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Sloth bear attacks on humans in central India: implications for species conservation

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Abstract: Conflicts with wild animals are increasing as human populations grow and related anthropogenic activities encroach into wildlife habitats. A good example of this situation is the increase in conflicts between humans and sloth bears (*Melursus ursinus*) in India. Sloth bears are known for their aggressive and unpredictable behavior. More human fatalities and injuries have been attributed to sloth bear attacks than all recorded incidences of wildlife attacks in Buldhana Forest Division of Maharashtra, India. We interviewed 51 victims that were attacked by sloth bears between 2009–2017 to better understand the reasons for the attacks. Thirty-four of the attacks (66.7%) resulted in serious injuries, and there were 7 human mortalities (13.7%) reported. Most attacks occurred close to agricultural fields (66.7%) and during mid-day (1100–1400 hours). More attacks (64.7%) occurred when a person was working or resting in the field, or retrieving water for the field followed by attacks while watching over grazing livestock (13.7%). Individuals aged 31 to 40 years (35.3%) were the most common victims of sloth bear attacks. Half of the attacks were during monsoon season (July to October, 51%) followed by summer (March to June, 35%) and winter (November to February, 14%). In 39% of cases, a single bear was involved while females with 2 cubs were found to be involved in 37% of attacks. This research was incorporated into a comprehensive conflict mitigation plan, which included field staff training for monitoring sloth bear population, formulation of a Rapid Rescue Unit to manage conflict situations, and sloth bear education programs in the high conflict villages. People were made aware of the behavior and activity pattern of sloth bears and preventive measures to mitigate potential conflicts.

Key words: bear attacks, central India, human fatalities, human injuries, human–wildlife conflicts, *Melursus ursinus*, mitigation measures, sloth bears

As human populations grow, anthropogenic activities will continue to encroach into wildlife habitats. The increased proximity of humans and wildlife has led to increased human–wildlife interactions (Messmer 2000). The phrase human–wildlife conflict is now commonly used to describe situations that involve any negative interactions between humans and wildlife (Messmer 2009). As human populations increase, the resulting competition with wildlife for space and food resources pose a major challenge for conservation of several wild species worldwide (Distefano 2003, Madhusudan 2003, Woodruffe et al. 2005). As such, managers will need better information regarding the cause of these conflicts to help mitigate them (Messmer 2000).

Sloth bears (*Melursus ursinus*) inhabit India, Sri Lanka, and Nepal and are rare in Bhutan (Garshelis et al. 1999, Sharp et al. 2015). They are currently listed as vulnerable by the

International Union for Conservation of Nature and Natural Resources (Garshelis et al. 2008, Dharaiya et al. 2016). Sloth bear populations are declining due to habitat loss through land conversion. Furthermore, diminished food resources (Murthy and Sankar 1995) and direct competition between bears and humans for food resources are also considered a major species conservation threat as human–bear conflicts increase (Rajpurohit and Chauhan 1996).

The villages in and around Dnyanganga Wildlife Sanctuary (hereafter, Dnyanganga WLS) of northern Maharashtra, India are experiencing increased human–bear conflicts, which include regular encounters with sloth bears around their agricultural fields and villages. The collection of non-timber forest products (NTFP), which typically include fruits, flowers, leaves, mushrooms, and medicinal plants along with firewood and livestock grazing, increases the risk of having these encounters. The resulting

