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STUDY ON THE IMPACTS OF LULC CHANGE ON THE WILDLIFE HABITAT AND THE LIVELIHOOD OF PEOPLE IN AND AROUND DAMPA TIGER RESERVE, MIZORAM, INDIA

Sushanto Gouda, Janmejey Sethy, Netrapal Singh Chauhan & Harendra Singh Bargali

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Study on the impacts of LULC change on the wildlife habitat and the livelihood of people in and around Dampa Tiger Reserve, Mizoram, India

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Abstract: Anthropogenic activities are a matter of serious concern in the Indian Himalayan region due to adverse impacts on wildlife and habitats. This study examines resource use patterns by local people in relation to the habitat of Malayan Sun Bear in and around Dampa Tiger Reserve in Mizoram. Standard questionnaire surveys and vegetation sampling methods were used for data collection and analysis. It was found that 221.3 km² (33.3%) of the forested areas have high human interference in the form of logging, indiscriminate tree falling and fuel wood collection, while 26% was moderately affected and 18% of the reserve had no impact. Among vegetation resources, fuel wood was used in the highest quantity (28%) followed by bamboo and edible plants (21%) and (11%), respectively. Ethno-zoological usage comprises of parts of animals like snake, bear, monitor lizard, and porcupine. Sun bears were considered pests that feed on maize, cucumber, sweet potato and pumpkins grown in 'jhum' crop fields. Anthropogenic pressures from farm-bush hunting, monoculture, and unplanned roads have contributed to severe biodiversity loss, and must be constrained for the conservation of sun bear and their habitat in the region. The Land Use/ Land Cover on human built-up, jhum land (current and abandoned jhum/shifting cultivation), forests (dense and open), bamboo forest, plantation etc. were used to develop maps for each village. The land use pattern for the eight villages studied. Information obtained from MIRSAC and its mapping in Arcview shows that highest number of agricultural land was in villages of West Phaileng (319sq.ha) and Damparengpui (283.8sq.ha). Closed or dense forest was in highest proportion in Phuldungsei and least in Tuipuibari (120sq.ha). Grazing activities was relatively low or absent in most part of DTR. Abandoned jhum fields were in largest number in Damparengpui (939.60sq.ha) followed by Silsuri (881.17sq.ha) and Serhmun (880.99sq.ha).

Keyword: Bear-Human interactions, conservation, foraging, habitat fragmentation, human interference, Malayan Sun Bear, monoculture.

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Author contributions: JS and SG have designed and wrote the manuscript. JS and S Gouda have analysed, interpreted and edited the manuscript. NPSC and HSB have compiled and edited the research article. All the authors have read and approved the manuscript.

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INTRODUCTION

Forest and wildlife are integral components of a dynamic ecosystem. The recent exponential growth in human populations and encroachment towards protected areas (PAs) have led wildlife populations and their habitats to declined so drastically this has been referred to as an “ongoing sixth mass extinction” by Barrueto et al. (2014) and Ceballos et al. (2017). The depletion of wildlife species has been intimately linked to the food demands and livelihood dependency of forest-dwellers in tropical rainforest regions of the world (Nasi et al. 2008), who rely on forests for timber, firewood, and other non-timber forest products (NTFPs) such as fodder, medicine, food, and raw materials for making handicrafts and construction of houses (Sahoo et al. 2010). As human populations continue to expand, so does pressure on protected lands (Jones et al. 2018; Broekhuis et al. 2019).

Human-induced chronic changes or anthropogenic pressures in the form of forest fires, habitat fragmentation or destruction, and changes in land use patterns, are common around PA's in India. In the Himalayan region, deforestation and forest degradation are major concerns for floral and faunal diversity (Dhyani et al. 2013; Mohanta & Chauhan 2014). Changes in land use patterns and increases in agricultural areas have greatly affected the habitat, food selection pattern and conservation of sun bear in the northeastern states of India, including Arunachal Pradesh, Manipur, Nagaland, and Mizoram (Chauhan & Lalthunpuia 2008; Sethy & Chauhan 2013). Anthropogenic activities often harm wild animals directly through agriculture, human settlement, transportation, and indirectly by disturbing the ecological balance, cross-species transmission of pathogens, pollution, and climate change (MacRae 2011; Becker et al. 2015). Many of these activities have received little attention, resulting in an alteration of habitat use, foraging behavior of animals and severe human-wildlife negative interactions (Sih et al. 2011; Becker et al. 2018). Bears being large omnivores have a continuous interspecies competition with humans for space and food in several niches of an ecosystem (Ladle et al. 2018; Sethy & Chauhan 2018). At the population level, bears appear to be less selective in their habitat choice; however, during sedentary and stop-over phase, they move across forest slope and distance close to the road inciting conflict with humans across their home ranges (Cozzi et al. 2016). Easy bioavailability of anthropogenic food resources in agricultural crop fields is reported to attract bears more towards human

