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Sloth bear attacks on the Deccan Plateau of Karnataka, India

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Abstract: The sloth bear (*Melursus ursinus*) is endemic to India, Nepal, Bhutan, and Sri Lanka, and is among the least studied of all bear species. Sloth bears behave aggressively toward humans when they feel threatened and are considered among the most dangerous wild animals in India. Our research objective was to interview those that had close encounters with sloth bears and attack survivors so that we could learn from these unfortunate events and prepare persons to be safe in sloth bear country. Consequently, we interviewed 342 people—162 that had close encounters that did not result in attacks and 180 that were involved in attacks—in the southern Indian state of Karnataka between the years 1985 and 2016. Our surveys revealed that all attacks were defensive in nature, that people that had been making noise while moving through sloth bear country were less likely to be attacked, and that persons in groups of ≥ 2 were very rarely attacked. Nine percent of people that fought back during an attack were killed and 11% of people that attempted to run from the bear were killed. There were no deaths among people that fell to the ground and did not fight back. Drawing from this work and that of others, we provide suggestions for safe conduct in sloth bear country.

Key words: bear attack, bear behavior, Deccan Plateau, human–bear conflict, India, Karnataka, *Melursus ursinus*, sloth bears

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India is among the most biodiverse countries in the world and is recognized internationally as a global treasure (Myers et al. 2000). With only 2.4% of the earth's land area, India accounts for approximately 8% of the world's animal species. India is also home to 1.3 billion people (United Nations 2017), and this burgeoning population places tremendous pressure on the nation's natural capital. As a result, India's rich wildlife heritage suffers from habitat loss, fragmentation, air and water pollution, and human–wildlife conflicts.

The sloth bear (*Melursus ursinus*) is endemic to India, Nepal, Bhutan, and Sri Lanka (Garshelis et al. 1999). Of the 4 species of bears in India, the sloth bear is the most widespread; but details of its occupied range are still being refined and there are only a few scientifically sound population studies; therefore, the worldwide population estimate of this animal is still rough and ranges anywhere from 10,000 to 25,000 individuals. However, the International Union for Conservation of Nature lists the sloth bear as vulnerable (Dharaiya et al. 2016) based

on the fact that most of the species' habitat is not protected and is being degraded, and the human population in India is growing steadily. Sloth bear populations are currently threatened by poaching; capture of live bears; killing of nuisance bears; loss of habitat by destruction, fragmentation, and degradation; and conflict with humans (Garshelis et al. 1999).

Maintaining a low level of human–carnivore conflict is a critical component if carnivore conservation is to be effective (Loe and Roskaft 2004). Unfortunately, sloth bears behave aggressively toward humans and are considered one of the most dangerous wild animals in India (Sterndale 1884, Pillarisett 1993). Consequently, human–sloth bear conflict leads to retaliatory killings, removal of nuisance bears, and undermines efforts to conserve them.

It is not known how many people are seriously injured or killed by sloth bears in India annually. However, a number of research publications on the subject depict a desperate situation for both people and bears throughout their range (Rajpurohit and Krausman 2000, Bargali et al. 2005, Debata et al. 2012, Mardaraj 2014, Patel and Dharaiya 2014, Ratnayeke et al. 2014, Garcia et al. 2016, Dhamorikar et al. 2017, Lamichhane et al. 2018). For

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example, in the state of Madhya Pradesh, 48 sloth bear-inflicted fatalities and 687 maulings were reported between 1989 and 1994 (Rajpurohit and Krausman 2000), for an average of 8 deaths and 115 maulings/year. By comparison, only 63 bear-inflicted fatalities caused by American black bears (*Ursus americanus*) occurred in North America over a 109-year span (1900–2009; Herrero et al. 2011). Additionally, Herrero (1985) estimated that in a 100-year span in the United States and Canada, approximately 100 persons were killed by brown bears (*U. arctos*).

Chronicling human–sloth bear conflict is the first step to resolving conflict. Once we understand the nature of these events, we can determine the best ways to avoid attacks, as well as how to behave during an attack. This paper reports on human–sloth bear conflict in the Deccan Plateau in the southern state of Karnataka, India, in an effort to understand why these events occur and how to avoid them.

Study area

Our study of human–sloth bear conflict took place in the southern Indian state of Karnataka (Fig. 1). Karnataka has 3 predominant geographic zones: a coastal region bordered by the Arabian Sea to the west, a hilly region consisting of the Western Ghats, and the plains and rocky scrub jungle of the Deccan Plateau. Sloth bear habitats in Karnataka are considered some of the highest quality habitats for the species (Puri et al. 2015). Our study was conducted wholly in the Deccan Plateau of Karnataka. The study area has a semi-arid climate characterized by hot summers (24.2°–45°C) during April–June and low rainfall (571.92–802.00 mm) from June to November.

Methods

We interviewed persons in Karnataka that had (1) been attacked by sloth bears, (2) witnessed an attack (i.e., sometimes the victim did not survive), or (3) had an encounter with a sloth bear in the wild that did not result in an attack. The survey form we used for interviews is included in Appendix 1 (Supplemental Material).

For clarity, we defined a ‘bear attack’ as a human–bear interaction during which the bear came in physical contact with the person (Smith et al. 2005). A ‘human–bear incident’ (or simply ‘bear incident’) did not result in the bear making physical contact with the person, yet the person was at significant risk of injury. We term ‘human–bear conflicts’ as the sum of bear attacks and bear incidents. We collected data on bear incidents for analysis

comparison with bear attacks because we believed that by studying noncontact incidents we could learn important aspects of human–sloth bear conflict. Hence, in this paper, we report on both bear attacks (injury events) and bear incidents (non-injury events).