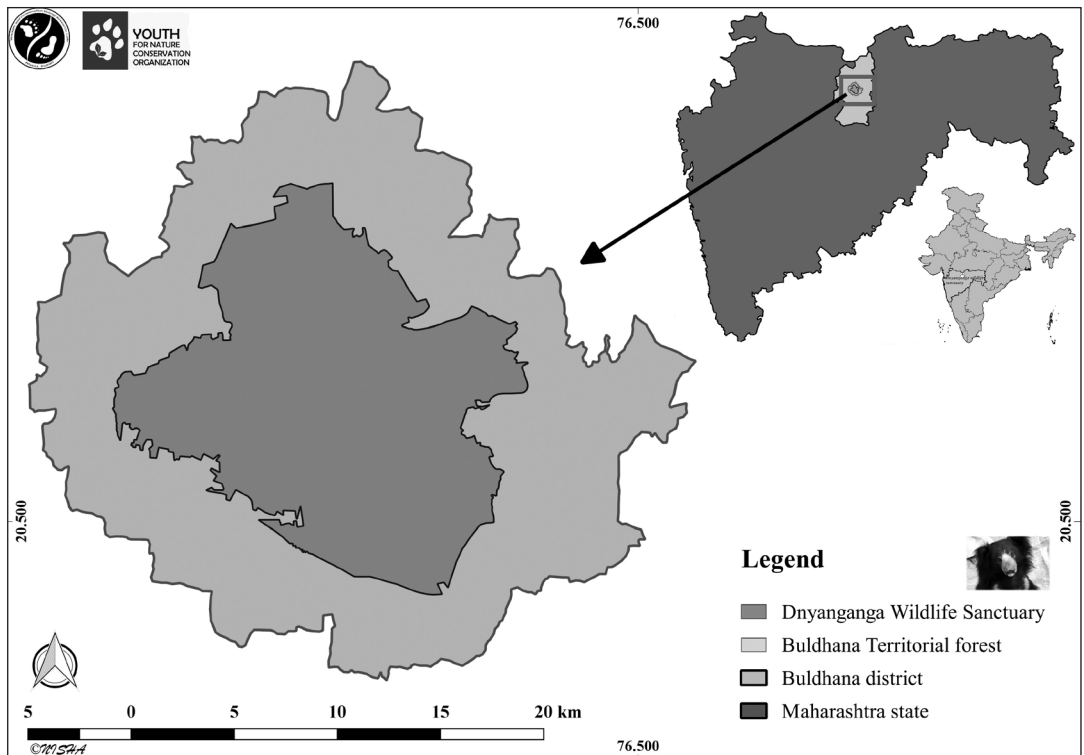


Figure 1. Dnyanganga Wildlife Sanctuary and territorial forest, Buldhana Division, Maharashtra, India.

consequences of these encounters may include temporary or permanent human physical injuries, property loss, and crop damage (Singh et al. 2017). Further, sloth bear attacks on humans decrease the tolerance of local communities toward the bears.

To better understand human–sloth bear conflicts, we analyzed human attack data between 2009 and 2017 obtained from forest department records of the Buldhana Forest Division of Maharashtra, India. We also interviewed victims to understand sloth bear attack patterns in Dnyanganga WLS and the territorial forest around the sanctuary. Based on the findings, we proposed preventive actions to formulate a conflict mitigation plan for Maharashtra state. This study was the first of its kind in Maharashtra, with the goal that the developed mitigation measures would reduce human–sloth bear conflicts and increase tolerance of local people toward sloth bears and the conservation of the species.

Study area

The Buldhana Forest Division is geographically located at 75°087' to 76°096' N longitude and

19°083' to 21°021' E latitude, in the northern part of the Maharashtra state of India (Figure 1). The forest is divided into the Dnyanganga WLS and surrounding territorial forests. The territorial forests are highly fragmented and disturbed due to several villages and their associated agricultural lands.

The topography is mainly undulating with an average elevation of 610 m above sea level (Tiwari 2009). The climate of Buldhana district is subtropical with 3 distinct seasons: the summer (March–June), monsoon (July–October) and winter (November–February). During summer season, the climate is dry and hot with a mean temperature exceeding 40 °C and at times reaching 49 °C. The sanctuary receives an average annual rainfall of 727.5-mm with very low availability of water during the dry season. The forest has different microhabitats such as grasslands, riverine system, dense and open forest covers, and areas with different dominant tree species.

According to the forest type's classification by Champion and Seth (1968), the sanctuary is a Southern tropical dry deciduous and dry teak forest. The main flora of the area are teak

(*Tectona grandis*), anjan (*Hardwickia binata*), amaltas (*Cassia fistula*), mahua (*Madhuca indica*), dhavda (*Anogeissus latifolia*), tendu (*Diospyros melanoxylon*), moin (*Lannea coromandelica*), charoli (*Buchanania lanzan*), baheda (*Terminalia belerica*), and bor (*Zizyphus* spp; Tiwari 2009).

