Status and Distribution of Malayan Sun Bear (*Helarctos malayanus*) in Dampa Tiger Reserve, Mizoram, India

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**Abstract**

Malayan sun bear is the smallest among all bears and the only tropical bear species inhabiting the lowland tropical forest of Southeast Asia. Once abundant, they are now considered as priority species due to excessive poaching and hunting across their home range. Although reported from several parts of Northeast India, the paucity of biological information on the species and its distribution has been a major constrained for conservation efforts. The study in Dampa Tiger Reserve, Mizoram, India determines the ecology, distribution and habitat selection of Sun bear, using foraging signs and invasive camera trapping techniques. A total of 43 transects were walked with 310 sampling plot. Evidence in forms of claw marks was found to be highest (60.23%) followed by scats (25.81%), nests (3.56%), cavity (6.23%) and footprints (4.15%). The mean occurrence of bear signs was 17.2±0.8. Bamboo forest and Tropical semi-evergreen forest with elevation between 501-1000 msl were found to be the most preferred habitat for sun bear. Majority of sun bear signs (74.1%) were observed in undisturbed forest regardless of sites ($r^2$= 0.8291, df= 3, p< 0.2713). With a camera trapping effort of 647 trap-nights, 18 independent images of sun bear were obtained. The photo-capture and block wise distribution index was estimated to be 5.26 with a trapping index of 1.89. Deserted areas within the tiger reserve serve as excellent sources of frugivory and fruiting phenology. From the study, it was determined that the population of sun bear in the region is relatively low and restricted to a few patches within the reserve. Habitats of sun bear are also under serious threats due to agricultural expansion and ever-increasing dependency of local communities on forest resources, hence immediate measures are needed for the conservation of sun bear in the region.

**Keywords:** Camera trapping, deserted areas, foraging signs, non-invasive technique, sun bear.

**Introduction**

Bears are one of the most fascinating mammalian species associated with numerous social and cultural aspects in the South-Asian countries for centuries. They are symbolically and physically integrated with the tribal communities in several traditional aspects (Servheen et al. 1999). The Malayan sun bear (*Helarctos malayanus*) is the smallest among all bears and the only tropical bear species inhabiting the lowland tropical forest of Southeast Asia (Servheen 1999). They are among the few species that were characterized as Data Deficient (DD) till 2008 by the IUCN Red list of Threatened species, but with improvement in researches on ecology and conservation, it is now considered as a ‘Vulnerable’ species (Scotson et al. 2017). In India, they are reported from the north-eastern states of Manipur, Mizoram, Nagaland, Arunachal Pradesh and Assam (Chauhan and Singh 2006, Sethy and Chauhan 2011, Choudhury 2011, Borah et al. 2012). As in most parts of Southeast Asia, the population of sun bear in India also faces threats from poaching for their meat or trade in their body parts (gall bladder and claws) (Sethy and Chauhan 2012).
Fragmentation of forest due to shifting cultivation, oil palm plantation and other activities have also triggered encroachment of bears to human settlement areas resulting in human-bear conflicts that often leads to injuries to bears or the humans (Chauhan and Singh 2006, Choudhury 2011). The availability of easy food sources in shifting crop fields along the protected areas attracts bears and other animals, causing crop predation and even retaliation killing from farmers (Pop et al. 2012, Nazeri et al. 2012). While evidence on the presence of sun bear are available form parts of northeast India (Chauhan and Singh 2006, Choudhury 2011, Borah et al. 2012), proper demarcation and information of its distribution, with photographic evidence for their confirmation is lacking, that serves as a major constraints for its conservation and management efforts (Sethy and Chauhan 2012).

