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# Occurrence, Causes and Consequences of Predator Attacks to Humans

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## ABSTRACT

*Attacks on humans by predators occur worldwide. This paper analyzes several documented and reported attacks in the available literature and discusses the causes and consequences of this type of human-wildlife conflict. We make a characterization of types of attacks and discuss a possible biased report of accidents between developed countries and exotic places with increased ecotourism activities. Finally, we propose a set of major suggestions to minimize both accidents and conflicts with predatory wildlife. We provide here a thorough comprehensive discussion on the following main topics: a) why predators attack humans, b) why accidents are apparently increasing and c) how to better report those accidents in order to make them available for proper study by the scientific community.*

*The need to reduce the number of attacks and conflicts with wildlife is crucial for the safety of populations living close to protected areas, predator conservation and, sustained and safe development of ecotourism.*

**Keywords:** Attacks to humans, Danger public awareness, Human-wildlife conflicts, Predators.

## INTRODUCTION

Ecotourism is widely considered the fastest growing sub-component of tourism, which is itself the world's largest industry [1]. Since 1990, ecotourism has increased by about 20-34% per year, with a growth rate of 4.1% expected at least until 2020 [2], and captured 7% of the international tourism market in 2007. There are now more than 60 million ecotourists [3], mostly from North America, Europe and Australia [4], and ecotourism accounts for a large share of some countries gross domestic product (e.g. Kenya, Madagascar, Nepal, Thailand, and Malaysia). Some remote regions are seeing particularly high growth rates, with Antarctica, for example, undergoing exponential increases in numbers of tourists [5]. Only a proportion of ecotourists are wildlife tourists and likely to encounter large predators. However, Kenya and Tanzania, countries where such opportunities are much sought after by visitors, alone account for about 75% of all wildlife tourists [2].

Bringing numbers of people with no or little such experience into close contact with large-bodied predators raises two kinds of risks. First, these people often do not know how to behave around such organisms, potentially placing themselves in circumstances where they are more likely to be attacked [6,7]. Second, with increased exposure to people from ecotourists, large-bodied predators may alter their own behavior both toward the ecotourists and to local people [8,9]. Differentiating between such causes in individual cases is difficult. Even in Zoos serious accidents do happen with many causes badly needing a sound discussion [10]. Nonetheless, there are important issues around the dynamics of other seriously problematic negative human-nature interactions. One of the most notable is the incidence of attacks on and fatalities of people by large wild vertebrate predators.

Here we review the evidence for growth in the numbers this kind of human-wildlife conflict, consider the possible causes, and the potential solutions considering both people welfare and predator conservation.

An additional Supplementary material section (see bottom) briefly discusses accidents with non-predatory mammals.

## THE EVIDENCE

By reviewing the available literature, we gathered relevant worldwide information describing attacks on humans by predators (Table 1). Here, an array of examples from published literature of people-predator interactions that have resulted in attacks on people are shown and discussed. They are from the terrestrial, freshwater and marine realms, in the terrestrial realm concern most continents, and involve a diversity of large-bodied fish, reptiles, and mammals. Many of the species are ones that have long been feared by local people, or around which they have taken careful precautions. For example, attacks and deaths from felines continue to occur, with those from lions and tigers being particularly notable [11]. Likewise, in 2015 The International Shark Attack File (SAF) investigated 164 alleged incidents involving this group of species alone, of which 98 (including 6 fatalities) were regarded as confirmed cases of unprovoked attacks on people in the shark's natural habitat (a further 36 were categorized as provoked); this was the highest annual number on record (http://www.flmnh.ufl.edu/fish/isaf/worldwide-summary/). Other cases apparently reflect recent changes in behavior with, for example, Dingoes Canis lupus dingo Meyer on Fraser Island, Australia, having "…lost their fear of humans and started to regard them as prey" [12]. Arguably more typical is the case of Black bears Ursus americanus Pallas, 1780 in North America, which are abundant (population estimated at 750.000 individuals, interval estimate 235.000-917.000, lower estimate 650.000; [13], and attacks from which are common, with fatalities increasing from 1 between 1900/09 to 17 between 2000/09 [14]. The increasing coincidence between humans and bears has arisen from nature walks and bears being attracted by food and garbage near camping sites, but most accidents have been predatory and caused by adult males [14]. For North America, Penteriani et al. [15] compiled a comprehensive database describing and analyzing the pattern of attacks on humans by a grizzly, black bear, cougar, wolf, and coyotes. No such an extensive set of data is available for a vast number of places where these types of conflicts occur.

