in Siberia and on the Pacific Coast could also cause changes in bear behavior, as has been documented in British Columbia (Shelton, 1994). Nonetheless, predicting bear´s behavior remains complicated, owing to a variety of environmental, human-, and bear-related factors entangled in a human-bear incident (Zavatskiy, 1987; Herrero, 2002).

In addition, the density of paved roads in Siberia and on the Pacific Coast doubled since 1991 (Federal State Statistics Service, 2018a), providing better access to areas rarely visited by people before. Therefore, recently increased numbers of people pursuing outdoor activities other than hunting in bear country during summer and autumn in Siberia and on the Pacific Coast also seemed to cause numerous bear-inflicted injuries and deaths; 21 incidents in July, 58 in August, 49 in September, and 27 in October (Fig. 5).

When human food is available, bears may start to associate food with humans, lose fear, and are more likely to have conflicts with people (Pazhetnov, 1990; Graf et al., 1992; Revenko, 1994; Herrero & Higgins, 2003). However, bears considered to be food-conditioned were responsible for just 8 casualties in Siberia and 5 on the Pacific Coast. At the same time, there were other 46 cases where bears apparently consumed or attempted to consume their victims.

This suggests a predatory intention of the bears involved in those cases, yet I do not know if some of them were habituated or food-conditioned to human resources.

Lone bears were involved in more fatalities than female bears with cubs, in agreement with previous studies from North America (Herrero & Higgins, 2003) and Scandinavia (Støen et al., 2018). Only 15 incidents were attributed in the reports to vagabond bears, "shatuns", a concept that is vaguely defined, but repeatedly used in the Russian literature (Suvorov & Smirnov, 2006; Zyryanov, 2011; Puchkovskyi, 2017). Therefore, I suggest using the term more cautiously in future scientific studies.

Study limitations

This thesis has built and makes public a large dataset with very valuable information that should help improve bear management and policy for large carnivores in general in the vast Russia and elsewhere. However, this study also has limitations related to the huge scale of the study area, which has implied the use of coarse environmental, bear-, and human-related variables. Furthermore, summarizing information from a variety of sources implies that I had to assume, rather than confirm, the reliability of the data. The final dataset included all the records with enough information regarding location, date, and outcome of the encounter, but I cannot discard the possibility that some incidents were fraudulent, as has been shown elsewhere (Caniglia et al., 2016). Ideally, the site of a large carnivore attack should be described and analyzed with similar criteria as in human crime scenes, to ensure that very detailed information is available (Garrote et al., 2017). This is very important to inform the public, given the consequences that such incidents have for human wellbeing and on human attitudes towards carnivores. For instance, in Scandinavia, bears are shot by default if they are involved in an incident with people, regardless of the cause of the incident (Støen et al., 2018), and in my study, at least 31% of the bears involved in incidents were killed.

Conclusion

Increased levels of human disturbance in bear country, human risk-enhancing behaviors (Shelton, 1994; Penteriani et al., 2016), and inappropriate human food and garbage storage (Herrero, 2002) have contributed to human-bear conflicts in the USA and Europe, and only mitigating these factors has reduced the negative consequences, both for human safety and bear welfare (Creachbaum et al., 1998; Linnell et al., 2001). In Russia, the presence of these same factors (Pazhetnov, 1990; Revenko, 1994; Suvorov & Smirnov, 2006; Buyanov, 2015), exacerbated by the enlarged bear population and bear habitat degradation due to forest fires, necessitates education campaigns on how to avoid bear incidents.

Increasing hunting quotas, provisioning free bear licenses for indigenous people, and segregating prices on bear licenses for different categories of hunters have been recommended by Russian bear specialists (Zyryanov, 2011; Komissarov & Gubar, 2013; Baskin, 2016) as a precautionary measure against human-bear conflicts in Siberia and on the Pacific Coast. Nevertheless, hunting is certainly a high-risk activity that increases human injuries by wounded bears, as documented in Scandinavia (Støen et al., 2018), which casts serious doubts on the suggestion that increasing hunting quotas would alleviate, rather than aggravate, bear-human conflict. Less pervasive actions, such as educating the public to avoid dense vegetation, warning bears of human presence by being noisy in the forest (Ordiz et al., 2013; Sahlén et al., 2015b), preventing food-conditioning of bears (Graf et al., 1992), and studying the potential use of bear deterrent spray (Smith et al., 2008) and electric fences to protect livestock (Breitenmoser et al., 2005) and campgrounds (Herrero, 2002) may be useful in reducing the risk of bear incidents and prevent human casualties.

