Human behaviour can trigger large carnivore attacks in developed countries

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The media and scientific literature are increasingly reporting an escalation of large carnivore attacks on humans in North America and Europe. Although rare compared to human fatalities by other wildlife, the media often overplay large carnivore attacks on humans, causing increased fear and negative attitudes towards coexisting with and conserving these species. Although large carnivore populations are generally increasing in developed countries, increased numbers are not solely responsible for the observed rise in the number of attacks by large carnivores. Here we show that an increasing number of people are involved in outdoor activities and, when doing so, some people engage in risk-enhancing behaviour that can increase the probability of a risky encounter and a potential attack. About half of the well-documented reported attacks have involved risk-enhancing human behaviours, the most common of which is leaving children unattended. Our study provides unique insight into the causes, and as a result the prevention, of large carnivore attacks on people. Prevention and information that can encourage appropriate human behaviour when sharing the landscape with large carnivores are of paramount importance to reduce both potentially fatal human-carnivore encounters and their consequences to large carnivores.

During the last few decades, large carnivore attacks on humans in developed countries have increased over time1–8 (Fig. 1). This is expected to increase people’s apprehension and reduce their willingness to share the landscape with large carnivores. Unfortunately, such rare events are usually overplayed by the media. Indeed, media coverage of such attacks generally includes sensational texts and dreadful pictures (Extended Data 1), appealing more to the public’s emotions than their logic. Denominator neglect9 is a well-studied phenomenon leading humans to overestimate the risk of rare events that evoke strong emotions. Overestimating the risk of large carnivore attacks on humans irrationally enhances human fear and triggers a vicious cycle that may affect the increasingly positive conservation status of many of these contentious species10–12. With an increasing number of large carnivore attacks on humans there is, now more than ever, a need for objective and accurate information regarding not only the long-term trend and underlying mechanisms of large carnivore attacks on humans, but also potentially risky situations and risk-enhancing human behaviours8. Surprisingly, the few available studies focus on attacks by people's apprehension and reduce their willingness to share the landscape with large carnivores. Unfortunately, such rare events are usually overplayed by the media. Indeed, media coverage of such attacks generally includes sensational texts and dreadful pictures (Extended Data 1), appealing more to the public’s emotions than their logic. Denominator neglect9 is a well-studied phenomenon leading humans to overestimate the risk of rare events that evoke strong emotions. Overestimating the risk of large carnivore attacks on humans irrationally enhances human fear and triggers a vicious cycle that may affect the increasingly positive conservation status of many of these contentious species10–12. With an increasing number of large carnivore attacks on humans there is, now more than ever, a need for objective and accurate information regarding not only the long-term trend and underlying mechanisms of large carnivore attacks on humans, but also potentially risky situations and risk-enhancing human behaviours8. Surprisingly, the few available studies focus on attacks by
single carnivore species and thus they do not provide a comprehensive perspective concerning the pervasiveness and socio-ecological correlates of this phenomenon in developed countries.

Our main hypothesis is that lack of knowledge of people about how to avoid risky encounters with large carnivores engenders risk-enhancing behaviours, which can determine an increase in the number of attacks if more humans are sharing landscape with large carnivores. Three main predictions arise from this hypothesis: (1) an increased number of people are engaging in outdoor leisure activities in areas inhabited by large carnivores; (2) many people are not prepared to safely enjoy outdoor activities or they behave inappropriately in the countryside; and (3) large carnivore attacks are influenced by the interaction between several human- and animal-related factors.

Thus, we first explored whether the long-term patterns in the number of attacks have been similar among different large carnivore species, and how they varied throughout the year. Then, we evaluated whether there might have been a general long-term change in the attack patterns by assessing whether victim ages and the frequency of attacks on parties vs. lone humans have changed in a congruent manner for the different species. Finally, we assessed the possible relationships between temporal trends of attacks on humans and outdoor activities, as well as the role that risk-enhancing human behaviour can have played in the observed increase in large carnivore attacks.
We analysed the circumstances of ca. 700 large carnivore attacks on people from 1955 in detail (when more reliable data became available) until the present for six species responsible for most of the large carnivore attacks recorded in North America and Europe: brown/grizzly bear *Ursus arctos*, black bear *Ursus americanus*, cougar *Puma concolor*, wolf *Canis lupus* and coyote *Canis latrans* in North America, brown bear in Europe, and polar bear *Ursus maritimus* circumpolar, i.e. Europe, Russia and North America. We also collected statistics concerning outdoor activities during the same period (see Methods for more details).