A database, containing information provided by attack victims, contained up to 59 variables for each conflict, including date and time of conflict, location, number of persons, number of bears involved in the attack, human injury, etc. (Appendix 1). We restricted analyses and conclusions to those aspects of data we felt confident were accurate and unbiased.

We assigned human activity to categories describing what the person(s) was doing at the time of the bear encounter. Categories included unknown (unreported), walking, farming, cattle or goat grazing, gathering forest materials, defecating, in the vicinity of their home, or other. Consistent with Smith and Herrero (2018), we ascribed probable cause of the sloth bear encounter using the following categories:

1. Surprise encounter—the human–bear encounter was abrupt and the human and bear were surprised. Such encounters generally occurred at close range (<50 m). A person collecting leaves in the forest and suddenly encountering a mother and cubs would be an example of a surprise encounter.
2. Predation—was identified by a series of behaviors: searching, following and testing, attacking (capturing), killing, sometimes dragging a person, sometimes burying, and often feeding upon a person. Vocalizing and stress behaviors by the bear were usually absent (Herrero and Higgins 2003).

We qualitatively ranked visibility of the land cover in which conflicts occurred. Those rated ‘poor’ were either heavily forested, dense shrub lands, or rough terrain with short sight distances. We also rated low light levels (as in dawn, dusk, and nighttime) as poor. Land cover rated ‘fair’ had shrub and tree cover, but also open areas providing increased visibility, as compared with those rated ‘poor.’ Land cover rated ‘good’ was typically very open, such as agricultural fields (those with low-profile crops), meadows, and poorly vegetated barren areas.

We used the chi-square goodness-of-fit test to determine whether observed and expected data were independent of each other, such as whether party group size and bear encounter group size were different (Dytham 2003).



Fig. 1. Location of sloth bear attack surveys, Deccan Plateau (cross-hatched) in the Indian State of Karnataka, India (in gray), 1985–2016.

Table 1. Sloth bear–inflicted injuries caused by known bear group size in Karnataka, India, 1985–2016.

Injury level	Females with cubs	Single bears	2 similar-sized bears	Row total
Unknown	6	5	0	11
Injury unknown	1	1	0	2
No injury	1	0	0	1
Slight injury	23	40	0	63
Moderate injury	31	36	0	67
Severe injury	14	7	2	23
Fatality	7	5	1	13
Grand total	83	94	3	180

Results

Our review of the Web of Science and Zoological Abstracts databases yielded 20 research papers that addressed human–sloth bear conflict. We downloaded and reviewed each paper and have included them as references in this report.

We conducted interviews between June 2014 and March 2016 in the Karnataka districts (no. of interviews conducted are in parentheses) of Ramnagara ($n = 49$), Arasikere ($n = 67$), Tumakuru ($n = 104$), and Ballari ($n = 122$). Interviews yielded information regarding 342 conflicts comprising 15,268 data entries. These incidents occurred over a 33-year period from 1985 to 2016. Of the 342 incidents reported, 53% ($n = 180$) consisted of physical contact and injury, whereas the remaining 47% ($n = 162$) did not result in contact. These conflicts involved 149 female sloth bears with dependent young, 190 single sloth bears of unknown gender, and 3 pairs of adult sloth bears.

Injuries

One hundred sixty-eight people reported being injured in 180 sloth bear attacks, including 13 fatalities, 23 severe injuries, 67 moderate injuries, 63 slight injuries, and 2 persons injured without the specific degree reported (Table 1). In 1 case where the bear made physical contact with the person, the person was not injured; and in 11 cases it was unknown whether the person was injured or the extent of the injury. Of those that reported, <1% suffered no injuries, 37% slight injury, 40% moderate injury, 14% severe injury, and 9% fatality. Of the reported 168 sloth bear–inflicted injuries, females with dependent young accounted for 45% ($n = 76$), single bears 53% ($n = 89$), and a pair of similar sized bears 2% ($n = 3$).

Temporal nature of sloth bear conflicts

Bear attacks ($n = 159$) and bear incidents ($n = 157$) occurred during every month of the year on the Deccan Plateau (Fig. 2). Most attacks ($n = 76$, 48%) occurred during the winter months (Nov–Feb), followed by summer (Mar–Jun; $n = 49$; 31%), and monsoon (Jul–Oct; $n = 34$, 21%). Likewise, most incidents ($n = 77$, 49%) occurred during the winter months (Nov–Feb), followed by summer (Mar–Jun; $n = 63$, 40%), and the monsoon (Jul–Oct; $n = 17$, 11%).

Time of day was reported for 342 human–sloth bear conflicts (Fig. 3), including 180 bear attacks and 162 bear encounters. The most frequent time of day humans were attacked by sloth bears was during dark hours (morning and night when there was no light), accounting for 46% ($n = 82$) of all attacks. The dark hours, both before and after midnight, also accounted for the most bear incidents at 59% ($n = 95$). Dusk accounted for the second-most attacks ($n = 35$; 19%) and the second-most incidents ($n = 26$, 16%). Dawn accounted for the third-most attacks ($n = 23$, 13%) and the third-most incidents ($n = 16$, 10%). The remaining 22% of attacks ($n = 40$) and 15% of incidents ($n = 25$) occurred during daylight hours.

Profile of bears involved

The slight majority of attacks involved single bears (52%, $n = 93$), although females with dependent young made up 47% ($n = 84$); and roughly 2% ($n = 3$) were pairs of bears, which could have been mother bears with large young or a different grouping. Incidents with sloth bears that did not result in an attack were primarily single bears 60% ($n = 96$) and females with young 40% ($n = 65$).