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Appendix

Biomes		Description
Southern tundra	**Pre-tundra woodland**	**Southern tundra**. Temperature during the warmest month of the year >10 C; typical hypoarctic shrubs (e.g., dwarf birch and willow shrubs). Southern border is very dynamic. Tundra biota includes shrubs, *Sphagnum* moss species, *Ledum decumbens, Andromeda polifolia, Betula nana, Salix glauca, Vaccinium vitis-idaea, Rubus chamaemorus*. Southern tundra in Siberia and on the Pacific Coast also inlcludes *Pinus pumila, Betula middendorffii, Duschekia fruticose, D. kamtschatica, Vaccinium vittis-idaea* (Isachenko, 1985). **Pre-tundra woodlands**. Longer and warmer summer period, thinner snow and lower wind speed than in tundra make this biome more favorable for animals particularly for taiga inhabitants during summertime. Combination of tundra and taiga vegetation along the rivers. Canopy cover is formed by *Betula tortuosa, Pinus sylvestric* (atlantic sector), further to east – by *Picea abies* and *P. obovata*, in Western Siberia – by *Larix siberica* and partially by *Picae abies*, in Eastern Siberia – *Larix gmelnii*. Common plant species – *Rubus chamarmorus*, *Vaccinium vittis-idaea, Rubus idaeus, Rosa canina, and Pinus sibirica* (Pacific Coast). The mildest climate is in Kola peninsula tundra, the harshest climate is in Eastern Siberia (continental climate with low precipitation). In European Russia birch and pine are the most common tree species, east from the Ural Mountains – larch. Kamchatka and the Kyril Islands (Pacific Coast) by having milder weather conditions and no permafrost (due to monsoons and volcanic activity) create a suitable habitat for *Alnus alnobetula* subsp. *fruticose, Pinus pumila,* and *Sorbus sibirica* (Isachenko, 1985; Petrov, 1991).
Northern taiga		**European Russia**. Spruce forests and sphagnum bogs and swamps. Main tree species – *Picea abies, P. obovate*, and *Betula pubescens*. Shrub and field layers – *Empetrum nigrum*, *Ledum palustre*, *Vaccinium uliginosum*, Equisetum spp., Carex spp. Ground layer – *Sphagnum* and *Cladonia* spp (Isachenko, 1985).
		Western Siberia. Forest cover does not exceed 50%. Forests are sparse and concentrate along the rivers. Main habitats – forests and bogs covered with *Sphagnum* spp. Forest types – larch-spruce and spruce (often with pine or Siberian pine). Area is covered both by continuous and discontinuous permafrost (Isachenko, 1985).
		Eastern Siberia and Pacific Coast. Sparse forests of *Picea obovate* and *Larix cajanderi*. Shrub layer in larch forests – *Betula exilis*, *B. middendorfii, Duschekia fruticosa*. Field layer – *Ledum palustre, Vaccinium uliginosum.* Another typical habitat – bogs covered by *Sphagnum* spp (Isachenko, 1985).