Dnyanganga WLS, along with its territorial forests, provides a safe habitat for a diversity of flora and fauna including sloth bears. Other terrestrial mammals occupying the area include leopard (*Panthera pardus*), blue bull (*Boselaphus tragocamelus*), black buck (*Antelope cervicapra*), four-horned antelope (*Tetracerus quadricornis*), striped hyena (*Hyaena hyaena*), jackal (*Canis aureus*), Indian fox (*Vulpes bengalensis*), porcupine (*Hystrix indica*), wild boar (*Sus scrofa*), small Indian civet (*Viverricula indica*), and jungle cat (*Felis chaus*; Tiwari 2009). The forested area (204 km²) is surrounded by 29 villages, including 1 village within the sanctuary. Most of the people are farmers and depend on the forest for various sources of income and survival, including cattle grazing and the gathering of fuel wood, fodder, honey, tendu leaves, gums, fruits, and medicinal plants.

Methods

Reported cases of sloth bear attacks on humans, compensation records claimed by victims, and attack cases resulting in human deaths were collected from the Buldhana Forest Division. We used this information to develop and implement village surveys. The villages we chose to survey were selected based on the number of cases recorded in the past 9 years (2009–2017) and the information obtained from the forest division. We conducted the surveys from April 2017 through March 2018.

Before each interview, we introduced ourselves to the interviewees and briefed them about the importance of the present study. This was important because often times the villagers consider the research team to be a part of the forest department and are thus hesitant to reveal much about the incidences. The interviews were conducted in the local language Marathi and occasionally Hindi to make the interviewee comfortable during the interview.

We interviewed 51 people attacked by sloth bears, from a total of 28 villages. Family members or witnesses of attack victims that

were killed were asked about the incident. We recorded the age and sex of victims; year, month, and time of attack; season; location or area of attack; activity of the victim at the time of attack; reaction of victim; level of injuries; type of habitat; use of weapon; circumstances leading to the attack; bear behavior during the attack; activity of the bear before the attack; number of bears involved; mode of attack; and frequency of bear sightings around agricultural fields and villages. We also asked victims the minimum distance at which they first sighted the bear prior to the attack, occupation of the victim, and the compensation received from the forest department compared to their medical expenses.

We classified the injuries into 3 classes: serious injuries, minor injuries, and death. We classified victims into age groups ranging from 1–80 years. Attack locations were characterized as 4 broad categories: agricultural fields, villages, forests, and agricultural road or farm track (farm tracks are typically unpaved dirt roads or roads covered with gravel). Number of bears involved were classified as a single bear, 2 individuals (presumably female with 1 cub), 3 individuals (female with 2 cubs), 2 adults, 3 adults, and 4 adult bears, according to the data provided by victims. We also visited 46 encounter locations and noted habitat and terrain type and vegetation cover. This was done to know whether the bear attack occurred within the protected area and also to know the proximity of bear attack location from the human activity area. We also recorded the time of day that each attack occurred.

The data we obtained were analyzed through Microsoft Office Excel. Statistical analyses such as the *t*-test (*t*) were used to find significant differences between groups (male–female and various age groups), single-factor ANOVA to compare the differences in attack cases during different seasons, and Pearson chi-square (χ^2) was used to find significant differences in group proportions of the obtained data. The significance level for all the tests was set to $\alpha = 0.05$. Data collected were used to estimate the seasonal and annual mean (*M*) and percentage (%) while variability in collected data was recorded in terms of standard deviation (SD). We used the program Q-GIS V2.18.6 in the Geographic Information System (GIS) to digitize