Conservation priorities and strategies in any region are based on assessments of population size and distribution trend (Servheen et al. 1999, Wong et al. 2004). Camera trapping is recognized as a key method for monitoring invasive, nocturnal and cryptic species where climate and landscape act as large-scale ecological stressors (Schmeller 2015, Steenweg et al. 2017, Rich et al. 2019). However, reliable abundance estimation through capture-recapture is difficult to achieve at larger spatial scales and is confined to species that are naturally marked and have a large population size (Mackenzie et al. 2002, Palai et al. 2015). As the density of sun bear is perceived to be relatively low in all their home ranges, it makes mark-recapture technique as an intricate process for their estimation (Garshel et al. 1999). Hence, photo-capture rates or trapping effort serve as the ideal approach for the valuation of distribution and abundance of mammals including bears in a tropical forest of India (Carbone et al. 2001, Trolle and Kery 2005, Palei et al. 2015). There is also increasing evidence of the linear relationship between Relative abundancy Index (RAI) and abundance estimated through more rigorous methodologies (Rovero and Marshall 2008). Assessing population density on the incidence of sign (scats, tracks, marked trees) has been successfully used for estimation of the small population (<20) in any given area (Garshel et al. 1999, Karanth et al. 2006). It may be possible to account for all individuals through a comprehensive record of track measurements and direct observation with an assist from invasive tools like camera trapping (Karanth and Nichols 1998, Rowcliffe and Carbone 2008, Ngoprasert et al. 2012, Wong et al. 2012).

Considering the caveats above, the study aims to determine the status and assess the spatial-temporal distribution of Malayan sun bear (Helarctos malayanus) from secondary evidence backed with camera trapping. Such methods are best suited for the tropical forest of Mizoram, where the presence had been reported but evidence for its confirmation is still deficient (Choudhury 2011).

**Materials and Methods**

**Study area**

Dampa Tiger Reserve (DTR) was selected for the study as some of the earlier publications had cited the presence of sun bear in the region. The area also holds important geographical characteristics as it shares the border with Bangladesh where the occurrence of sun bear was reported by Islam et al. (2013) and Scotson (2017) already. The reserve lies within the biodiversity hotspot and stretches over an area of 550 km² within latitude 23° 23' to 23° 42' N and 92° 16' to 92° 25' E (Fig. 1). The reserve is home to a rich floral (Sahoo et al. 2010) and faunal diversity including Clouded leopard (Neofelis nebulosa), Golden cat (Catopuma temminckii) and Great hornbill (Buceros bicornis) (Gouda et al. 2016, Singh and Macdonald 2017) and contains a profusion of habitats characterized by diverse biota. The natural vegetation in the reserve is tropical evergreen to semi-evergreen. The forest in the moist valleys is lofty and evergreen, while the steeper slopes on the west aspect have more deciduous elements, often with sympodial

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bamboos in the understory (Lalrinchhana and Solanki 2015). The diverse vegetation can be attributed to the villages that were once within the reserve forest but later relocated to the buffer region.

Figure 1. Map of the study area showing the international boundary and villages in vicinity of the reserve.
Sampling design and data collection

Different sets of approach were adapted for collection of samples and evidence on the presence of Malayan sun bear in the region, which comprises of the questionnaire survey, transect survey, bear’s sign survey and camera trapping.

Questionnaire survey

Inputs from locals are considered as an asset for obtaining valuable information in any region. Semi-structured questionnaire surveys were conducted to gather information on the past and present status, distribution, the extent of human-bear interactions and threats to bears population, etc. Male members of the families were preferred for the survey as they spend more time in the agriculture crop fields and surrounding areas compared to the female members. Women were also helpful in providing additional information related to crop depredation and bear-human interaction.

Line transect

Forty-three transects of varying length (3-5 km) were laid in a stratified manner covering different habitats of DTR (Fig. 2). Each transect was traversed and covered at least 2-3 times in every season (summer, rainy and winter) with 15-20 days interval. During the transect walks, bear signs (claw marks, footprints, feeding signs, feces and crop-raiding signs) were searched. Bear’s nest, broken bee’s nest, digging sites, seat, tracks, and trails were also extensively looked for. Claw marks of bears while climbing on trees were recorded as one sign. In the situation where claw marks of different age categories were observed on one tree, the most recent sign was recorded following Steinmetz and Garshelis (2008), Steinmetz (2009) and Islam et al. (2013). Claw mark measurements were recorded and photographs were taken for species identification. GPS coordinates of the tree with claw marks were also noted. Based on the sightings of sun bear and their signs, distribution map was prepared for sun bear in DTR.