**Table 1:** Indicative numbers of predator attacks on humans in selected areas of the world. Indicating species, location, the time range of studies and accidents. NA (Not Available).

| Species | Location | Period (years) | Attacks | Deaths | Main causes for attacks | Reference |
|---|---|---|---|---|---|---|
| **Blue shark Prionace glauca (Linnaeus, 1758)** | Portugal (Azores) | 4 | 1 | 0 | Recent shark-diving industry boom, food enticement of a pelagic shark | [18] |
| **American Alligator Alligator mississippiensis (Daudin, 1802)** | USA/Florida | 56 | 376 (88.8% in Florida) | 15 (14 in Florida) | Attempting to capture/pick up/ exhibit. Both locals and tourists | [6] |
| **Indo-Pacific Crocodile Crocodylus porosus (Schneider, 1801)** | Australia (N Territory) | 42 | 63 | 18 | Increasing populations of crocodiles, lack of educational programmes, an increase in eco-tourism. | [7] |
| **Mugger C. palustris Lesson, 1831** | India (Kerala) | 21 | 6 | 6 (5 in 2001) | Reintroduction programme/ washing and bathing. Close proximity to conservation areas | [44] |
| **Nile Crocodile C. niloticus Laurenti, 1768 Lion Panthera leo (Linnaeus, 1758)** | Mozambique (North, Cabora Bassa Lake, Zambezi River, Borders with Kruger and Limpopo Natl. Parks) | 2.3 | 273 | 201 | Mainly local people living close to protected areas. | [8] |
| **Lion P. leo** | Tanzania | 20 | >1000 | NA | Mostly rural communities living close to protected areas. | 31 |
| **Lion P. leo** | Kenya (Tsavo) | >100 | NA/High | NA/High | Cattle depredation/Rural communities living close to protected areas. | [47] |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Leopard P. pardus (Linnaeus, 1758)** | India (W Maharashtra) | < 1 | NA | NA/ frequent in this densely populated area | High population density >300 people per km2 in close proximity to conservation areas | [35] |
| **Leopard P. pardus** | India and Nepal | >100 | High | NA/high | Increasing populations. Opportunistic attacks. Domestic livestock predation | [11] |
| **Jaguar P. onca (Linnaeus, 1758)** | Brazil (Pantanal) | 1 | 3 | 1 | Locals attacked inside protected areas. Increasing ecotourism with food enticement for jaguars. | [17] |
| **Tibetan Black Bear Ursus thibetanus G. Cuvier, 1823** | India (Kashmir) | 2 | 19 | NA | Livestock depredation. Close proximity to conservation areas. | [38] |
| **American Black Bear U. americanus Pallas, 1780,** | USA/Canada, widespread | 109 | NA/High | 63 | Opportunistic predator attracted by food and human garbage. Most victims were camping and/or nicking. High numbers of tourists. | [14] |
| **Coati Nasua nasua Linnaeus, 1766** | Brazil | 1 | 2 | 0 | Increase interaction/contact between wild coatis and humans | [37] |
| **Coyote Canis latrans (Say, 1823)** | USA/Canada (49% California, 13% Arizona | 46 | 159 (37% predatory, 22% investigative | NA | Range expansion, urban adaptability. Densely populated areas. A high number of tourists. | [51] |
| **Tiger P. tigris (Linnaeus, 1758)** | S and SE Asia | 209 | Very high but decreasing since mid XXth century. Remains high in Bangladesh | 373 | Active tiger predation on humans | [16] |
| **Dingo Canis lupus dingo (Meyer, 1793)** | Australia (Fraser Island) | 5 | 279 (39 serious) | 1 | High nº visitors/People approach dingoes/animals start to see humans as prey. | [12] |
| **Wolf C. lupus pallipes Sykes, 1831** | India (Kashmir) | 2 | 7 | 2 | Deforestation, lack of natural prey, increasing human population | [46] |
| **Nabi et al. (2009)** | India (Kashmir) | 2 | 104 | 2 | Deforestation, lack of natural prey, increasing human population | [46] |
| **Leopard P. pardus** | India (Kashmir) | 2 | 18 | 16 | Deforestation, lack of natural prey, increasing human population | [46] |

As referred in Penteriani et al., [15] of attacks in developed countries in the Northern hemisphere are available although these encompass only the USA, Canada, and Western Europe. Once again, the biased situation for shark attacks is clear and we believe that this is due to the long-term existence of a fully global shark attack file. The same applies to snake bites, a situation also strongly approached in S America, especially in Brazil.