Middle taiga	**European Russia**. Spruce forests with *Vaccinium myrtillus, Linnaea borealis*, *Maianthemum bifolium* in the field layer. Shrub layer is usually absent (Isachenko, 1985).
	Western Siberia. Higher forest cover than in European Russia. Spruce-Siberian pine forest types prevail except in the southern part with its spruce-Siberian fir type. Bogs and swamps covered by *Sphagnum* spp. occur around fluvial water bodies. Forest areas burnt after fires often transform into birch or aspen forests (Isachenko, 1985).
	Eastern Siberia. Main tree species – Siberian larch, spruce, Siberian pine. Shrub and field layers – *Alnus fruticosa*, *Vaccinium myrtillus, V. vittis-idaea, V. uliginosum*, grasses, and herbs. Ground layer – green mosses. Typical habitat – Dahurian larch or Dahurian larch-spruce forests with *Ledum palustre,* and *Vaccinium uliginosum* in the field layer. Near the Yenisey River – spruce, Siberian pine forests with *Alnus fruticosa*, *Salix* spp., *Sorbus sibirica*, *Prunus padus*, and *Rosa canina* in the shrub layer (Isachenko, 1985).
	Pacific Coast. Larch forests, birch forests (on areas burned in forest fires) with *Ledum palustre, L. hypoleucum, Vaccinium vittis-idaea* (field layer) and *Betula middendorffii* (shrub layer) (Isachenko, 1985).
Southern taiga	**European Russia**. For the most part, spruce-pine forests with well-defined shrub (broad-leaved species – alder, birch, and linden) and field layers (usually includes *Vaccinium myrtillus* and *Oxalis acetosella*) cover the area. Taiga forests east of the Volga River are also formed both by spruce and Siberian fir (Isachenko, 1985).
	Western Siberia. Siberian pine-spruce-Siberian fir forests with *Carex* spp., *Oxalis acetosella* and *Trientalis europaea* prevail. Siberian fir and spruce-Siberia fir forests have a shrub layer formed by *Sorbus sibirica* and *S. aucuparia, Rosa canina, Sorbaria sorbifolia*, and *Ribes spp.* In some areas forests are predominantly formed by *Pinus sibirica* (Isachenko, 1985).
	Eastern Siberia. Spruce-Siberian fir and spruce-Siberian pine forests with grasses in the field layer and green mosses in the ground layer. Pine and pine-larch forests are also widely spread. Birch and aspen forests on areas burnt by forest fires (Isachenko, 1985).
	Pacific Coast. Forests with *Larix gmelinii*, *Pinus koraiensis*, *Quercus mongolica*. Dense shrub and field layers are formed primarily by *Vaccinium vittis-idaea, Ledum palustre, Padus*, and *Calamagrostis spp.* and sometimes with *Corylus mandshurica* and *Lespedeza bicolor*. On sand soils – pine forests with dense grass cover and *Rhododendron dauricum* (Isachenko, 1985; Ogureeva et al., 1999).