The number of large carnivore attacks on people has increased significantly over time, with contrasting trends across species (Fig. 1; Extended Data Table 1). In North America, coyotes (31.0% of the total number of attacks) and cougars (25.7%) were responsible for the majority of attacks, followed by brown bears (13.2%), black bears (12.2%) and wolves (6.7%). A similar increase over time was observed for brown bears (9.3%) in Europe and circumpolar for polar bears (1.9%; Fig. 1). Moreover: (a) the age of victims has also increased significantly over time showing different patterns across species (Extended Data Table 2 and Extended Data Fig. 1); and (b) the propensity to attack lone humans or parties depends on the large carnivore species, and only a slight but non-significant increasing trend of attacks on parties has been observed (Extended Data Table 3 and Extended Data Fig. 2A,B).

The patterns of attacks reported here may also reflect an increasing number of bold individuals in large carnivore populations, as this trait is often correlated with aggressiveness\(^{13,14}\), and this might lead to more aggressive responses when large carnivores encounter humans. We hypothesise that intense and prolonged human-caused mortality imposes selection pressures on target populations (selective removal of certain phenotypes) and might lead to rapid evolutionary changes\(^{15}\). Natural selection maintains a mix of behavioural phenotypes in populations\(^ {16}\), the shy-bold behavioural continuum\(^ {17}\); bold individuals thrive on risk and novelty, whereas shy individuals shrink from the same situations\(^ {18}\). Persecution, however, is expected to result in the disproportionate removal of bold individuals, as they are less cautious\(^ {19}\), and thus more likely to be killed. As a consequence, shy individuals might have been overrepresented in remnant large carnivore populations in the past\(^ {17,18,20–22}\). Additionally, individuals may become more vigilant and actively avoid contact with humans during times of intense persecution\(^ {23}\). Although the history of large carnivore persecution and conservation differ across regions\(^ {2}\), the contemporary conservation paradigm emerged during the 1960s–1970s\(^ {34}\), when most bounty systems were banned\(^ {25}\) and large carnivores were reclassified from vermins or bountied predators to game or protected species. Since then, although large carnivores have continued to be hunted or managed (Extended Data Fig. 3), most populations have generally increased during the past four decades\(^ {9,11,12}\). Increasing population trends in conjunction with relaxed artificial selection may potentially engender higher variation in behavioural temperaments\(^ {26}\), which is likely to alter individual responses to human encounters\(^ {22}\). This significant increase of large carnivore populations in both North America and Europe, and their consequent range expansion, also may contribute to explain the observed increase in the attacks on humans.

However, similar to the increasing trend in attacks, the number of people engaging in outdoor leisure activities also has risen over time, a phenomenon that is significantly correlated with the observed trend in the number of attacks (Fig. 1; Extended Data Table 4, Extended Data Fig. 4A–C). Seasonally, most of the attacks occurred between late spring and early autumn (Fig. 2), when most people pursue outdoor activities; in addition, because bears hibernate, they are unlikely to attack people in winter. Such an increase in recreational activities in areas inhabited by large carnivores implicitly increases the probability of a risky encounter and, therefore, a potential attack. However, even with more people visiting those areas, attacks are still extremely rare (Fig. 1): although some people may only focus on the total number of attacks, we have to bear in mind the long time period during which these attacks occurred.