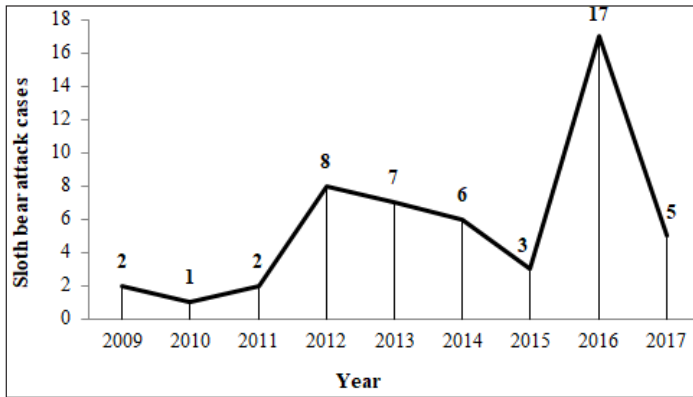


Figure 2. Sloth bear (*Melursus ursinus*) attacks on humans, Dnyanganga Wildlife Sanctuary, Buldhana Division, Maharashtra, India, 2009–2017.

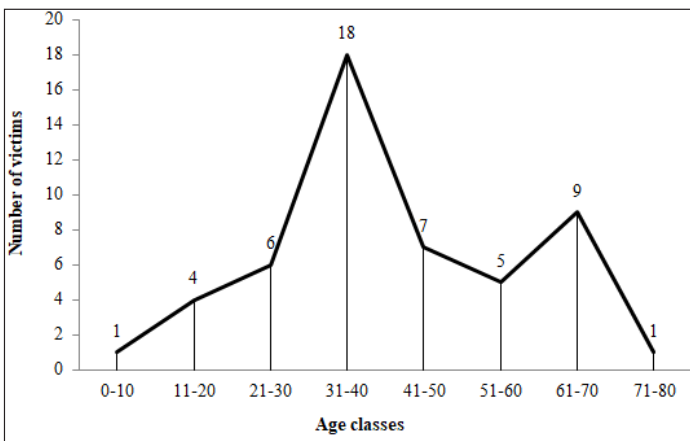


Figure 3. Variation in age classes of sloth bears (*Melursus ursinus*) attack victims in Buldhana Division, Maharashtra, India, 2009–2017.

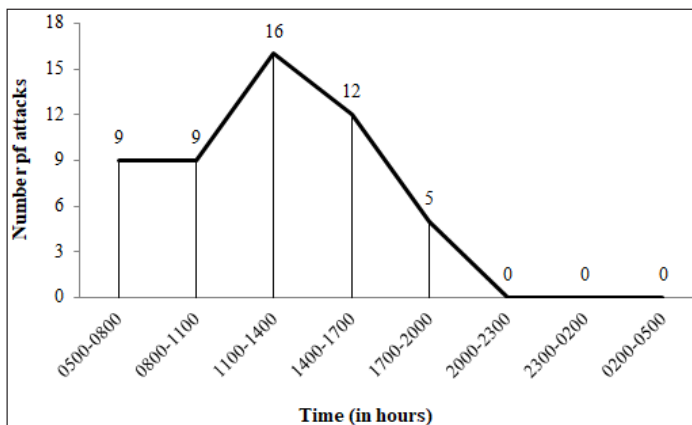


Figure 4. Number and time of occurrence of sloth bear (*Melursus ursinus*) attacks on humans in Buldhana Division, Maharashtra, India, 2009–2017.

and produce maps of the study area, including boundaries of the wildlife sanctuary, territorial forests, and global positioning system (GPS) points recorded from field surveys of conflict locations.

Results

We evaluated 51 of the 55 attack cases that occurred between 2009 and 2017. Four interviews could not be conducted, as the victims had no longer resided in the village after the attack and no contact could be made. Thirty-seven attacks (66.7%) resulted in serious injuries to victims, 10 (19.7%) in minor injuries, and 7 (13.7%) in mortality. Males (86.3%) were the most common victims. On average, 5.67 (\pm 4.89 SD) attacks per year were recorded in the study area (Figure 2). Most of the affected villages were located in the territorial forest surrounding the Dnyanganga WLS.