Camera trapping

Based on preliminary survey and sign survey, areas with evidence of the presence of Malayan sun bear were identified and selected for deployment of camera traps. A grid size of 8 km² was selected to match the scale of other camera-trapping surveys in South-east Asia (O’Brien et al. 2003, Kawanishi and Sunquist 2004, Grassman 2005, Jackson et al. 2006). Of the 40 grids covering the study area, 20 grids were randomly selected for camera trapping. Sun bear was photo-captured using 10 passive camera trap units between May 2015 and March 2016. All camera traps were operational for 24 hours per day, time and date for each exposure were preset, and had a 15-sec delay between photographs. Camera traps were placed on trees at ~50 cm from the ground and 1-2 m from the monitoring area. Sensors were aimed at ground to monitor a conical area approximately 1 m in diameter at 10 m distance. Independence of photo capture was determined following O’Brien et al. (2003) and Jenks et al. (2011) suggesting that two photo-capture images can be considered as independent if photo-captured
after a minimum time gap of 30 minutes. The photo capture was determined using the method suggested by Rovero and Marshall (2008).

**Block wise density**

While estimating the density it may be noted that different animal shares their minimum limit for their habitat and it solely varies with the species. Further, the number of captures was far too less to perform other calculations to assess the populations with more conviction. However, if it is considered that bears that were captured by independent camera traps at least once are separate individuals, then a crude density of sun bears in different forest blocks may be calculated as block wise density (BWD) from the following equation:

\[
BWD = \frac{\text{Photos captured at least once by a camera in a block}}{\text{Area of the block in which the camera was set up}}
\]

**Results**

A total of 469 respondents from 7 villages were interviewed during the questionnaire surveys. In the survey, 70.0% of respondents (n=338) confirmed the presence of sun bear in the reserve while 26.8% (n=117) respondents accepted the possibilities of sun bear and 3.2% denied its occurrence (Table 1). High percentage of sighting was reported in the semi-ever green forests and forest edges due to the richness of the fruit trees and availability of anthropogenic food sources in agricultural crop fields in the vicinity of DTR (Sati and Rinawma 2014). During the survey, the respondent had sighted single bears 32 times, bears in a pair was sighted three times and mother with cubs for five times in and around the reserve.

Based on the reconnaissance survey and local knowledge on the distribution of bears in the reserve, 43 linear transects were set randomly encompassing in seven different habitat types including dry mixed forest, tropical semi-evergreen forest, tropical wet-evergreen forest, tropical moist deciduous, wet temperate forest, dry temperate forest, and bamboo forest (Raman 1998, Raman 2001). Along each transect of 3-5 km length, sampling circular plots of 10 m radius with 200 m interval were laid for evidence and determining forest types. Bear signs were recorded from 236 of the 310 plot sites. In forms of evidence, claw marks were highest in number (60.23%) of different age categories. Other signs recorded from the study sites include scats (25.81%), nests (3.56%), cavity (6.23%) and footprints (4.15%) (fig. 3).

Claw marks were found on trees with 12-86 cm in diameter at breast height (DBH). The mean DBH was calculated to be 26 m.

**Table 1.** Respondents view on distribution of Malayan Sun bear in vicinity areas of DTR. NIP, CA, PA and DA stand for Number of people interviewed, confirmed occurrence, probable occurrence, denied occurrence respectively.

<table>
<thead>
<tr>
<th>Villages</th>
<th>NIP</th>
<th>CA</th>
<th>PA</th>
<th>DA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teirei</td>
<td>51</td>
<td>32</td>
<td>19</td>
<td>0</td>
</tr>
<tr>
<td>Damparengpui</td>
<td>170</td>
<td>148</td>
<td>19</td>
<td>3</td>
</tr>
<tr>
<td>Serhmun</td>
<td>59</td>
<td>45</td>
<td>12</td>
<td>2</td>
</tr>
<tr>
<td>Tuipu bari</td>
<td>96</td>
<td>75</td>
<td>18</td>
<td>3</td>
</tr>
<tr>
<td>Phuldungsei</td>
<td>21</td>
<td>18</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Saithah</td>
<td>27</td>
<td>17</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>Khawhnai</td>
<td>45</td>
<td>3</td>
<td>38</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>469</td>
<td>338</td>
<td>117</td>
<td>14</td>
</tr>
</tbody>
</table>

The transect study revealed that the number of bear signs per unit area varied with the forest types in the reserve. The mean occurrence of bear signs was 17.2 ± 0.8. The density of signs was highest in the bamboo forest (39.51%), followed by tropical semi-evergreen forest (17.74%), semi-evergreen forest (12.5%), tropical wet-evergreen forest (12.5%), mix forest and temperate forest (12.0%). Density of bear signs per hectare was found to be highest in the bamboo forest (113.5/h) followed by tropical semi-evergreen forest (112.1/h), tropical wet-evergreen forest (109.6/h), semi-evergreen forest (98.7/h), mix forest (93.4/h) and temperate forest, (84.9/h) (Table 2).
The occurrence of bears signs also varied along transects of different altitude gradients. Elevations were categorized as lowland ranged (0 to 500 msl), Mid-elevation (501-1500 msl) and temperate (1500- above). Percentage of bear signs was highest at an elevation of 501-1000 msl (53.1%) followed by 0-500 msl (26.0%) and 1001-1500 msl (13.2%).