In 340 conflicts (179 attacks and 161 incidents), persons reported the bear’s activity when the person first became aware of the bear (Fig. 4). In a majority of attack instances, bears were either moving away from the direction from which people had been approaching (32%, $n = 58$) or foraging (30%, $n = 54$). Roughly 12% ($n = 22$) of the bears were already charging at the person when they first became aware of the bear. A small number of bears were walking in the direction of the people (8%, $n = 15$), apparently unaware that people were present. In incidents that did not result in attacks, the bears were most often moving away from the direction from which people were approaching (49%, $n = 79$) or bears were foraging (25%, $n = 41$). Roughly 7% ($n = 12$) of the bears were already charging at the person when the person first became aware of the bear, but the bear then ran off without making physical contact. A small

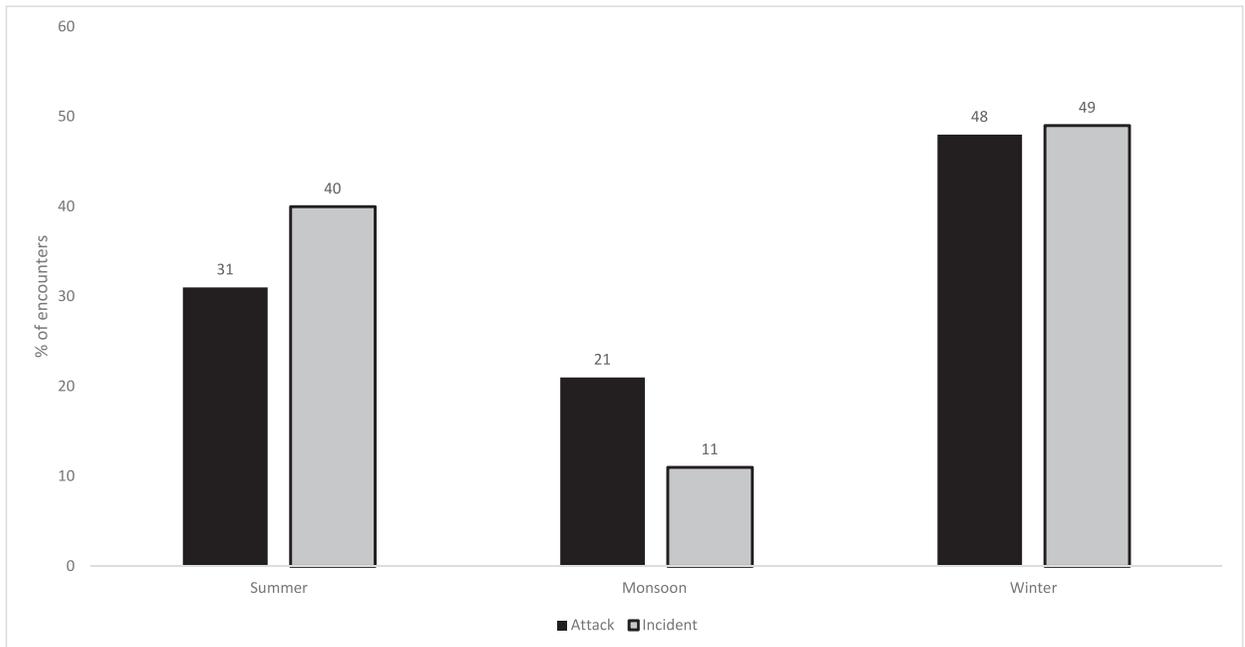


Fig. 2. The occurrence of all sloth bear–human conflicts by season, Karnataka, India, 1985–2016.

number of bears were walking in the general direction of the people (8%, $n = 13$), unaware that people were present in the area. Bears involved in conflicts with people ($n = 324$) had the following outcomes: bears suffering no injury ($n = 321$, 99%) and bears wounded to some degree ($n = 3$, 1%).

In conflicts that resulted in an attack, the sloth bears' most common response when confronted by a person ($n = 176$) was to charge the person (89%, $n = 156$). The second-most common response was to make loud vocalizations before charging (5%, $n = 9$). Sloth bears were also documented walking away first (4%, $n = 7$), and ignoring the person (2%, $n = 4$). In conflicts that did not result in an attack ($n = 162$), the sloth bears' most common response was to charge (47%, $n = 76$). In these instances, no contact was made and bears left the area immediately. The second-most common response was to immediately run from the site of confrontation (36%, $n = 59$). Other initial reactions by bears to sudden human encounters included standing on their hind legs (4%, $n = 6$), holding their ground and making noise (5%, $n = 8$), and walking away slowly (2%, $n = 3$).

When sloth bears charged persons, 94% charged once, and the remainder twice (6%). Sixty-one percent of the time sloth bears charged victims, they vocalized. In 97% of all cases, sloth bears did not return after the initial

encounter. The remaining 3% of victims said that the bear did return, but never more than twice, to the site of the encounter.

Profile of humans involved

The majority of persons involved in bear conflicts ($n = 371$), both in attacks and incidents, were adult men (94%). Data for 180 groups that were attacked show that 158 were alone (88%) and the remainder were with one other person ($n = 22$, 12%). Data for 162 groups that were not attacked show that 155 were alone (96%) and 7 (4%) were with another person. If bear encounters were independent of group size, we would expect human–sloth bear conflicts to reflect the proportion of group sizes reported. However, observed distribution varied from these expectations, with single persons involved more than expected and groups ≥ 2 involved less than expected ($\chi^2 = 786.46$, 1 df, $P < 0.001$). The activity ($n = 342$) persons were most often engaged in when encountering bears was farming ($n = 156$, 46%), followed by grazing cattle or goats ($n = 69$, 20%; Fig. 5).