Most victims (35.5%) were 31–40 years old, 13.7% were 41–50 years old, and 17.6% were 61–70 years old (Figure 3). The youngest attack victim was 9 years old and the oldest was 75 years of age (Figure 3). A significant difference in the age groups of the victims were found by Pearson chi-square test (χ^2 [7, $n = 51$] = 32.61, $P < 0.05$).

Most of the attacks (about 90%) happened during daylight (Figure 4). Sixteen of the attacks (31.4%) occurred from 1100–1400 hours, 12 (23.5%) from 1400–1700 hours, and 9 (17%) from 0500–1100 hours. Five attacks were recorded during the evening (1700–2000 hours). Not a single case of attack was reported during night time (2000–0500 hours). The difference between time of attacks was found to be

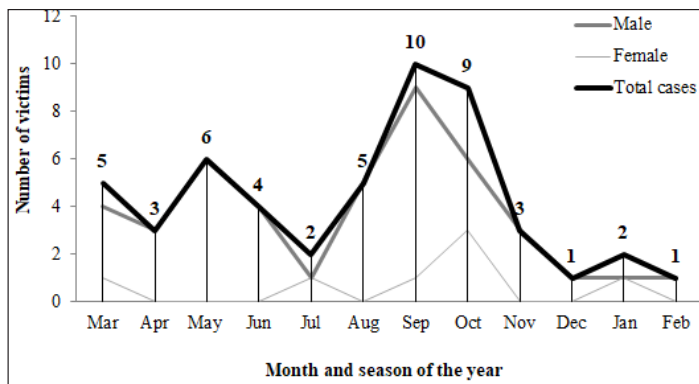


Figure 5. Monthly and seasonal variations in the number of sloth bear (*Melursus ursinus*) attacks on humans by sex, Buldhana Division, Maharashtra, India, 2009–2017.

significant ($\chi^2 [7, n = 51] = 41.08, P < 0.05$).

Bear attacks on humans were recorded throughout the year; however, more (51%) occurred during monsoon, followed by summer (35.2%) and winter (13.7%; Figure 5). Both male (47.73%) and female victims (71.43%) were found to be attacked more during monsoon followed by summer (14.3% and 38.6%, respectively). However, there were no differences between male ($14.67 \pm 7.76, M \pm SD$) and female victims ($2.33 \pm 2.31, M \pm SD$) across 3 seasons (i.e., summer, monsoon, and winter; $P = 0.058$ [at $\alpha = 0.05$ level]). Most attacks occurred in the months of September (19.6%) and October (17.6%), followed by May (11.8%). The fewest attacks were reported in December and February (1.9%; $n = 1$ each); however, frequency of attacks did not differ by months ($\chi^2 [11, n = 51] = 26.29, P = 0.023$). We found no difference between the number of cases during different seasons ($P = 0.057$).

Most encounters occurred around agricultural fields (66.7%), while 17.6% occurred around forests and edges (Figure 6). More attacks occurred outside the protected area when people were working in agricultural fields (64.7%) and leading their livestock to graze within the territorial forest (13.7%; Figure 7). Other activities precipitating attacks include moving through forest areas (9.8%), passing through a village street early in the morning (5.9%), defecation in open areas around agricultural fields or adjacent to forests (3.9%), and NTFP collection (1.9%). More attacks occurred when the victim was alone (59%) or accompanied by another person (21%) or 2 people (6%). Attacks decreased with increasing group size ($\chi^2 [4, n = 51] = 52.82, P <$

0.05). Most attacks involved a single adult bear (39.2%). Attacks involving 3 bears (mother with 2 cubs) accounted for 37.3% of incidences. There were only 2 occasions of an attack involving ≥ 3 adult bears (Figure 8).

In 31.4% of cases, the victims reported that the bear was hidden in bushes or in dried water canals and charged suddenly. In 35.3% of cases, the bear approached the victim from the front, and 25.5% of victims reported that the bear charged from behind. In 4 cases, no information about encounter direction was obtained (due to victim’s death on the site).