Sub-taiga	Higher temperatures than in taiga forests. In European Russia and on the Pacific Coast sub-taiga forms a buffer zone between taiga and broad-leaved forests and includes plant species of both biomes (pine-spruce-oak-linden forests). Second tree layer is represented by *Tilia* spp., *Corylos avellana*, *Enonymus verrucosa*, *E. europaea, Sorbus ancupata*. Shrub and field layers – by *Vaccinium myrtillus*, *Vaccinium vittis-idaea, Oxalis acetosella* and grass species. Proportion of coniferous and broad-leaved species depends on soil fertility and drainage. In Western Siberia sub-taiga forests consist of broad-leaved forest (birch and/or aspen) and form a buffer zone between taiga forests and forest steppe (Isachenko, 1985).
Mountainous taiga	Sparse forests formed by *Larix cajanderi*. In Eastern Siberia forests are sometimes formed by *Pinus sibirica*. Shrub and field layers in larch forests – *Pinus pumila*, *Betula middendorfii, Betula exilis, Duschekia fruticosa, Ledum palustre, Vaccinium uliginosum.* With the increasing altitude larch forests substituted by scattered patches with *Pinus pumila* thicket and the field layer consisting mainly of *Vaccinium vittis-idaea, Empetrum nigrum, Arctos alpina, Cassiope ericoides, and Rhododendron parvifolium.* Ground layer – predominantly lichens (e.g., *Centaria cucllata*) (Petrov, 1991).
Deciduous forest	Typical for the European Russia and the Far East, no deciduous forest zone in Siberia due to harsh continental climate. High variety of tree species – *Quercus robur, Tilia cordata, Fraxinus excelsior, Carpinus betulus, Acer pseudoplatanus, A. platanoides, Ulmus laevis, Cerasus owium*, wild varieties of apple and pear. Shrub layer - *Frangula angula, Lonicera xylosteum, Euonymus verrucosus, E. europaeus, Rosa canina*, and *Corylus* spp. Beech forests are typical for Caucasus. In the Far East species composition differs from other areas – *Ulmus japonica, Fraxinus mandshurica, Phellodendron amurese, Junglans mandshurica* (tree layer), *Aralia elata, Eleutherococcus senticosus, Corylus spp., Lonicera spp., Philadelphus tennifolius, Syringa amurensis, Vitis amurensis, Actinidia kolomikta*, *Schisandra chinensis* (shrub layrer), high grasses and large ferns (field layer), as well as epiphytes and mosses (ground layer) (Isachenko, 1985; Petrov, 1991).
Mountainous deciduous and dark coniferous forest	Similar to northern taiga spruce forests. In Caucasus – oak and beech forests. Higher in mountains *Picea orientalis* and *Abies nordmanniana* form the tree canopy and *Oxalis acetosella, Trientalis europaea, Maianthemum bifloium, Circaea alpina,* and *Vaccinium arctostaphylos* – the field layer. Siberian fir-Siberian pine forests occur around Lake Baikal in Siberia. Forests with *Abies nephrolepis* and *Picea jezoensis* on the Pacific coast, and with *Abies sachalinensis* – on the Sakhalin Island. In Primorskyi Krai mixed forests with broad-leaved forests and *Pinus koraiensis* are widely spread. *Pinus pumila*, *Duschekia manshurica, Betula divaricata, Rhododendron aureum* dominate in the shrub layer on the Pacific coast (Isachenko, 1985; Petrov, 1991)

Bald mountains (golets) and alpine tundra		**Bald mountains** – definition used to describe highly rugged mountain peaks covered by scattered vegetation above the tree line and alpine meadows in the Ural region, Siberia, and on the Pacific Coast. Lichens usually form the ground layer, and bald mountains are often covered by *Pinus pumila*. **Alpine tundra** primarily consists of dwarf plants (*Salix glauea, S. arbuscula, S. pulchra*, *Empetrum nigrum, Carex arctisibirica, Poa arctica, Vaccinium uliginosum, Dryas octopetala, Diapensia lapponica, Arctos alpina)* and scale as well as leaf lichen species (Isachenko, 1985; Petrov, 1991)
Alpine meadow	**Alpine grassland**	**Alpine grassland** biome covers large areas in Southern Siberia and the Caucasus. Plant communities have low species richness and consist predominantly of xerophytes, mainly *Poaceae* and *Cyperaceae* families. **Alpine meadow**, in contrast with alpine grassland, has high species richness due to the dominance of Angiosperms (*Gentiana*, *Primula*, *Pedicularis*, *Myosotis* spp). In the Caucasus flowering plants are typical both for alpine grassland and meadow (Ogureeva et al., 1999).
Meadow steppe	**Steppe**	Steppe and meadow steppe biomes vary both along the latitude and longitude. Meadow steppes in Western Siberia have lower biodiversity as compared to Eastern Siberia. In Western Siberia meadow, both semidesert and taiga animals tend to seasonally migrate to the steppe. High grasses like *Stipa pennata, S. tirsa, Festuca valesiaca, Koeleria cristata, Phleum phleoides, Helictotrichon schellianum, Poa angustifolia, Bromopsis inermis, B. riparia,* and *Calamagrostis epigeios* dominate in the landscape (Isachenko, 1985).

Table S1: Description of biomes where brown bear-caused incidents of human injury or death occurred in Russia during 1991-2017.