Just prior to encountering a sloth bear, 68% of persons stated that they were moving quietly, not making any noise to alert a sloth bear of their approach. The remainder (32%) said that they were making noise. At the moment of encounter, the most common response was

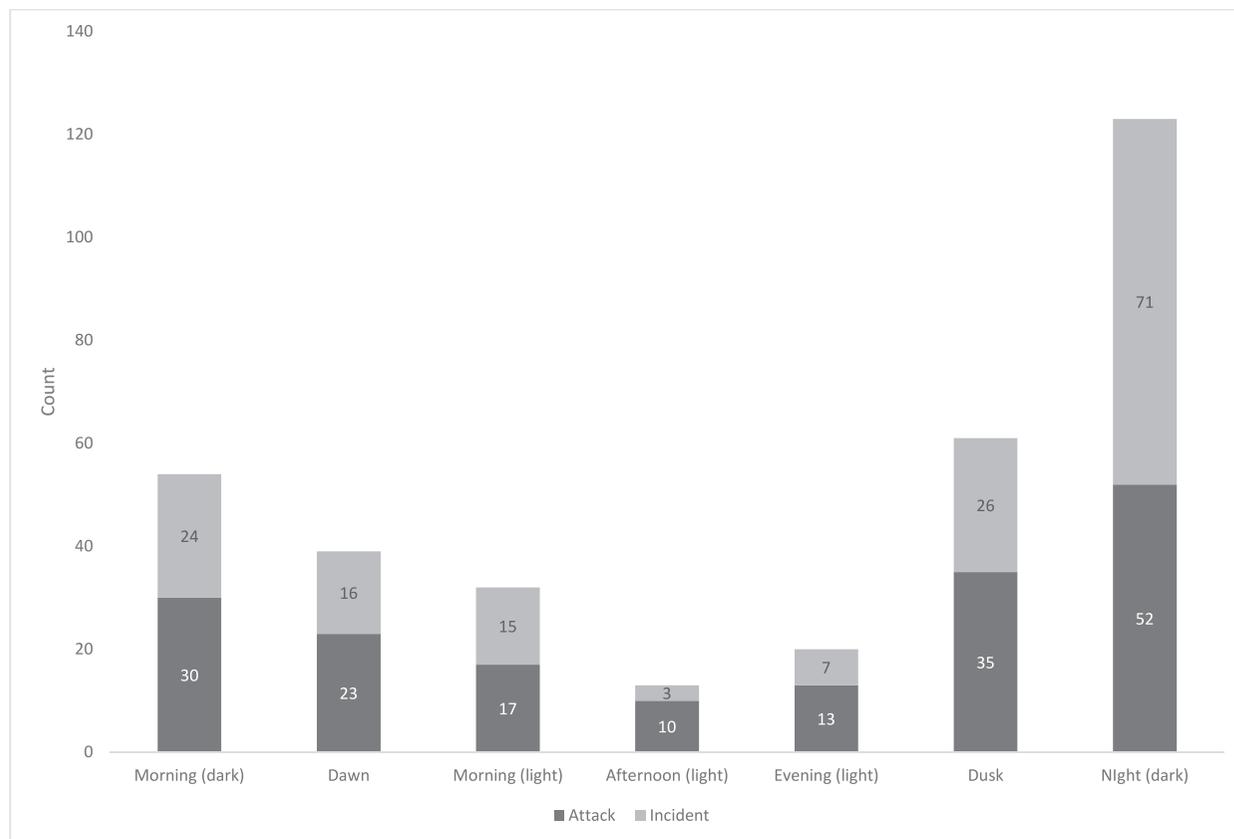


Fig. 3. The occurrence of all sloth bear–human conflicts by time of day, Karnataka, India, 1985–2016.

to run from the bear (39%). The next most common responses reported were to (1) climb a tree (22%), (2) lie prone on the ground (14%), (3) stand their ground (9%), (4) attempt to defend themselves with a stick or tool (5%), (5) attempt to climb a tree by running to it (2%), and finally, some few (6) fainted or passed out when suddenly confronted with a bear (1%). The resulting injuries from running from a sloth bear were highly significant with 2% uninjured, 36% suffering slight injuries, 42% moderate injuries, 9% severe injuries, and 11% fatalities. Although all injury categories were significantly different from expected categories, persons suffering no injuries, severe injuries, and fatalities occurred less than expected, whereas slight and moderate injuries occurred more than expected ($\chi^2 = 41.00$, 4 df, $P < 0.001$).

Victims of attacks reported fighting back 24% of the time. When victims that chose to fight back ceased fighting (69%; 27 of 39), they reported that the bear stopped attacking. Fighting an attacking sloth bear resulted in 9% fatalities ($n = 6$), whereas running from an attacking sloth

bear resulted in 11% ($n = 7$) fatalities. Falling to the ground and not fighting back when confronted by an attacking sloth bear resulted in no fatalities.

Profile of encounters

When attack victims first became aware of the sloth bear, 70% were ≤ 3 m and 88% were ≤ 5 m from the bear. In incidents that did not result in an attack, 50% were ≤ 3 m and 73% were ≤ 5 m from the bear. Only 3 attacks occurred when a person was ≥ 10 m from a bear. The farthest a bear was from the person before it attacked was 12 m. When contact was made, most victims (38%) were running, standing (34%), laying on the ground (15%), or climbing a tree (2%). For attacks for which an estimate of duration was provided ($n = 52$), 94% of respondents reported that their encounter was very brief in duration (< 3 min), whereas the remaining 6% said their encounter lasted < 10 minutes.