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**Figure 2. Temporal trends in large carnivore attacks on humans in developed countries: monthly patterns.** Most large carnivore attacks occurred from late spring to early autumn, when most people usually engage in outdoor activities. (The coyote picture has been downloaded from 123RF ROYALTY FREE STOCK PHOTOS (http://www.123rf.com), Image ID 14988151, James Mattil).
Remarkably, risk-enhancing human behaviour has been involved in at least half of the well-documented attacks (47.6%; Fig. 3). From highest to lowest, the five most common human behaviours occurring at the time of an attack were (a) parents leaving children unattended, (b) walking an unleashed dog, (c) searching for a wounded large carnivore during hunting, (d) engaging in outdoor activities at twilight/night and (e) approaching a female with young. These are clearly risk-enhancing behaviours when sharing the landscape with large carnivores. For example, the most frequently recorded human behaviour was children left unattended (47.3%), which were most often attacked by cougars (50.8%), coyotes (27.9%) and black bears (13.2%). Risk-enhancing human behaviour is not the sole reason behind large carnivore attacks on humans. The causes of the other half of the attacks do not seem to be related to risk-enhancing human behaviour, for example, accidentally walking close to a mother with young or to a carcass with a bear nearby or an encounter with a food-conditioned individual (which is an indirect result of a risk-enhancing human behaviour).

Thousands of interactions occur between people and large carnivores with no human injuries or fatalities. Even if attacks have increased over time, they remain extremely rare events (e.g. a cross-continental average of 24.1 attacks and 3.9 fatalities per year during the last decade, all species pooled; Fig. 1). Other wildlife (bees and mosquitoes, spiders, snails, snakes and ungulates) and domestic dogs are far more responsible for human fatalities1,27. But humans are not the only victims. When attacks occur, large carnivores are frequently killed and negative attitudes towards large carnivores harden6. Lethal removal of ‘problematic’ individuals is effective in solving the local problem caused by a given individual28, but generally this happens after an aggressive behaviour, human injury or death has occurred. Consequently, both humans and carnivores suffer from these incidents.

After decades of minimal interaction between humans and large carnivores in many regions of developed countries, many people involved in outdoor activities may lack knowledge about how to avoid risky encounters with large carnivores and what to do when such encounters occur. From an early age most of us learn social norms, rules and how to decrease risks in urban environmental settings, but much less effort is expended to teach us how to safely enjoy outdoor activities or to behave appropriately in the countryside. However, it is up to us to reduce the likelihood of an attack. The increasing human presence in areas inhabited by large carnivores, together with their population recoveries9,11,12, requires an improvement in information, education and prevention guidelines, and their enforcement, which are of paramount importance to reduce both the risks to humans and the killing of carnivores9,11,14. Educating people that share landscape with large carnivores can represent a crucial factor to help reducing the number of attacks and also the negative attitudes towards large carnivore conservation, especially because of the difficulty to envisage risk estimates. Indeed, scenarios of attacks are extremely different and may depend on many different factors, such as human population and carnivore densities, time of the day, human activities, personality and condition of the large carnivore, party size or even subtle details, like the presence of an unleashed dog at the moment of the attack and/or the landscape features of the area where an attack has happened. As conflicts between humans and large carnivores continue to increase, accurate information becomes crucial to informed human–wildlife conflict management. Communicating about large carnivore-inflicted human injuries and fatalities in a statistical manner contributes to better understanding of common patterns in large carnivore attacks, further reduces chances of injury or death and promotes public appreciation of these species. An important strategy to reduce attacks on humans is to inform people how to avoid

Figure 3. The number of attacks is modulated by human behaviour. Around half of the attacks were associated with risk-enhancing human behaviours. Out of 271 well-documented attacks, 47.6% were associated with certain human behaviours that may have contributed to the probability of suffering an attack. Within the principal category (children left unattended by their parents), the main species responsible for 91.9% of these attacks were cougars (50.8%), coyotes (27.9%) and black bears (13.2%). (The cougar picture has been downloaded from 123RF ROYALTY FREE STOCK PHOTOS (http://www.123rf.com), Image ID 2597979, Eric Isselee).
and manage aggressive encounters. But nowadays, educational and interpretive efforts aimed at decreasing the risk of large carnivore attacks should not focus exclusively on people living in rural and wilderness areas. Indeed, many people living in cities should also be included within the category of groups at risk because of the increasing number of them enjoying outdoor activities in areas inhabited by large carnivores and the expanding population of carnivores (mainly coyotes) in suburban areas.