Geographical area	Administrative regions (krais, oblasts, autonomous okrugs, and republics)
European Russia	Arkhangelsk Oblast, Kirov Oblast, Komi Republic, Kostroma Oblast, Leningrad Oblast, Murmansk Oblast, Nizhniy Novgorod, Novgorod Oblast, Perm Oblast, Republic of Bashkortostan, Republic of Karelia, Smolensk Oblast, Tver Oblast, Udmurt Republic, Vologda Oblast, Kabardino-Balkar Republic, Karachai-Cherkess Republic, Krasnodar Krai, Republic of Dagestan
Siberia	Altai Republic, Buryat Republic, Chelyabinsk Oblast, Irkutsk Oblast, Kemerovo Oblast, Khanty-Mansi Autonomous Okrug, Krasnoyarsk Krai, Novosibirsk Oblast, Omsk Oblast, Republic of Khakassia, Sakha (Yakutia) Republic, Sverdlovsk Oblast, Tomsk Oblast, Tyumen Oblast, Tuva Republic, Yamal-Nenets Autonomous Okrug, Zabaikalsky Krai
Pacific Coast	Amur Oblast, Chukotka Autonomous Okrug, Kamchatka Krai, Khabarovsk Krai, Magadan Oblast, Primorsky Krai, Sakhalin Oblast

Table S2: Administrative regions in the Russian Federation within the three areas where brown bear-caused human casualties used in our analysis have been recorded between 1932 and 2017.

Administrative region	Online articles, databases, and reports
European Russia	
Kabardino-Balkar Republic	http://www.mnr.gov.ru/activity/regions/kabardino_balkarskaya_respublika/ http://pravitelstvo.kbr.ru/oigv/minprirod/deyatelnost/gosdoklad.php
Kirov Oblast	http://priroda.kirovreg.ru/press-center/news/v-kirovskoy-oblasti-utverdili-limity-izyatiya-okhotnichikh-resursov-na-2017-2018-gody.html?sphrase_id=3449
Komi Republic	http://www.agiks.ru/data/gosdoklad/gd2015.pdf
Kostroma Oblast	http://dpr44.ru/filearhiv/pub/dinamika_Animals.pdf
Krasnodar Krai	http://www.mprkk.ru/media/main/attachment/attach/6__doklad_ob_oos_kk_v_2016.pdf http://www.mprkk.ru/media/main/attachment/attach/doklad_2008_UXX6jzu.pdf
Leningrad Oblast	http://www.nature.lenobl.ru/Document/1488455716.pdf
Murmansk Oblast	https://mpr.gov-murman.ru/upload/iblock/523/ekolog-ekspertiza-dlya-slushaniy-5-rayonov-2017-ch-2.pdf
Novgorod Oblast	http://leskom.nov.ru/images/uploads/priroda/ecology/obzor2016.pdf
Perm Krai	http://priroda.permkrai.ru/hunt/
Republic of Bashkortostan	https://ecology.bashkortostan.ru/upload/uf/ddf/75a9bba52f4f87f53ae88de3f689bd7c.pdf
Republic of Dagestan	http://ministerstvo13.aiwoo.ru/file/download/4356
Smolensk Oblast	http://prirod.admin-smolensk.ru/files/283/doklad-2017.pdf
Tver Oblast	http://mpr-tver.ru/deyatelnost-iogv/napravleniya/%D0%93%D0%BE%D1%81%D0%B4%D0%BE%D0%BA%D0%BB%D0%B0%D0%B4%20%D0%B7%D0%B0%202016%20%D0%B3%D0%BE%D0%B4.pdf https://mpr-tver.ru/Min_file/Государственный%20доклад%202015%20год.pdf
Vologda Oblast	https://utro.ru/news/2016/12/07/1307910.shtml http://ohotdep.gov35.ru/vedomstvennaya-informatsiya/novosti/525/113311/
Karachai-Cherkess Republic, Pskov Oblast, Republic of Karelia, Udmurt Republic	http://www.ohotcontrol.ru/resource/Resources_2008-2013/Бурый%20медведь.pdf http://biodat.ru/vart/hunt/texts/brown_bear.htm
Siberia	
Altai Republic	https://www.zmir-altai.ru/index.php?option=com_content&view=article&id=898:-2018-2019-&catid=48:2014-04-13-09-22-38&Itemid=197 http://altai-republic.ru/society/doklad_nature_2016.pdf
Buryat Republic	http://burprirodnadzor.ru/information/statistics/