Most encounters occurred in agricultural areas (227 of 339, 67%), followed by forested areas (76 of 339, 22%),

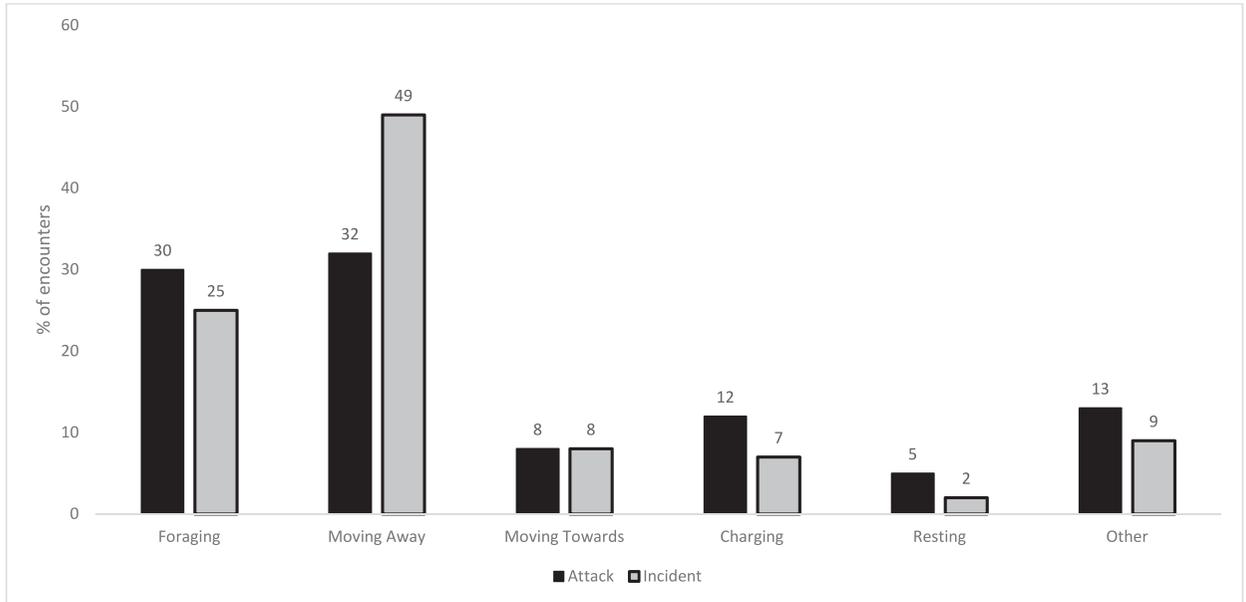


Fig. 4. Sloth bear activity at the time of human–bear conflict, as reported by victims, Karnataka, India, 1985–2016.

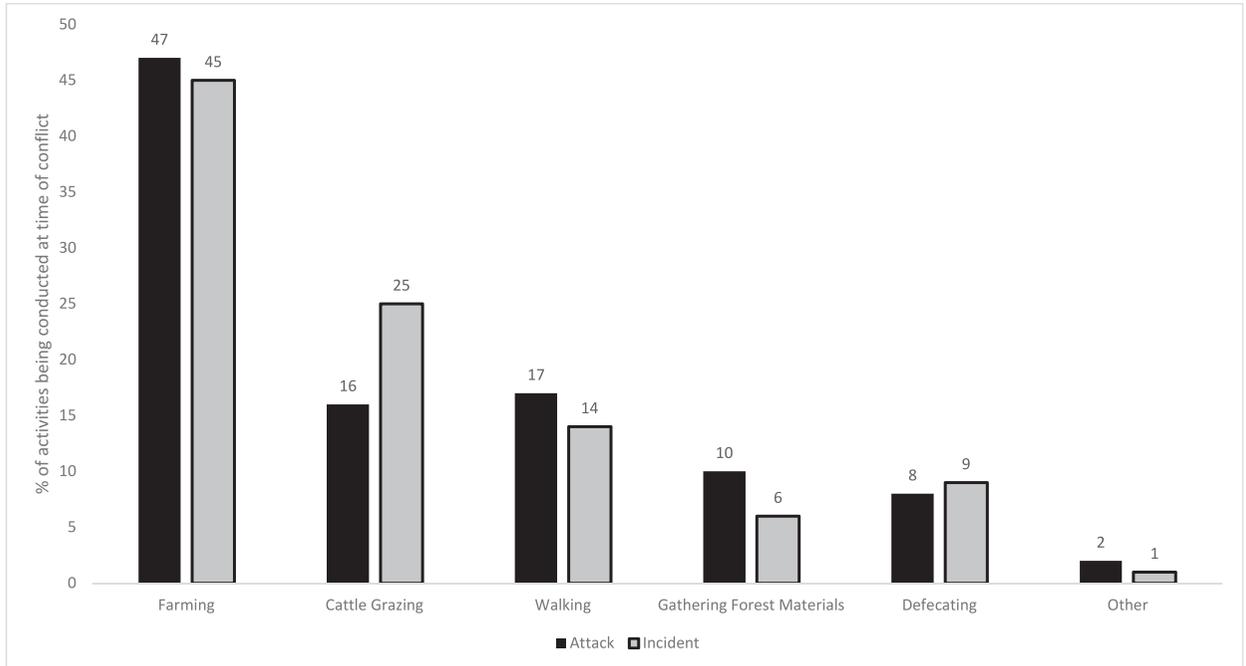


Fig. 5. The activity of persons involved in human–sloth bear encounters, Karnataka, India, 1985–2016.

on roadways (30 of 339, 9%), in riparian areas (4 of 339, 1%), and in scrub vegetation (2 of 339, <1%). Attack locations took place in agriculture areas (131 of 179, 73%), forested areas (29 of 179, 16%), and roadways (16 of 179, 9%). Visibility of habitats where sloth bears were encountered was poor (76% of respondents). An additional 20% were confronted by sloth bears in medium-visibility areas, and only 5% were in open areas.