The percentage of bear signs was lowest at an elevation of 1500 and above (7.8%). There was a distinct relationship between the season, elevation and density of bear signs per unit area ($r^2 = 0.81488$). The density of bear signs showed an increasing trend with the increase in elevation in Dampa TR. The high density of signs can be attributed to the presence of a large number of the fruiting trees like *Actocarpus heterophyllus*, *Trema orientalis*, *Syzygium cumini* where the highest numbers of claw marks were also observed. Similar results were recorded by Wong *et al.* (2012) and Islam *et al.* (2013), in which bears were found to mostly feed on papaya (*Carica papaya*), jackfruit (*Actocarpus heterophyllus*), eucalyptes (*Eucalyptus grandis*, *E. robusta*) and banana (*Musa paradisa*) in the low lying forest patches. The habitat selection by the sun bear in the reserve can be backed by works of Fredriksson *et al.* (2006), in which plants from families of Moraceae, Burseraceae, and Myrtaceae contributed more than 50% of the diet of sun bear. Preference of the bamboo forest and degraded habitat types by the bear species may be due to the higher abundance of insects such as termites (Isoptera), beetles (Coleoptera), and beetle larvae (Coleoptera) causing bears to use these areas more intensively (Fredriksson *et al.* 2006, Wong *et al.* 2002, Joshi *et al.* 1997, Wong 2002). The distribution map of Malayan sun bear in Dampa TR is presented in figure 4.

Table 2. Secondary shreds of evidence collected on Sun bear from different habitat in DTR

<table>
<thead>
<tr>
<th>Habitat category</th>
<th>No. of plots (n=310)</th>
<th>No. of bear signs (%) in sample plots (n=248)</th>
<th>No. of plots with bear signs (n=236)</th>
<th>Density of signs (signs/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mix forest</td>
<td>30</td>
<td>8.87</td>
<td>20</td>
<td>93.4</td>
</tr>
<tr>
<td>Tropical wet-evergreen forest</td>
<td>50</td>
<td>12.5</td>
<td>39</td>
<td>109.6</td>
</tr>
<tr>
<td>Tropical semi-evergreen forest</td>
<td>50</td>
<td>17.74</td>
<td>41</td>
<td>112.1</td>
</tr>
<tr>
<td>Semi-evergreen forest</td>
<td>40</td>
<td>12.5</td>
<td>27</td>
<td>98.7</td>
</tr>
<tr>
<td>Temperate forest</td>
<td>30</td>
<td>8.87</td>
<td>15</td>
<td>84.9</td>
</tr>
<tr>
<td>Bamboo forest</td>
<td>110</td>
<td>39.51</td>
<td>94</td>
<td>113.5</td>
</tr>
</tbody>
</table>

Figure 3. Number of bear signs recorded during the transect survey in different forest habitat

The distribution map of Malayan sun bear in Dampa TR is presented in figure 4.
Figure 4. Distribution map of Malayan Sun bear in Dampa Tiger reserve based on primary and indirect evidences

Sun bear was found to use both disturbed and undisturbed habitats to a varying extent. The majority of bear signs (74.1%) were observed in undisturbed forest regardless of sites ($r^2 = 0.8291$, df= 3, $p< 0.2713$). In areas with higher intensities and extents of disturbance, fewer bear
signs (25.9%) were observed. Matthews et al. (2006) and Mattson (1990) in their studies had highlighted the use of buffer area more often by adult females and sub adults primarily because of their ability to virtually consume all human foods that have been established in former wildlands and also to avoid a clash with male bears. Pop et al. (2012) in their study found that GPS-collared brown bears preferred to remain longer inside the buffer zone than subadults who are more present outside the buffer area.