Chelyabinsk Oblast	http://www.mineco174.ru/Upload/files/%D0%9C%D0%B0%D1%82%D0%B5%D1%80%D0%B8%D0%B0%D0%BB%D1%8B%20%D0%BE%D0%B1%D0%BE%D1%81%D0%BD%D0%BE%D0%B2%D0%B0%D0%BD%D0%B8%D1%8F%202018%20%D0%B3%D0%BE%D0%B4.docx http://mineco174.ru/htmlpages/Show/protectingthepublic/2016/52Polzovanieobektamizhivotno
Irkutsk Oblast	http://irkobl.ru/sites/ecology/picture/
Kemerovo Oblast	http://kuzbasseco.ru/wp-content/uploads/2018/02/doklad_01032018.pdf http://kuzbasseco.ru/001/1.7.2..htm
Krasnoyarsk Krai	http://www.mpr.krskstate.ru/envir/page5849
Novosibirsk Oblast	https://vn.ru/news-novosibirskie-medvedi-perestali-razmnozhatsya-/ http://www.ohotcontrol.ru/resource/Resources_2008-2013/Бурый%20медведь.pdf http://biodat.ru/vart/hunt/texts/brown_bear.htm
Omsk Oblast	http://mpr.omskportal.ru/ru/RegionalPublicAuthorities/executivelist/MPR/otraslevaya-informaciya/Ypravleniya/Ecobezopasnost/doklad-ob-eko-sityacii/PageContent/0/body_files/file5/Доклад%20за%202016%20год.pdf
Republic of Khakassia	http://www.mnr.gov.ru/activity/regions/respublika_khakasiya/ http://www.eruda.ru/files/khakasiya_gosugarstvennyu_doklad_sostoyanie_okruzhayushchey_sredy_dobycha_poleznykh-iskopaemykh_zoloto_ugol_2016.pdf
Sakha (Yakutia) Republic	https://depohota.sakha.gov.ru/news/front/view/id/2638319 https://new.wwf.ru/upload/iblock/2c2/bears.pdf https://minpriroda.sakha.gov.ru/uploads/ckfinder/userfiles/files/2254%20Якутск%20Природа%20Макет_07%2009%202017_окончат(1).pdf
Sverdlovsk Oblast	https://mprso.midural.ru/article/show/id/1126
Tomsk Oblast	http://www.tomsk.ru/news/view/128270/ http://www.tomsk.ru/news/view/129138 https://depnature.tomsk.gov.ru/2016-god
Tyumen Oblast, Khanty-Mansi Autonomous Okrug, Yamalo-Nenets Autonomous Okrug	https://regnum.ru/news/society/2322770.html https://prirodnadzor.admhmao.ru/upload/iblock/b76/doklad-2015.pdf https://prirodnadzor.admhmao.ru/doklady-i-otchyety/ http://www.greenpatrol.ru/sites/default/files/doklad_ob_ekologicheskoy_situacii_v_tyumenskoy_oblasti_v_2014_godu.pdf http://ekollog.ru/doklad-ob-ekologicheskoj-situacii-v-yamalo-neneckom-avtonomnom-v2.html?page=8 https://admtyumen.ru/files/upload/OIV/D_nedro/Документы/Доклад%20об%20экологической%20ситуации%20в%20Тюменской%20области%20в%202015%20году.pdf https://admtyumen.ru/files/upload/OIV/D_nedro/Документы/Доклад%20об%20экологической%20ситуации%20в%20Тюменской%20области%20в%202016%20году.pdf
Tyva Republic	http://docs.cntd.ru/document/450280230
Zabaikalsky Krai	http://минприр.забайкальскийкрай.рф/action/ohrana-okrujayushchey-sredy/ekologicheskaya-situaciya-v-zabaykalskom-krae/
Pacific Coast	
Amur Oblast	https://ampravda.ru/2016/08/19/069106.html
Kamchatka Krai	https://new.wwf.ru/upload/iblock/2c2/bears.pdf https://kamgov.ru/files/595eb10f687f12.46665956.pdf https://kamgov.ru/minprir/ohrana-okruzausej-sredy
Khabarovsk Krai	https://www.ohotniki.ru/archive/news/2016/09/27/646657-minprirodyi-habarovskogo-kraya-chislennost-medvedey-v-regione-nado-sokraschat.html https://www.dvnovosti.ru/khab/2016/09/30/56196/ https://mpr.khabkrai.ru/Deyatelnost/Ekologiya/84
Magadan Oblast	https://new.wwf.ru/upload/iblock/2c2/bears.pdf