settlements than their natural foraging grounds (Bargali et al. 2012; Can et al. 2014). Through this study, we wanted to better understand changes in land use and land cover patterns in the context of conserving of Malayan Sun Bear habitats in and around Dampa Tiger Reserve, Mizoram. We also aimed to collect information on bear-human interaction and the dependency of locals on forest resources.

Land use and land cover changes (LULC) represent a serious threat to ecosystem sustainability as naturally vegetated forms give way to manmade vegetation (Lambin & Geist 2007). Such conversion is known reduce the availability of energy, water and nutrients supplies to ecosystems. On the other hand, it also facilitates the invasion of natural system by exotic species (Kamusoko 2007).

MATERIALS AND METHODS

Study area

Dampa Tiger Reserve (DTR) is situated in the Mamit district of Mizoram, India. DTR has an area of about 500 km² and a buffer region of over 448 km² with 15 fringe villages and population of over 22,500 tribal from the Mizo, Reang (Bru) and Chakma communities (Image 1). The reserve is home to several endemic and rare species like Red Serow *Capricornis rubidus*, Clouded Leopard *Neofelis nebulosa*, Golden Cat *Catopuma temminckii*, and Great Hornbill *Buceros bicornis* (Gouda et al. 2016; Sethy et al. 2017; Singh & Macdonald 2017). DTR is one the last remaining habitats for Malayan Sun Bear *Helarctos malayanus* in Mizoram and also among the few in the northeastern states of India (Sethy & Chauhan 2013; Gouda et al. 2020). The region is under extreme threat due to the rapid increase in the human settlement, practice of shifting cultivation and other monoculture activities (Chauhan & Lalthunpuia 2008; Raman 2011). Livelihood of locals is mostly depended on the agriculture system of slash & burn and other forest products.

Questionnaire Survey

Data on anthropogenic activities was acquired through a set of questionnaires adapted for similar work by Aiyadurai et al. (2010). The survey was conducted from April 2015 to March 2016. Villages and households were selected based on information from key informants (village headmen, teachers, forest officials). Male members of the family were prefer over females for the survey as they spent more time in crop

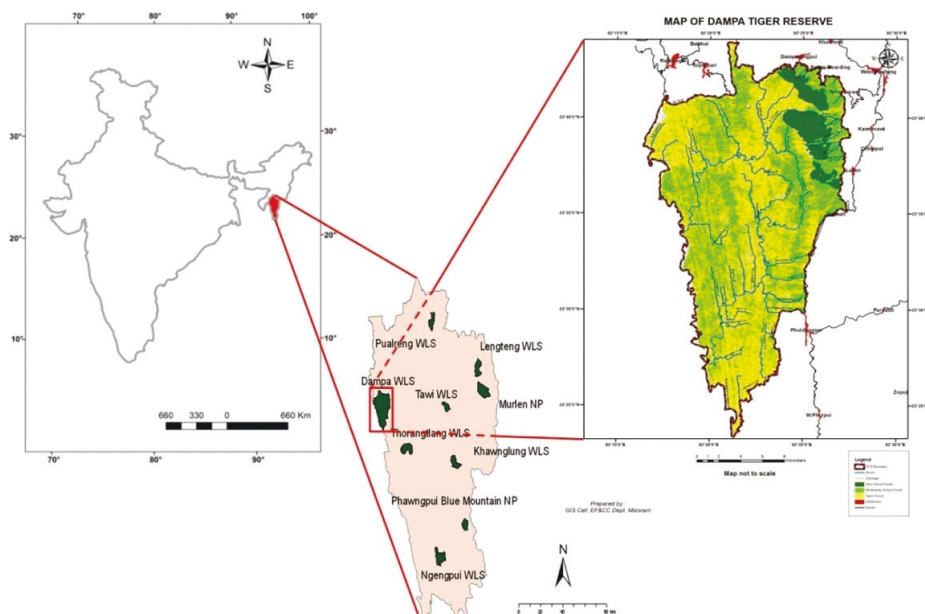


Image 1. Dampa Tiger Reserve, Mizoram, India.