More victims (31.4%) reported first observing the bear at a distance of about 5–6 m, while 27.4% first saw the bear at 2–3 m. The attack period (duration of incidence) varied from 3–20 minutes (mean = 5.22 min \pm 4.94 SD).

In 49% of incidents, the bear vocalized continuously during and after charging. Almost half (47%) of the cases recorded involved multiple injuries while 39% reported a single injury to the victim. Among the single injuries, hips and legs were the most affected body parts followed by the face and head (Table 1). Most victims suffered injuries classified as serious that completely affected their ability to work (66.7%, $n = 34$), while 19.6% ($n = 10$) had minor injuries. Seven of the victims died. During the attacks, 69% ($n = 35$) of victims lacked any type of weapon while in 31% ($n = 16$) of cases, the victims were armed. Types of weapons included bamboo stick ($n = 7$), sickle ($n = 5$), and small axe ($n = 4$). Despite having some kind of weapon, over half of these armed victims were not able to use the weapon.

Discussion

Sloth bears and humans have been cohabitating for decades in the study area; however, forest department records suggest a substantial increase in the number of sloth bear attacks in Buldhana district in the last 9 years. Most of the encounters with bears are known to occur when villagers enter the forests for collection of fruits, flowers, leaves, mushrooms, fuel wood, and medicinal plants,

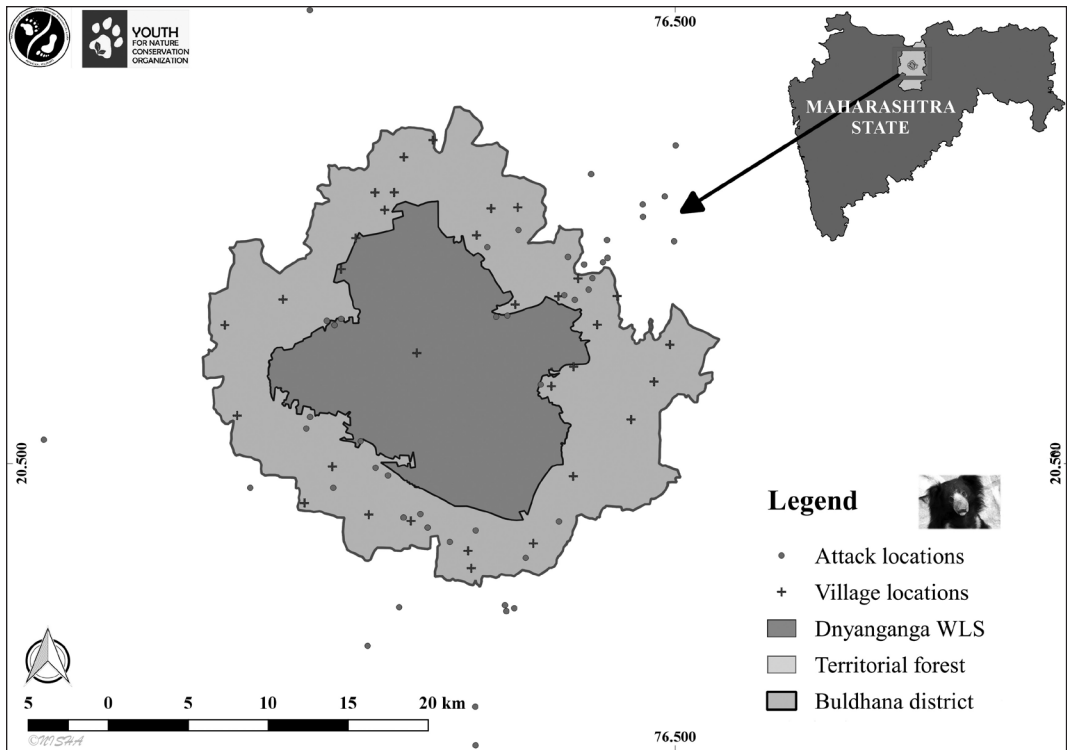


Figure 6. Map showing location of sloth bear (*Melursus ursinus*) attacks on humans and village locations in the Dnyanganga Wildlife Sanctuary and territorial forest, Maharashtra, India, 2009–2017.

or to graze livestock in different months of the year (Chauhan 2003, Bargali et al. 2005, Garcia et al. 2016, Dhamorikar et al. 2017).