	https://minprirod.49gov.ru/common/upload/23/editor/file/Doklad_za_2016_god.pdf
Primorsky Krai	http://www.primorsky.ru/upload/medialibrary/ed1/ed1d02dedb6f84f4c6c0ad7a5ed1f71e.pdf http://www.primorsky.ru/upload/medialibrary/8d2/8d23d73b5c8580c5c83065a82861241b.pdf
Sakhalin Oblast	http://mpr.sakhalin.gov.ru/fileadmin/doc/dokladi/doklad2015.pdf https://astv.ru/news/society/2017-09-06-ryby-malo-medvedej-mnogo-minleshoz-ozvuchil-dannye-o-chislennosti-hishnikov-na-sahaline https://new.wwf.ru/upload/iblock/2c2/bears.pdf

Table S3: Articles, databases, and reports on brown bear population dynamics in Russia between 1991 and 2017.

Year	**Month**	**Area**	**Human activity**	**Berry/stone pine production in area**
1995	October	Siberia	hunting	normal year
1996	October	Pacific Coast	hunting	normal year
2002	December	Pacific Coast	gathering wild resources	normal year
2007	December	Pacific Coast	hiking	normal year
2011	November	Siberia	inside a house	**bad year**
2012	November	Siberia	hunting	**bad year**
2013	December	Pacific Coast	hunting	**bad year**
2014	November	Pacific Coast	fishing	normal year
2015	December	European Russia	hiking	normal year
2017	November	Siberia	hunting	**bad year**

Table S4: Human fatalities caused by brown bears reported to be vagabond bears in Russia, 1991-2017.

Type of activity	1932-1990				1991-2017			
	Injured	**%**	**Killed**	**%**	**Injured**	**%**	**Killed**	**%**
Hunting	8	26	10	27	18	10.5	16	12.5
Hunting bears	4	13	3	8	4	2.3	3	2.3
Professional outdoor activities	4	13	8	22	24	14	16	12.5
Gathering wild resources	4	13	3	8	36	21.1	31	24.2
Hiking	2	6	5	14	32	18.7	17	13.3
Fishing	1	3	2	5	15	8.8	14	10.9
Herding livestock	0	0	0	0	5	2.9	6	4.7
In a settlement	4	13	2	5	31	18.1	12	9.4
Inside a house/hunting cabin/car	1	3	1	3	0	0	5	3.9
NA	3	10	3	8	6	3.5	8	6.3
Total	**31**	100	**37**	100	**171**	100	**128**	100

Table S5: The primary activity of humans involved in brown bear-caused human casualties in Russia during 1932-1990 and 1991-2017.

Model structure	ß	LL	UL	AICc	Delta	Weighted AICc	φ
Incidents ~ bear population size, forested area burned				143.4	0.00	100	1.88
(Intercept)	-1.1	-1.78	-0.44				
Parameter: bear population size	1.17e-05	7.39e-06	1.61e-05				
Parameter: forested area burned	6.91e-07	5.2e-07	8.61e-07				
Incidents ~ forested area burned				176.9	33.54	0.00	3.00
(Intercept)	0.39	4.15e-02	7.17e-01				
Parameter: forested area burned	9.31e-07	8.01e-07	1.07e-06				
Incidents ~ bear population size				203.5	60.13	0.00	5.07
(Intercept)	-1.56	-2.22	-0.91				
Parameter: bear population size	2.26e-05	1.1e-05	2.62e-05				
Null model				380.0	236.67	0	