Although large carnivore attacks on humans are influenced by the interaction between multiple human- and animal-related factors, adapting our own behaviours when coexisting with large carnivores has the potential to reduce the number of attacks to about half of today's level. The examples provided by the numerous cases of children injured/killed while left unattended by their parents, attacks on people jogging/walking alone at twilight and during hunting, should make us reflect on our responsibilities, the possibility of decreasing the number of these tragic events and changing the observed trends. Understanding the circumstances associated with large carnivore attacks should help us to reduce them and thereby minimize the role that fear and supposition may play in large carnivore management and conservation.

Methods
Collection of records of large carnivore attacks on humans. Records of large carnivore attacks (i.e. attacks resulting in physical injury or death) on humans for the brown bear, black bear, cougar, wolf and coyote were collected for North America (the United States and Canada). In addition, with the aim to broaden our research and obtain a general picture of large carnivore attacks on humans in developed countries, we complemented the North American dataset with information on brown bear attacks in three European countries (Sweden, Finland and Spain) as well as data on attacks by polar bears in Europe (Svalbard; Norway), Russia, the United States, and Canada. Our time period spanned from 1955 to 2014 and our search resulted in a total of 697 attacks of large carnivores on people.

We consider that we both recorded the majority of such events occurring during the last six decades in these developed countries and avoided bias due to possible changes in reporting probability given (i) the large number of experienced people involved in the work (some of them had their own database on attacks, which started at the beginning of the 1900s), (ii) the multiple sources of information used to collect recorded attacks and (iii) the sensational nature and media impacts of attacks that end with injuries or the death of the victim since the beginning of the past century. Records of attacks were collected from unpublished reports and PhD/MS theses, webpages (last accessed in November 2014, but currently available at the specific addresses listed by species below), books and scientific articles, as well as personal datasets from some of the co-authors. In addition, to complete the data obtained from the above-cited sources, we also collected dozens of news reports from online newspapers. To do this, for each species and area, we searched on an annual basis for news articles on Google using the combination of the following terms: “species name” + “attack” and “species name” + “attack” + “human”. Because of the use of multiple sources, several attacks recur several times during the search, but we used information such as date, locality and sex/age of the victims to prevent duplicate records in the dataset. However, the lack of some records would still not result in a bias in the general patterns we observed in the present work, because: (i) we followed the same procedure for each species and, thus, we collected at least an equally biased sample of attacks per species and (ii) patterns of attacks on humans over time are less sensitive to unequally biased samples of attacks than quantitative comparisons of the frequency of attacks across species (which is not the aim of the present work).

When possible, we recorded the following information for each attack: (1) species; (2) year; (3) month; (4) country; (5) time of the attack during the day (which we classified into three categories: twilight, day, night); (6) activity of the victim (15 categories: hunting, fishing, field work, camping, hiking, jogging, skiing, biking, horse riding, fruit/mushroom picking, photography, walking, dog walking, activity near the house/in the backyard, playing); (7) size of party being attacked (simplified into three categories: victim alone, child – from 0 to 16 years old – in a party of adults, adult – > 16 years old – in a party of adults); (8) end of the attack, i.e. attack resulting in human injuries or death; and (9) scenario when the attack occurred, i.e. the factor that could have triggered the attack. We were able to delineate eight categories: female with young, aggressive reaction after a sudden encounter (i.e. a person surprises the large carnivore at close range), food defence (e.g. a bear close to a carcass), food conditioning (i.e. encounter with a large carnivore that consumes human-derived foods, consequently associating people with easily accessible, attractive foods, and which has lost much of its avoidance mechanisms towards humans), predatory (i.e. when the large carnivore exploited a human as prey), wounded animal (i.e. during hunting), feeding large carnivores, and presence of one or more dogs. Unleashed dogs can exacerbate the probability of a large carnivore attack, because a dog that runs away from a large carnivore towards the owner can trigger a consequence of its proximity to the dog or because of its reaction towards the large carnivore.

Below, we describe the sources used to collect data on large carnivore attacks on people for each species since 1955:

1. **North American brown and black bears.** We recorded a total of 92 and 85 attacks, respectively. Information was compiled from\(^1\) Wikipedia List of fatal bear attacks in North America (http://en.wikipedia.org/wiki/List_of_fatal_bear_attacks_in_North_America), Fatal Bear Attack Statistics for the USA & Canada (http://www.blackbearheaven.com/bear-attack-statistics.htm) and online newspapers. Additionally, we also extracted information for the black bear from\(^2\) and California Black Bear Public Safety Incidents, California Department of Fish and Wildlife (https://www.wildlife.ca.gov/News/Bear/Bear-Incidents).