No updated lists were found for Australia (sharks and indo-pacific crocodiles are the exception as well as the Dingoes but almost only in Fraser Island), Southern Africa (shark attacks and felid attacks are well documented only in South Africa), Asia (including SE Asia) where only updated lists of Tiger attacks are available and even these must be regarded with caution [16], S. America where reports and scientific publications are known from Brazil dealing with attacks by black caimans, anacondas and Jaguars [17]. The only updated databases known report snake bites and invertebrate accidents (spiders, ants, scorpions). As in the other sites, S. America and especially Brazil also report exhaustively shark attacks.

This means a lack of credible and sustained information regarding top ecotourism rising destinations in Africa, Asia, Australia, and S America. Globally, attacks on humans-especially nonfatal attacks that result in only minor injury-likely remain under-reported due to the lack of monitoring programs and standardized reporting protocol [11]. On the other hand, authors have particularly highlighted concerns in the shark diving industry that connections will be drawn between this growing activity and shark attacks [18,19].

Whilst the data we present in Table 1 are sufficient in themselves to raise concerns, they are most probably just a limited reflection of the number of attacks on and fatalities of humans, although the overall scale is hard to estimate.

There are concerns that there may be conscious efforts to avoid reporting of attacks by vertebrate predators on people. The ecotourism industry, in particular, could suffer significant economic losses from any reduction of business associated with media, scientific and regulatory attention being paid to such incidents. Likewise, a recent communication to one of us (JPB) by an officer of the Maritime Police from Madeira Island reported three attacks on divers by the Mediterranean Monk Seal Monachus. This emblematic and highly endangered species is making a steady comeback in the Madeira Archipelago and more often in contact with tourists and recreational divers. These, however, are often unaware that monk seals are large animals with strong canine teeth, and fiercely territorial. Local authorities and commercial enterprises apparently managed to block and destroy evidence of these accidents, impeding accurate investigation and description.

There is a general sense that the number of reported attacks on people by vertebrate predators is increasing, but as with the overall scale of attacks, this is difficult categorically to demonstrate [19,20]. The recent work published by Penteriani et al. [15] reveals that from the year 1955 to 2014 the number of attacks reported by the media in both the USA and Europe increased significantly. Whilst we focus here on attacks by predatory vertebrates, there appears also to be a rise in incidents with non-predatory species.

## EXPLANATIONS

There are a number of possible explanations for an apparent increase in the number of people-predator incidents.

## BETTER REPORTING

Although reporting of people-predator incidents remains poor, it is almost certainly the case that it has improved, particularly given that news of such incidents can often be spread widely and rapidly through social media. Indeed, there appears to be associated with growth in the availability of photographs and videos of predator attacks on people. It thus seems inevitable that a component of any increase in the frequency of reported attacks is simply a result of better reporting. Traffic accidents caused by wildlife is thoroughly reported in Canada, mainly in British Columbia via a fully functional Wildlife Accident Reporting System (seehttp://tranbc.ca/2013/06/12/wildlife-accident-tracking-points-to-collision-prevention/#sthash.QuqKWC82.dpbs last accessed 25th February 2016)

Perhaps one of the best examples of a biased set of information regarding attacks on humans by predators is the popular and widespread news, often published in both serious and tabloid newspapers, of piranha attacks. Literally hundreds of popular tales and newspapers (also television) describe attacks by these fish mostly in Brazil, Nevertheless, the number of seriously investigated attacks is extremely scarce and may be resumed to just three [21].

## LOSS OF NATURAL HABITAT AND PREY

As natural habitat has been lost, and opportunities to obtain prey, vertebrate predators are increasingly found in more anthropogenic landscapes.