Increased attacks during the months of May, September, and October in the study area were correlated with the frequent forest visits made by villagers. Middle-aged people 31–50 years old are more actively involved in the above-mentioned outdoor activities and thus are more vulnerable to sloth bear attacks. Overgrowth of ground vegetation in monsoon season (July to October) reduced visibility, drastically accelerating the probability of encounters.

Studies from the Gujarat (Garcia et al. 2016) and Chhattisgarh (North Bilaspur; Bargali et al. 2005) states of India found that sloth bear attacks were highest during winter and monsoon season, and from 1300–1800 hours. In contrast, Sri Lanka reported an increased number of sloth bear attacks during early summer (Ratnayeke et al. 2014). In Odisha, India, the lack of toilet facilities has increased the likelihood of encounters with bears (Debata et al. 2016).

Compared to other studies where most of

the attacks were recorded during morning hours (Bargali et al. 2005), our results and those of Garcia et al. (2016) suggest an increased likelihood of attack during mid-day. The people living around the area are largely dependent on agriculture for their livelihood and are entering their fields during this time. These circumstances may lead to increasing conflicts. Further, the presence of bears around villages and agriculture fields increases in the summer season when bears increase their search for food and water sources.

Raimunia (*Lantana camara*) provided resting grounds for bears and other wild animals around villages and agricultural lands, leading to sudden confrontations. Other common attractants include fruit trees planted near villages and agricultural fields. Additionally, religious temples are very common in villages of India, and people leave fruit at these temples as an offering. Bears regularly visit these temples at night to feed on these offerings, increasing the chances of a sudden encounter.

Although 19 victims completely recovered from their injuries, 32 reported non-recoverable

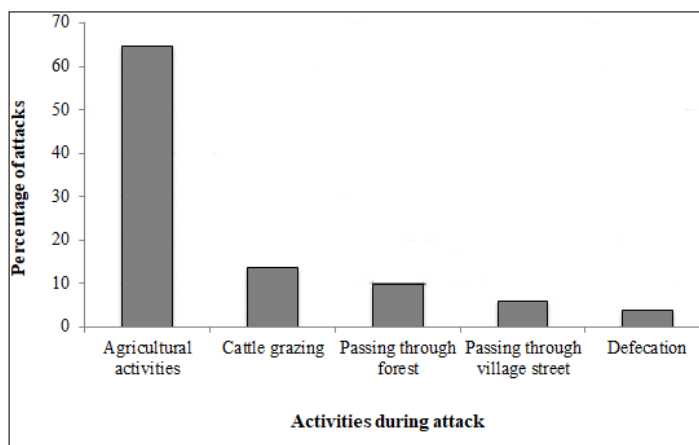


Figure 7. Activity of victims at the time of attack by sloth bears (*Melursus ursinus*) in Buldhana Division, Maharashtra, India, 2009–2017.

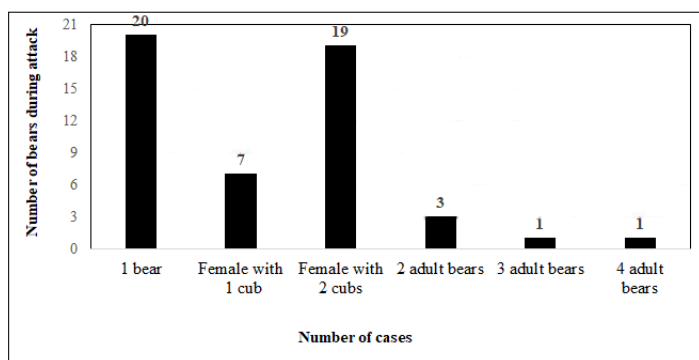


Figure 8. Number of sloth bears (*Melursus ursinus*) present at the time of human attacks, as provided by victims in Buldhana Division, Maharashtra, India, 2009–2017.