2. **Cougar.** We recorded a total of 179 attacks. Data on attacks were collected from\(^3\)–\(^5\), the List of Mountain Lion Attacks (http://www.cougarinfo.org/attacks.htm), Mountain Lion Attacks from 1991 to 2000 (http://www.cougarinfo.org/attacks2.htm), Mountain Lion Attacks from 2001 to 2010 (http://www.cougarinfo.org/
attacks3.htm), Mountain Lion Attacks from 2011 to Now (http://www.cougarinfo.org/attacks4.htm) and online newspapers.

3. **Wolf.** We recorded a total of 47 attacks. Data on attacks were collected from the Wikipedia List of wolf attacks in North America (http://en.wikipedia.org/wiki/List_of_wolf_attacks_in_North_America), Wikipedia List of wolf attacks (http://en.wikipedia.org/wiki/List_of_wolf_attacks), Wolf Attacks on Humans (http://www.aws.vcn.com/wolf_attacks_on_humans.html) and online newspapers. We did not include the wolf in Europe, because predatory attacks on people have been extremely rare during the last six decades, with the last recorded predatory attack occurring in 1974 in Spain.

4. **Coyote.** We recorded a total of 216 attacks. Data on attacks were collected from the Wikipedia Coyote attacks on humans (http://en.wikipedia.org/wiki/Coyote_attacks_on_humans), Coyote Attacks on Children (http://www.varmintal.com/attack.htm), Coyote Attacks: An Increasing Suburban Problem (http://escholarship.org/uc/item/8qq662fb), Coyote Attacks On People in the U.S. and Canada (http://chetester.org/sgm/lists/coyote_attacks.html) and online newspapers.

5. **European brown bear.** We recorded a total of 65 attacks. Information from Spain was available from the unpublished personal database of J.N. and A.F.G., whereas Fennoscandian records were obtained from and unpublished data from I.K., H.N. and J.F.

6. **Polar bear.** We recorded a total of 13 attacks. Information was recorded from Wikipedia List of fatal bear attacks in North America (http://en.wikipedia.org/wiki/List_of_fatal_bear_attacks_in_North_America) and online newspapers (both North American and European—some attacks have been recently recorded in the Norwegian Svalbard archipelago).
analysed a subset of the dataset considering only those attacks occurring in the US and, together with information on human in influx in natural areas, we tested if the number of attacks was related to the number of people involved in outdoor activities by building a GLM with a Gamma distribution, considering year, the number of visitors and their interaction term as factors in the model (Extended Data Table 4).

For each analysis, we used an information theoretic framework to rank a set of competing models based on AIC (Akaike’s Information Criterion [AIC]59). We used a stepwise selection procedure to create a candidate set of a priori competing models starting from the simplest null model (intercept only model) to the full model (Extended Data Tables 1, 2, 3 and 4). To select the best candidate model, we used AIC value corrected for small sample sizes (AICc) and Weighted AIC, which indicates the probability that the model selected is the best among the candidates59. Models within ΔAIC < 2 were considered to have substantial empirical support59. All statistical analyses were performed using R 3.0.2 statistical software60. GLMs were run with the “lme4”61 and “nlme”62 packages.

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Corrigendum: Human behaviour can trigger large carnivore attacks in developed countries

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This corrigendum aims to correct errors detected in the outputs of the Extended Data Tables from our article Scientific Reports 6, 20552 (2016). A mistake occurred due to a failure in the conversion of the variable “species” from integer to a categorical (factor) variable. We have updated the tables with ‘species’ as a factor (Extended Data Tables below). It is important to state that the essence of our results and conclusions do not change from those presented in the article.

Additionally, we took opportunity of this corrigendum to explore the variation in the group composition (party size) of humans that suffered large carnivore attack over time and across species. We simplified our response categorical variable ‘group composition’ into two categories, i.e., ‘victim alone’ and ‘victim in a party’ (binary coded variable). We conducted this analysis using a two-level categorical approach (binomial family in R) instead of using the previous multinomial approach. This change does not affect the results or conclusions of our analysis, as reported in the article, but is a simplification.