**Camera trapping**

Random sites in grids with positive signs of bear activity were selected for the deployment of camera traps in the study area. However, in grids with no sign, trap sites were selected according to the best-assumed capture success, e.g. at termite colonies or fruiting areas, along trails. From a combined trapping effort of 647 trap-nights with a total of 361 independent photos of 25 mammalian species were obtained from the camera trapping process. Sun bear was recorded in 47 trap-nights during the systematic survey period. The photo-capture rate or the least number of days requires to get an individual photo of sun bear was found to be least in the deserted villages of Dampa TR (12-14 trap nights) (Table 3 and Fig. 5). The photo-capture and block wise distribution index shows that Old Chikha (Deserted village) has the highest index of 1.89, followed by Chikha road (1.23) with an overall mean value of 5.26 in all the block of DTR (Table 3 and Fig. 5). Fruiting phenology with trees such as Jackfruit (*Artocarpus heterophyllus*), Charcol tree (*Trema Orientalis*), Chaplash (*Artocarpus chama*), Hairy Fig (*Ficus hispida*), Beal (*Aegle marmelos*), Banyan (*Ficus benghalensis*) that sun bears feeds were abundant in the deserted villages, thereby serving as an excellent source of frugivory within the reserve. These areas also have large wooden logs that hold termites, beetles, and other insects. Stingless bees and honey comb are also abundant in deserted areas that act as attractant for sun bears.

<table>
<thead>
<tr>
<th>Area</th>
<th>Total photos</th>
<th>Independent photos</th>
<th>RAI1</th>
<th>RAI2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Old Chikha</td>
<td>17</td>
<td>7</td>
<td>15</td>
<td>1.89</td>
</tr>
<tr>
<td>Malpui</td>
<td>5</td>
<td>2</td>
<td>21</td>
<td>0.23</td>
</tr>
<tr>
<td>Tuichar</td>
<td>2</td>
<td>2</td>
<td>37</td>
<td>0.05</td>
</tr>
<tr>
<td>Chikha road</td>
<td>11</td>
<td>3</td>
<td>12</td>
<td>1.23</td>
</tr>
<tr>
<td>Pathloi</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>IR camp</td>
<td>1</td>
<td>1</td>
<td>31</td>
<td>0.12</td>
</tr>
<tr>
<td>Tuilut</td>
<td>4</td>
<td>1</td>
<td>21</td>
<td>0.45</td>
</tr>
<tr>
<td>New chikha</td>
<td>7</td>
<td>2</td>
<td>14</td>
<td>0.78</td>
</tr>
<tr>
<td>Total/Mean</td>
<td>47</td>
<td>18</td>
<td>21.54</td>
<td>5.26</td>
</tr>
</tbody>
</table>

**Figure 5.** Photo-capture of Malayan sun bear in different forest zones of DTR

**Discussion**

Sun bear giving more preferences to honey and other sweet fruits over insects and termites were also reported in several studies (Wong et al. 2002, Kelvin et al. 2006, Datta et al. 2008, Steinmetz et al. 2013). The photo capture rate and block wise distribution of sun bear in DRT was found to vary with the forest habitat types. Habitat with mixed vegetation has a higher chance of photo-capturing bear compared to wet or moist habitat. The variation was noted to be influenced by the disturbance of humans in the area along with the availability of feeding trees or plants for bear species as evidenced by
findings of Nazeri et al. (2012). The block wise distribution suggests that the density of sun bear in the reserve is very low and has been confined to a relatively small area in the reserve (fig. 5). The fact that inhabitants of different villages surrounding DTR are solely dependent on the reserve and indigenous people regularly enter the forest for hunting furthers puts sun bear and their habitat in grave danger. Management and conservation of sun bear in the reserve requires urgent addressing and immediate steps from the concern authorities and stakeholders.

**Conclusion**

Dampa Tiger Reserve (DTR) has a rich faunal diversity and harbors several number of endangered and threatened species. However, due to the continuous degradation of forest resources, expansion of agriculture land, illegal hunting and increase in human population in surrounding villages, a sharp and continuous decline in animal species has been recorded. The introduction of camera-trap surveys has greatly increased the amount of information on secretive and cryptic species in tropical rainforest habitats. Well-designed monitoring programs along with regular patrolling from forest guards and local information can help to estimate precise information on the abundance of sun bears and their distribution in the reserve. Apart from the protection of habitat, awareness about sustainable agricultural practice, sustainable usage of forest resources and evading human-bear conflict will be key for the safeguard of the species and their habitat.

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