### *Increased human populations*

Ongoing growth in human populations is seen as a serious cause for the increase of accidents with predatory wildlife, mainly involving lions, tigers, and leopards in Africa and Asia [11,15]. Human settlements, mainly for cattle raising and agriculture, close to protected areas are a major cause of concern and despite reductions in accidents due to population declines of those predators in the XX$^{th}$ century, areas in Tanzania, Bangladesh, Pakistan, India, and Nepal are still affected by important numbers of yearly reports (Table 1).

### *Increased tourism*

In extreme cases, the behavior of some large predators is being actively modified to increase the interaction with ecotourists, with attendant risks. For example, in central Brazil (N and W of Pantanal region), an area characterized by vast seasonally flooded plains sightings of wild Jaguars Panthera onca Linnaeus, are "offered" by local entrepreneurs to tourists for "adrenaline" or "thrilling" moments. Here, the animals are attracted with food (cevas) or by simulating calls made by females in the breeding season, using the esturrador, an instrument made from bamboo. As pointed out by Netto et al. [17] these practices have made human presence less intimidating for certain animals. Big cats can become very dangerous when surprised by sudden movements or unwary postures by tourists, especially during the mating season or when cubs are present. Some non-provoked attacks are being observed in the same area and deaths and severe wounds registered.

## EXTINCTION OF EXPERIENCE

Penteriani et al. [15] the need for increasing education and information campaigns directed towards urban people since this group is certainly increasing the number of outdoor activities. However, a loss of experiences with predators by vast numbers of city dwellers and misleading perceptions of the real danger they may pose (e.g. through films, tabloid sensationalist news, internet video clips) could well lead to inadequate behaviors when people are engaged in wilderness activities. In fact, a simple search on the internet reveals hundreds of such occurrences. However, when trying to find a correspondent scientific analysis of a given accident, the numbers drop to a mere 1%-2%. The recent changing relations between people and nature are attracting much comment and debate as to their form, causes, and consequences. In the main, concern has focused on the 'extinction of experience', the progressive loss of positive human-nature interactions, and thence of the health and wellbeing benefits that these can provide [22,23]. Indeed, the overall consequences of this loss are thought to be profound, have been linked to declines in physical, psychological and social wellbeing [24], have been cast as constituting a medical disorder [25], and are increasingly well understood mechanistically [26,27]. Arguably, by contrast, in the context of how people's relations with nature are changing, negative human-nature interactions are attracting much less focus beyond obviously critical issues of, emerging infectious diseases, and the dynamics and control of disease vectors and agents [28,29].

### *What should be done?*

There is a number of practical responses to reduce the risks of attacks by large-bodied predators.

### *Better recording of incidents*

If a proper inventory of incidents can be established, the likely spatial and temporal occurrence of such attacks can be determined [30], and human activities modified accordingly. It is of the utmost importance that accurate details of accidents involving humans and wildlife are readily available to scientists and be treated by forensic and medical investigators as accurately as possible, preferably with the assistance of recognized scientists and other experts locally available. If sharks attacks are carefully monitored throughout the world (e.g. https://www.flmnh.ufl.edu/fish/sharks/isaf/isaf.htm last accessed 05th March 2016), similar organizations could perfectly be developed for a broader number of species, especially those that are generally accepted as major threatening and have caused well-documented accidents.

### *Removal of problem animals*

A common response to attacks on people by large predators is too often to place the blame on the latter. Nonetheless, it is undoubtedly the case that some individuals can become particularly problematic in their behavior. These need to be identified and often either culled or removed to more appropriate areas [31,32].

### *Training of guides*

With the expansion in ecotourism, often in areas with limited regulatory infrastructure.

Ecotourism operators can be required to follow appropriate codes of conduct, and individual ecotourists educated in responsible forms of behavior [33].

***General education***

Especially in developed countries, people should attend the basic recommendations outlined by Penteriani et al. [15]. This education implies basic common-sense human attitudes when in possible/potential predator country and these include unattended children [34-41], approaching females with cubs or injured animals (normally when hunting) and avoiding twilight or night walks in areas were predators are known to occur [42-49].

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## AUTHOR CONTRIBUTION

Both authors developed this work in similar proportions.

## CONFLICT OF INTEREST

We declare that we have no conflict of interest.

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