Table S6.1: Results from generalized linear models (GLM) using Poisson link function explaining the annual number of people injured/killed by brown bears in Russia, 1991-2017 (Russian brown bear population estimate with a decreasing trend after 2015).
ßs indicate parameter estimates, LL=lower limit of the 95% confidence interval, UL=upper limit of the 95% confidence interval, φ=dispersion parameter

Model structure	ß	LL	UL
Incidents ~ bear population size, forested area burned			
(Intercept)	-1.1	-2.03	-0.2
Parameter: forested area burned	6.91e-07	4.57e-07	9.25e-07
Parameter: bear population size	1.17e-05	5.82e-06	1.77e-05

Table S6.2: Results from the most parsimonious model using quasi-Poisson link function explaining the annual number of people injured/killed by brown bears in Russia, 1991-2017 (Russian brown bear population estimate with a decreasing trend after 2015).
ßs indicate parameter estimates, LL=lower limit of the 95% confidence interval, UL=upper limit of the 95% confidence interval.

Model structure	ß	LL	UL	AICc	Delta	Weighted AICc	φ
Incidents ~ bear population size, forested area burned				158.8	0.00	99.7	2.37
(Intercept)	-0.68	-1.39	-8.99e-04				
Parameter: bear population size	2.2e-05	2.33e-07	7.57e-07				
Parameter: forested area burned	4.9e-07	1.03e-05	3.37e-05				
Incidents ~ bear population size				170.7	11.93	0.3	2.91
(Intercept)	-1.44	-2.06	-0.85				
Parameter: bear population size	4.14e-05	3.55e-05	4.75e-05				
Incidents ~ forested area burned				176.9	18.13	0.00	3.00
(Intercept)	0.39	0.04	0.72				
Parameter: forested area burned	9.33e-07	8.01e-07	1.07e-06				
Null model				380.0	221.26	0.00	

Table S7.1: Results from generalized linear models (GLM) using Poisson link function explaining the annual number of people injured/killed by brown bears in Russia, 1991-2017 (IUCN bear population estimate).†
ßs indicate parameter estimates, LL=lower limit of the 95% confidence interval, UL=upper limit of the 95% confidence interval, φ=dispersion parameter

Model structure	ß	LL	UL
Incidents ~ bear population size, forested area burned			
(Intercept)	-0.68	-1.79	0.35
Parameter: forested area burned	4.9e-07	4.57e-07	9.25e-07
Parameter: bear population size	2.2e-05	5.82e-06	1.77e-05

Table S7.2: Results from the most parsimonious model using quasi-Poisson link function link function explaining the annual number of people injured/killed by brown bears in Russia, 1991-2017 (IUCN bear population estimate).†
LL=lower limit of the 95% confidence interval, UL=upper limit of the 95% confidence interval.

†According to the IUCN report on brown bear, Russia had the largest brown bear population, believed to exceed 100,000 (McLellan, 2017) – that is approximately half of the population numbers reported by Russian authorities (Federal State Statistics Service, 2018b). Therefore, I assumed that the trend of bear population increase was continuous and divided Russian annual bear population estimates during 1991-2017 by two in order to test if model results would still hold.

Model structure	AICc	Delta	Weighted AICc
Human killed ~ season	316.6	0.00	0.35
Human killed ~ season + area	317.4	0.81	0.24
Null model	317.9	1.33	0.18
Human killed ~ season + area + biomass of berries	318.8	2.21	0.12
Human killed ~ season + area + biomass of berries + fire susceptibility	320.5	3.92	0.05
Human killed ~ season + area + biomass of berries + fire susceptibility + bear density	321.1	4.52	0.04
Human killed ~ season + area + biomass of berries + fire susceptibility + bear density + protected area	322.7	6.08	0.02
Human killed ~ season + area + biomass of berries + fire susceptibility + bear density + protected area + human activity	324.2	7.68	0.01

Table S8: Comparison of all competing generalized linear models (GLM) using binominal link function on the lethal or non-lethal outcome of incidents between brown bears and people in Russia, 1991-2017. Competitive models are ranked form the lowest AICc value (best model) to the highest one.

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