Discussion

There have been a number of research efforts to document human–sloth bear conflict in India and Sri Lanka (Rajpurohit and Krausman 2000, Bargali et al. 2005, Debata et al. 2012, Mardaraj 2014, Patel and Dharaiya 2014, Ratnayeke et al. 2014, Garcia et al. 2016, Dhamorikar et al. 2017, Lamichhane et al. 2018). Those studies, along with this one, shed light on the nature of human–sloth bear interactions and provide guidance for minimizing sloth bear conflicts. For example, the vast majority of bear victims in Karnataka were alone. A small number were in groups of 2 and no persons in a group of >2 were attacked or even had a close encounter. This observation is generally consistent with findings by Ratnayeke et al. (2014) and Garcia et al. (2016), who both reported that the larger the group, the less chance there was of an attack. Garcia et al. (2016) speculated that larger groups likely deter bears because they are noisier and more intimidating. Traveling and working in groups of ≥ 2 persons is the simplest thing that can be done to provide greater safety in sloth bear habitat. However, this strategy only works if people remain together rather than dispersed. If people can hold a conversation while hiking, they are likely close enough to have the benefits of being in a group. We surmise that when walking singly, people make less noise and that has led to surprise encounters. Our data also clearly show that if a person bolts and runs when suddenly confronted by a sloth bear, the bear will chase and take them down (41% of incidents).

One attack was considered predatory by locals because the bear ate a portion of the victim. However, we believe that sloth bear attacks are wholly defensive in nature; they appear to attack humans only because humans are perceived as a threat, not because they are considered food. Consumption of human flesh may simply be opportunistic, not a behavior that reflects the initial motivation for the attack. Sloth bears do not hunt large mammals; it is not part of their foraging ecology (Garshelis et al. 1999). However, they have been documented scavenging on large mammals (Laurie and Seidensticker 1977). Additionally, it must be noted that that other bears, namely

the brown bear, have been documented eating people that they had killed in a defensive, rather than predatory, attack (Herrero 1985).

Although a few reports of predatory sloth bears exist, we suspect that this notion has arisen not only because sloth bears have on occasion eaten human flesh, but because a non-predatory attack could easily appear predatory from the victim's perspective, particularly if there seemed to be no other apparent motivation for the confrontation. Sloth bear attacks tend to focus on the victim's head and neck region, leading some to believe the attacks are predatory. However, focusing on the head and neck does not appear to be linked to predation in bears in general (Smith and Herrero 2018), but is instead indicative of bears' evolved attack strategy. Herrero (1985) speculated that bears attack the head and neck region largely because they perceive our teeth as a weapon threat, the same as they would with conspecifics.

The question of whether all sloth bear attacks are defensive, or if occasionally they attack in a predatory fashion, is far more than just an intellectual curiosity about sloth bear behavior. If our conclusion is correct (that sloth bears only attack in a defensive capacity), it greatly simplifies the message of how to react if one finds oneself attacked by a sloth bear. Instead of attempting to discern whether the attack is predatory or defensive, as one must do when faced with a brown bear attack, when attacked by a sloth bear there would be one course of action that clearly could be recommended. Thus, the message is simpler and easier to remember at the critical moment.

Numerous interdependent findings merit discussion, including the roles played by the victim's gender, group size, time of day, activity at the time of the attack, distance to the sloth bear when first encountered, whether or not the victim was making noise, and visibility of the attack area. The majority of persons attacked were men (90%), alone at the time of attack (88%), who encountered bears in darkness (77%), first became aware of the bear's presence at very close range (1–5 m; 88%), were moving silently and not making noise to alert bears (49%), and were in agricultural fields (67%). These variables can independently or in combination influence the probability of a human–sloth bear confrontation (Rajpurohit and Krausman 2000, Bargali et al. 2005, Debata et al. 2012, Mardaraj 2014, Patel and Dharaiya 2014, Ratnayeke et al. 2014, Garcia et al. 2016, Dhamorikar et al. 2017, Lamichhane et al. 2018). When a person violates best practices in all of these areas, the odds of an interaction and attack greatly increase.

In rural India, it is primarily the role of men to water and protect crops at night from being consumed and

destroyed by wild herbivores. For example, in one village in northern India, farmers estimated that as much as 40% of their crops were lost to crop-raiding wildlife (Parvaiz 2017). This dangerous situation, of sloth bears being drawn to highly nutritious, high-density crops, while farmers await with sticks expecting to drive off much less dangerous wildlife during hours of darkness, is the most common human–sloth bear encounter scenario on the Deccan Plateau. Possible solutions to crop-raiding include natural fencing consisting of dense saplings, and awareness campaigns that inform farmers about a variety of techniques for safeguarding their farms (Parvaiz 2017).

In North America, persons are cautioned not to enter bear habitat without a deterrent option, such as a firearm or bear spray (Smith and Herrero 2018). People in India generally do not have access to deterrents common in the West, such as guns and bear spray. Singh et al. (2018) recommended persons working in sloth bear habitat construct a 2–3-m-long wooden stick, festooned with bells (noise-makers) and threatening dowel rods (defensive), to form a nonlethal, defensive tool for warding off attacking sloth bears. Although this low-cost solution may provide a deterrent option for some situations, it appears cumbersome and is likely difficult to deploy rapidly, a drawback shared by firearms (Smith et al. 2012). Adding this to the fact that the majority of persons involved in sloth bear encounters in Karnataka were first made aware of the bear's presence at 1–3 m distance (this study), their being armed only with a stick would have resulted in serious limitations. Nonetheless, sticks have been useful for defending oneself or one's acquaintances during sloth bear attacks (Bargali et al. 2005, Dhamorikar et al. 2017), and represent a first step toward a defensive approach to sloth bear safety.