The correct Extended Data Tables 1, 2, 3 and 4 appear below as Table 1, 2, 3 and 4 respectively.
### Table 1. Variation in the number of large carnivore attacks on humans over time and among species.

(1a) Comparison of the five competing models built to study variation in the number of large carnivore attacks on humans over time and among species (n = 231). Summary of fitted parameters is shown for the most parsimonious candidate model (the selected model was the one with the lowest AICc score). Competitive models are ranked from the lowest AICc value (best model) to the highest one. (1b) We present the same analysis, but removed those species showing some patterns in the residuals of 1a. It is worth mentioning that in both cases we obtained the same results. European brown bear is included in the intercept. Negative binomial distribution error was selected over a Poisson distribution error, considering the output of the function odTest from the “pscl” package in R, which compares the log-likelihood ratios of a Negative Binomial regression to the restriction of a Poisson regression (critical value of test statistic at the alpha = 0.05 level: 2.7055; Chi-Square Test Statistic = 10.661, P < 0.001).

| COMPETING MODELS | β    | SE   | p    | AICc | ΔAICc | Weighted AICc |
|------------------|------|------|------|------|-------|---------------|
| 1a               |      |      |      |      |       |               |
| Year + Species + Year: Species |      |      |      | 850.5 | 0.2   | 0.48          |
| Intercept        | −0.333 | 0.453 | 0.462 |      |       |               |
| Year             | 0.024 | 0.010 | 0.016 |      |       |               |
| Grizzly          | 0.737 | 0.527 | 0.162 |      |       |               |
| Black bear       | 0.472 | 0.539 | 0.381 |      |       |               |
| Cougar           | 0.499 | 0.517 | 0.335 |      |       |               |
| Wolf             | 0.514 | 0.639 | 0.421 |      |       |               |
| Coyote           | 0.115 | 0.599 | 0.848 |      |       |               |
| Polar bear       | −0.398 | 1.093 | 0.716 |      |       |               |
| Year: Grizzly    | −0.009 | 0.012 | 0.458 |      |       |               |
| Year: Black bear | −0.008 | 0.012 | 0.530 |      |       |               |
| Year: Cougar     | 0.006 | 0.011 | 0.609 |      |       |               |
| Year: Wolf       | −0.016 | 0.016 | 0.326 |      |       |               |
| Year: Coyote     | 0.023 | 0.013 | 0.071 |      |       |               |
| Year: Polar bear | 0.002 | 0.023 | 0.930 |      |       |               |
| Year + Species   | 850.6 | 0.2   | 0.48 |      |       |               |
| Species          | 908.1 | 57.6  | 0.00 |      |       |               |
| Year             | 933.5 | 83.0  | 0.00 |      |       |               |
| Null model       | 996.3 | 145.8 | 0.00 |      |       |               |

(1b)

| COMPETING MODELS | β    | SE   | p    | AICc | ΔAICc | Weighted AICc |
|------------------|------|------|------|------|-------|---------------|
| Year + Species + Year: Species |      |      |      | 508.6 | 0.88  |               |
| Intercept        | 0.411 | 0.284 | 0.148 |      |       |               |
| Year             | 0.015 | 0.007 | 0.035 |      |       |               |
| Cougar           | −0.264 | 0.391 | 0.500 |      |       |               |
| Coyote           | −0.706 | 0.524 | 0.178 |      |       |               |
| Year: Cougar     | 0.015 | 0.009 | 0.104 |      |       |               |
| Year: Coyote     | 0.034 | 0.012 | 0.004 |      |       |               |
| Year + Species   | 512.6 | 4.0   | 0.12 |      |       |               |
| Year             | 529.4 | 20.8  | 0.00 |      |       |               |
| Species          | 549.7 | 41.1  | 0.00 |      |       |               |
| Null model       | 575.3 | 66.7  | 0.00 |      |       |               |
### COMPETING MODELS