fields and surrounding forested areas than females. In the survey, female respondents provided additional information on consumption of food items by bears and other incidences of crop-raiding. The survey was carried out in the presence of a field assistant from the local community having thorough knowledge of local dialects. Questions were generally asked at respondent's home mainly at dusk time as most villagers return from their fields during these hours. Each interview lasted for about 20–30 minutes, depending on how the respondent interacts with us in the survey. Questions related to encounters with sun bear, land-use pattern, livelihood options, collection of forest products, hunting, use of animals or their parts as sources of ethno-medicine were enquired. The questions were both open- and close-ended (Appendix I) (Aiyadurai et al. 2010).

Transect survey and Data analysis

Evidence on the presence of Malayan Sun Bear such as digging signs, scats and claw marks, remains of fruit/food materials was documented through transect surveys using Steinmetz & Garshelis (2007). The surveys consist of 3–4 persons walking through a pre-determined transect path of 2–2.5 km. Vegetation sampling was carried along the transect using the layout represented in Appendix II. Plant species were identified using their local name based on Sawmiliana (2003).

Presence of humans including settlements, forest cover, and agricultural land in eight villages around DTR were acquired through the Indian Remote Sensing satellite data (LISS-III and Cartosat-I) and digitized using

QGIS software for preparation of land use land cover (LULC) maps.

RESULTS

The extent of biotic pressures

In the study 760 households were surveyed, of which 60% of respondents practiced slash & burn (jhum) cultivation on more than a hectare of agricultural land, while 33% had less than a hectare and 5.9% of surveyed individuals had no agricultural land and were involved in other activities like small scale business, forest guard, and daily wage labors. Of the 500 km² of DTR, about 221.3 km² (33.3%) were found to have high human interference and were less occupied by sun bears. An area of 111.1 km² (26%) was regarded as moderately affected, while 96.9 km² (22.5%) was affected to a lower extent. Only 70.7 km² (18%) of the core region was without any form of biotic pressures with intact vegetation (Table 1).

The land use pattern for all the villages is represented in Image 2. Information obtained from MIRSAC and its mapping shows that highest number of agricultural land is in villages of West Phaileng (319 ha²) and Damparengpui (283.8 ha²). Closed or dense forest was in highest proportion in Phuldungsei and least in Tuipuibari (120 ha²) (Table 2). Grazing activities was relatively low or absent in most part of DTR (Figure 1). Abandoned jhum fields were in largest number in Damparengpui (939.60 ha²) followed by Silsuri (881.17 ha²) and Serhmun (880.99 ha²) (Figure 1).