If the goal is simply to survive an encounter, falling to the ground and not fighting back resulted in a 100% survival rate. However, many of those that fell to the ground and did not fight back were still seriously or moderately injured. In fact, people that fell to the ground suffered a higher rate of moderate injuries (65%) than did those that fought back (30%), or those that ran away (42%). The reasons for this are difficult to ascertain; however, it appears that those that played dead rarely did so using a protective position: (1) face down, and (2) protecting the head and neck. It is likely that if the victims used a protective position when falling to the ground, they would have suffered fewer injuries. Therefore, it is at least possible that if people were taught how to properly protect their head and neck regions from injury, the severity of injuries would lessen.

Many of those that fought back suffered only minor injuries (46%); however, 12% were severely injured and 9% died. Likely, these reported differences in injury have to do with unreported actions on the victim's part or the motivation of the bear to press the attack. When a bear's jaws encompass the head, injuries are most often fatal; whereas when its canines slip off the curvature of the skull, severe lacerations occur, including avulsions of the ear(s) and nose, but the brain remains protected. With this in mind, one can see how under the similar attack scenarios, one individual may die while another might survive. Finally, those that attempted to run from the attacking bear fared poorly, with a higher percentage dying than in the other response scenarios (11%). There is little doubt that running triggers a chase response in sloth bears, just as it does in grizzly bears (Herrero 1985). There have been many cases of sloth bears chasing, catching, and mauling human victims (Sharp and Sonone 2011).

Many victims of sloth bear attacks are only slightly injured. This is likely related to the fact that most attacks occur when the human and bear are very close to one another and the bear reflexively reacts to the threat (the person) and instinctively attacks. However, the bear's objective is to escape the situation unharmed, not to unnecessarily engage in a fight. So, once the bear determines “this is not a tiger, or a serious threat” the bear stops, evaluates, and leaves the area in a hurry. However, if the victim actively engages in fighting the bear, then the bear may be more prone to view the victim as a true threat and thus press the attack further, potentially inflicting serious injuries or even killing the victim. However, even in cases where people fought back, the bear likely will take any apparent opportunity to run away. This is likely the reason that many people that did fight back suffered only slight injuries.

It is important to not lose sight of the fact that avoiding sloth bear encounters is the most important action people can take while in bear habitat. Were people to simply practice bear avoidance techniques (e.g., hiking in groups, making noise appropriately, etc.), then knowing how to survive an attack becomes much less important to understand. Those people that violate this basic principle—avoid bears in the first place—put themselves unnecessarily in harm's way. Therefore, we highly recommend that persons working, traversing, or recreating in sloth bear habitat focus mostly on avoidance behaviors. If that is done correctly, worrying about how to defuse a bear encounter or how to survive a mauling is not nearly as important.

Here we summarize a number of insights regarding safety in sloth bear country that will be beneficial for

those people that work and live in sloth bear habitat in India:

- 1) Sloth bears are wholly defensive, meaning that they only attack if they feel threatened. This means that by telegraphing one's presence to the surrounding terrain (i.e., making noise), bears will be alerted to an oncoming human and move clear to avoid confrontation.
- 2) If attacked, protection of the head and neck is critical. The defensive positions described by Herero (1985) are recommended to protect the head and neck.
- 3) Sloth bear conflicts occurred during every month of the year in Karnataka. One must practice bear safety (e.g., make noise, travel in a group, be alert at all times, etc.) year round.
- 4) Sloth bear conflicts occurred largely during the dark hours of the day (77%), and in agricultural areas when sloth bears were coming in to drink water or feed. Stationing single persons to water or protect crops from raiding wildlife puts people at a high risk of injury.
- 5) Sloth bear family groups were often involved in conflicts (49% of all encounters), but single bears were involved as much as any other cohort (51%).
- 6) Encounter group size plays an important role in avoiding bear conflicts: single persons were involved in the vast majority of bear conflicts. Hence, singles were involved significantly more than expected, whereas groups of ≥ 2 persons were involved significantly less than expected.
- 7) Sloth bear conflicts were most common in areas of poor visibility, or at times of low light resulting in poor visibility. When poor visibility areas cannot be avoided, or when at low light or no light times of day, people should group together, be alert, and make noise to avoid surprising bears.
- 8) Persons should carry a 2-m stick. The stick may be used to fight off a bear attacking another person. Singh et al. (2018) suggested carrying a stick modified with bells and multiple dowels extending from it (aka "Ghanti Kathi") to optimize safety in bear country.
- 9) Running is rarely a successful strategy for dealing with an aggressive sloth bear, unless there is a bear-safe haven (e.g., vehicle, cabin, etc.) very close by.
- 10) Playing dead, a strategy of last resort, can save one's life as long as the victim lies prone, face

down, and protects their neck with hands clasped over it.

It is our hope that studies such as this will inform bear safety messaging for persons living in sloth bear country. We know that if these best practices guidelines are adopted, both people and bears will enjoy a more peaceful coexistence. India without sloth bears would be a loss for everyone, so it is our hope that this work will contribute positively to both their future and human safety.

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Literature cited

- BARGALI, H.S., N. AKHTAR, AND N.P.S. CHAUHAN. 2005. Characteristics of sloth bear attacks and human casualties in North Bilaspur Forest Division, Chhattisgarh, India. *Ursus* 16:263–267.
- DEBATA, S., H. KU, SAHU, AND K.K. SWAIN. 2012. Human–sloth bear conflict in Balasore Wildlife Division, Odisha, India. 21st International Conference on Bear Research and Management, 26–30 Nov 2012, New Delhi, India.
- DHAMORIKAR, A.H., P. MEHTA, H. BARGALI, AND K. GORE. 2017. Characteristics of human–sloth bear (*Melursus ursinus*) encounters and the resulting human casualties in the Kanha–Pench corridor, MadhyaPradesh, India. *PLoS ONE* 12:0176612. <https://doi.org/10.1371/journal.pone.0176612>. Accessed 20 May 2020.
- DHARAIYA, N., H.S. BARGALI, AND T. SHARP. 2016. *Melursus ursinus*. The IUCN Red List of Threatened Species 2016:e.T13143A45033815. International Union for the Conservation of Nature. <http://dx.doi.org/10.2305/IUCN.UK.2016-3.RLTS.T13143A45033815.en>. Accessed 7 Dec 2019