|                      | $\beta$ | SE  | p       | AICc | $\Delta$AICc | Weighted AICc |
|----------------------|---------|-----|---------|------|-------------|---------------|
| Year + Species       |         |     |         |      |             |               |
| Intercept            | -28.016 | 9.767 | 0.005  |      |             |               |
| Year                 | 0.016  | 0.005 | 0.001  |      |             |               |
| Grizzly              | -0.543  | 0.223 | 0.016  |      |             |               |
| Black bear           | -1.174  | 0.193 | 6.65e-09 |     |             |               |
| Cougar               | -1.440  | 0.306 | 5.13e-06 |    |             |               |
| Wolf                 | -2.021  | 0.202 | <2e-16 |      |             |               |
| Year + Species + Year: Species | | | | 493.2 | 5.6 | 0.06 |
| Species              | 496.1 | 8.5 | 0.01 |
| Year                 | 572.9 | 85.3 | 0.0 |
| Null model           | 573.3 | 85.7 | 0.0 |

### Table 2. Variation of the age of victims in large carnivore attacks on humans in relation to time and species.

Comparison of the five competing models built to study the variation in the age of victims over time and across species ($n = 188$). A summary of fitted parameters is shown for the most parsimonious candidate model. Competitive models are ranked from the lowest AICc value (best model) to the highest one. European brown bear is included in the intercept. Response variable: Log (age of victims)–normal distribution error. Adjusted R-squared = 0.3842.

### COMPETING MODELS

|                      | $\beta$ | SE  | p       | AICc | $\Delta$AICc | Weighted AICc |
|----------------------|---------|-----|---------|------|-------------|---------------|
| Year + Species       |         |     |         |      |             |               |
| Intercept            | -1.335  | 0.503 | 0.008  |      |             |               |
| Grizzly              | 1.558  | 0.556 | 0.005  |      |             |               |
| Black bear           | 1.079  | 0.571 | 0.059  |      |             |               |
| Cougar               | 1.259  | 0.532 | 0.018  |      |             |               |
| Wolf                 | 1.671  | 0.651 | 0.010  |      |             |               |
| Coyote               | 0.566  | 0.574 | 0.324  |      |             |               |
| Polar bear           | 1.740  | 1.042 | 0.095  |      |             |               |
| Year + Species + Year: Species | | | | 508.91 | 0.4 | 0.41 |
| Species              | 512.71 | 4.2 | 0.06 |
| Year                 | 514.51 | 6.0 | 0.02 |
| Year + Species       | 515.91 | 7.4 | 0.01 |

### Table 3. Variation of the group composition (party size) targeted in a large carnivore attack on humans over time and across species.

Comparison of the five competing models built to study the variation of the group composition targeted in an attack over time and across species ($n = 371$). A summary of fitted parameters is shown for the most parsimonious candidate model. Competitive models are ranked from the lowest AICc value (best model) to the highest one. Group composition was classified into two categories: (1) victim alone and (2) victim in a party. European brown bear is included in the intercept. Response variable: Group composition (2 levels: victim alone and victim in a party)–binomial distribution error. Deviance = 0.032.

### COMPETING MODELS

|                      | $\beta$ | SE  | p       | AICc | $\Delta$AICc | Weighted AICc |
|----------------------|---------|-----|---------|------|-------------|---------------|
| Visitors             |         |     |         |      |             |               |
| Intercept            | -1.297  | 0.385 | <0.001  |      |             |               |
| Visitors             | 0.035  | 0.001 | <0.0001 |      |             |               |
| Null model           | 330.38 | 59.2 | 0.00 |

### Table 4. Relationship between the yearly number of large carnivore attacks and the number of recreation visitors in national parks in the US.

Comparison of the two competing models built to study the relationship between the number of large carnivore attacks on humans and recreation visitors over time in national parks in the US as a surrogate of the visitation rates across the entire United States ($n = 53$). Summary of fitted parameters is shown for the most parsimonious candidate model. Competitive models are ranked from the lowest AICc value (best model) to the highest one. Year was not considered in this analysis because it was highly correlated with the number of visitors (Spearman rank correlation $r_s = 0.926$, $P < 0.001$). Response variable: Number of attacks per year–Negative binomial distribution error. Deviance = 0.692.