Table 1. Body parts of victims being affected or lost due to sloth bear (*Melursus ursinus*) attacks in Buldhana Division, Maharashtra, India, 2009–2017.

Body parts	No. of cases	Percentage
Back	4	7.8
Arms and shoulder	6	11.7
Face and head	7	13.7
Hips and legs	10	19.6
Multiple injuries	24	47.0

injuries. In cases of serious injuries, victims had suffered fractures in fingers, wrists, shoulders, or legs, leading to permanent physical disability. Instances of multiple injuries were relatively greater as victims tried to defend themselves repeatedly by running and fighting.

Our results indicated that larger groups of

people were less susceptible to attack. However, group size was largely dependent upon season and the activities the people are involved with. For example, while planting seeds or harvesting crops, people are generally in larger groups. During livestock grazing or NTFP collection, people are by themselves or with another person, making them more susceptible to attacks.

Compensations for crop damage and human injury by wild animals are provided by the regional forest department of Maharashtra. During the study, we found 4 types of compensation schemes being provided by the department for victims of sloth bear attacks. For minor injuries, the total cost of medical treatment authorized by the government hospital was up to ₹20,000 Indian Rupees (INR; \$290.94 USD). For serious injuries it was ₹1,25,000 INR (\$1,818.36 USD). For permanent disability, it was ₹5,00,000 INR (\$5,839.60 USD), and in the case of death it was ₹10,00,000 INR (\$11,679.20 USD) to the family of the victim. The compensation provided by the Maharashtra Forest Department under different schemes was found to be among the highest in India (Maharashtra Forest Department 2018). Immediate financial support from the forest department for treatment in the hospital is provided on the same day in the amount of ₹5,000–10,000 INR, or \$73–146 USD). Complete compensation was found to be provided within 4–8 months.

Our results further suggested that most sloth bear attacks were sudden encounters and likely a defensive response by bears. Thus, such incidences could be avoided using sound making devices that alert the bears to human presence. One such device was designed by



Figure 9. The *Ghanti Kathi*, a semi-circular surface having nails with blunt points and bells, and attached with a wooden stick 2–3 m long. The device, developed by our research team, produces sounds while walking and can also be used as a nonlethal defensive weapon against sloth bear (*Melursus ursinus*) attacks.

our team called *Ghanti Kathi*, a semi-circular surface having nails with blunt points and bells and attached with a wooden stick 2–3 m long (Figure 9). The device produces sounds while walking and can also be used as a nonlethal defensive weapon against bears. Thick bushes and shrubs growing along field edges or roads should be removed to increase visibility, especially during and after monsoon. Fruiting trees should be removed from agricultural fields and when applicable should be replaced with non-fruiting species.

Large-scale dependency of villagers on forests and its products could be reduced by providing villagers an adequate source of income. Government schemes such as *Swachh Bharat Abhiyan*, which provides toilet facilities for every household, and *Pradhan Mantri*

Ujjwala Yojana, which provides liquefied petroleum gas to people in rural areas, has been well implemented in most villages in the study area. However, because some people still prefer to defecate openly and collect fuel wood in the forests, it is not only about providing facilities to people but encouraging their utilization through educational programs.

Management implications

In India, it will be necessary to have mitigation measures in place to minimize human–bear conflicts. Because increasing conflicts decreases the tolerance the local people have for sloth bears, we recommend educational programs for villagers residing in close proximity to forests inhabited by bears. These education programs should focus on bear behavior and ecology with an emphasis on avoiding conflicts, and should be targeted to school children and the young villagers. Use of forests should be avoided in monsoon season, as visibility is reduced. We suggest that the Maharashtra Forest Department form Rapid Response Units, with a dedicated forest staff, rescue vehicle, and equipment. The staff should be trained in how to monitor sloth bear populations and in human–bear conflict mitigation. With the help of the forest department, we have made plans to form a primary response team in individual villages. They will be provided with the information needed, as well as training to take immediate action during conflict situations.

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