- DYTHAM, C. 2003. Choosing and using statistics: A biologist's guide. Second edition. Blackwell, Malden, Maine, USA.
- GARCIA, K.C., H.M. JOSHI, AND N. DHARAIYA. 2016. Assessment of human–sloth bear conflicts in North Gujarat, India. *Ursus* 27:5–10.
- GARSHELIS, D.L., A.R. JOSHI, J.L.D. SMITH, AND C.G. RICE. 1999. Sloth bear conservation action plan (*Melursus ursinus*). Pages 225–240 in C. Servheen, S. Herrero, and B. Peyton, compilers. Bears: Status survey and conservation action plan. International Union for the Conservation of Nature and Natural Resources/Species Survival Commission, Bear and Polar Bear Specialist Groups, Gland, Switzerland.
- HERRERO, S. 1985. Bear attacks: Their causes and avoidance. Winchester, Piscataway, New Jersey, USA.
- , AND A. HIGGINS. 2003. Human injuries inflicted by bears in Alberta: 1960–98. *Ursus* 14:44–54.
- , ———, J.E. CARDOZA, L.I. HAJDUK, AND T.S. SMITH. 2011. Fatal attacks by American black bear on people: 1900–2009. *Journal of Wildlife Management* 75:596–603.
- LAMICHHANE, B.R., G.A. PERSON, H. LEIRS, S. POUDEL, N. SUBEDI, C.P. POKHERAL, S. BHYATTARAI, B.P. THAPALIYA, AND H.H. DE LONGH. 2018. Spatio-temporal patterns of attacks on humans and economic losses from wildlife in Chitwan National Park, Nepal. *PLoS ONE* 13:e0195373. <https://doi.org/10.1371/journal.pone.0195373>.
- LAURIE, A., AND J. SEIDENSTICKER. 1977. Behavioural ecology of the sloth bear (*Melursus ursinus*). *Journal of Zoology* 182:187–204.
- LOE, J., AND E. ROSKAFI. 2004. Large carnivores and human safety: A review. *Journal of the Human Environment* 33:283–288.
- MARDARAJ, P.C. 2014. A sloth bear rescued from retaliation killing in eastern India. *International Bear News* 23:16–17.
- MYERS, N., R.A. MITTERMEIER, C.G. MITTERMEIER, AND J. KENT. 2000. Biodiversity hotspots for conservation priorities. *Nature* 403(6772):853–858. <https://doi.org/10.1038/35002501>. Accessed 16 Jan 2019.
- PARVAIZ, A. 2017. Wild animals spoil farmers' hard work in Darjeeling. The Village Press, Darjeeling, West Bengal, India. <http://www.villagesquare.in/2017/03/24/wild-animals-spoil-farmers-hard-work-darjeeling/>. Accessed 12 Mar 2019.
- PATEL, D., AND N. DHARAIYA. 2014. Human–wildlife conflicts in arid areas of western India: Strategies for mutual co-existence. *Ambient Science* 1:29–37.
- PILLARISETT, A.M. 1993. Are sloth bear man marauders? Two decades of project tiger, Melghat (1973–1993). Pages 41–46 in M.G. Gogate and P.J. Thorsare, editors. Melghat Tiger Reserve, Melghat, India.
- PURI, M., A. SRIVATHSA, K.K. KARANTH, N. KUMAR, AND K.U. KARANTH. 2015. Multiscale distribution models for conserving widespread species: The case of sloth bear *Melursus ursinus* in India. *Diversity and Distributions* 21:1087–1100. DOI: 10.1111/ddi.12335.
- RAJPUROHIT, K.S., AND P.R. KRAUSMAN. 2000. Human–sloth bear conflicts in Madhya Pradesh, India. *Wildlife Society Bulletin* 28:393–399.
- RATNAYEKE, S., F.T. VAN MANEN, R. PIERIS, AND V.S.J. PRAGASH. 2014. Challenges of large carnivore conservation: Sloth bear attacks in Sri Lanka. *Human Ecology* 42: 467–479.
- SHARP, T., AND S.D. SONONE. 2011. Sloth bear attacks: Causes and consequences. *International Bear Newsletter* 20(1): 14–17.
- SINGH, N., S. SONONE, AND N. DHARAIYA. 2018. Sloth bear attacks on humans in central India: Implications for species conservation. *Human–Wildlife Interactions* 12: 338–347.
- SMITH, T.S., AND S. HERRERO. 2018. Human–bear conflict in Alaska: 1880–2015. *Wildlife Society Bulletin* 42: 254–263.
- , ———, AND T.D. DEBRUYN. 2005. Alaskan brown bears, humans, and habituation. *Ursus* 16:1–10.
- , ———, C.S. LAYTON, R. LARSEN, AND K.R. JOHNSON. 2012. Efficacy of firearms for bear deterrence in Alaska. *Journal of Wildlife Management* 76:1021–1027.
- STERNDALE, R.A. 1884. Natural history of the Mammalia of India and Ceylon. Thacker, Spink, and Co., London, England, UK; AND Calcutta, India.
- UNITED NATIONS. 2017. World population prospects 2017. United Nations. <https://population.un.org/wpp/Download/Standard/Population/>. Accessed 15 Jan 2019.
- WIKIPEDIA. 2019. Karnataka. <https://en.wikipedia.org/wiki/Karnataka>. Accessed 6 Feb 2019.

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Supplemental material

Appendix 1. Survey form used when collecting information regarding sloth bear attacks on humans in Karnataka, India, 1985–2016.