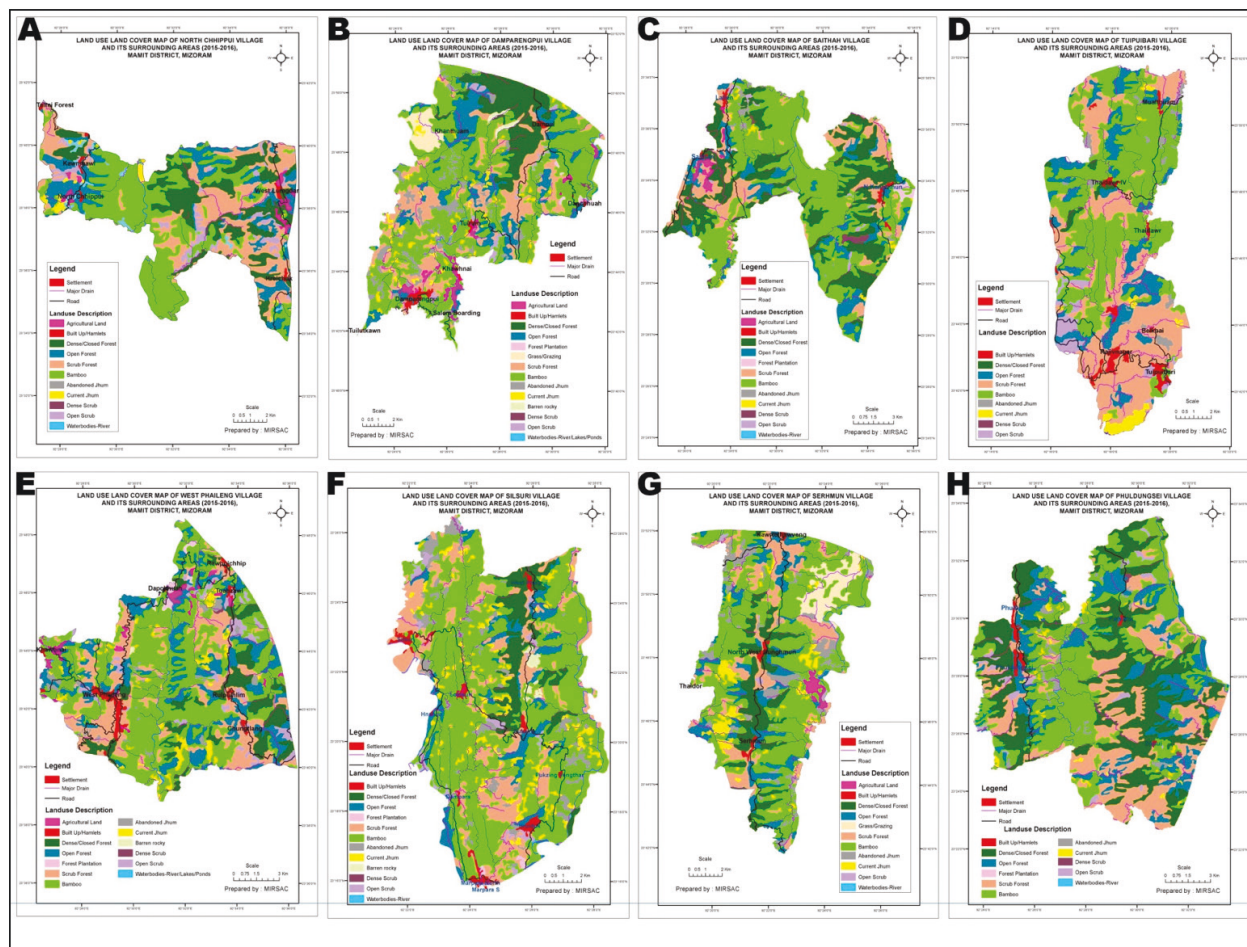


Image 2. Villages around Dampa Tiger Reserve and their LULC pattern: a—N. Chippui | b—Damparengui | c—Saithah | d—Tuipubari | e—W. Phaileng | f—Silsuri | g—Serhmun | h—Phuldungsei.

Usage of forest resources

In the study area, it appeared that the locals rely heavily on forest resources for their livelihood. Forest products in the form of NTFPs, food materials, and medicines were collected from the buffer region and the surrounding forest patches or community forest. Locals in the region collect 21% of their bamboo, 2.8% of timber, 28% of fuel wood, and 11% of food and medicines from the forest. About 37% of respondents were recorded collecting all the above from the buffer region. Various plant species were used as food items, including young leaves of *Acacia* sp., *Eurya japonica*, & *Garcinia lancifolia*, tubers of *Amomum dealbatum* and shoots of *Adiantum caudatum*, *Diplazium esculentum*, *Dysoxylum procerum*, & *Melocana bambosoides*. Tree species like *Anogeissus acuminata*, *Vitex pendularis*, *Schima wallichii*, *Syzygium cumini*, and *Albizia* sp. were used for their timber quality. Fuel wood mostly comprises of bamboo sp., *Derris robusta*, *Castanopsis*

Table 1. Extent of biotic pressure and affected areas in Dampa Tiger Reserve.

Value designated	Extent of biotic pressure	Affected area in each category (km ²)	% Area affected
0	Nil	70.7	18.1
1	Low	96.9	22.5
2	Medium	111.1	26.1
3	High	221.3	33.3

tribuloides, *Anogeissus acuminata*, *Vitex pendularis*, *Schima wallichii*, and *Albizia chinensis*. Areas of fuel wood collection ranged 1–5 km away from the village boundary. During winter 25–30 kg (54.24%) of fuel wood was required per household every day; whereas in summer it was only 10–15 kg per day. The fuel wood requirement was very low (18.22%) in monsoon than winter and the summer. These variations in fuel wood

Table 2. Geographical variables in surrounding villages of Dampa Tiger Reserve.

Village	Geographical variables (Area in ha ²)								
	Agricultural land	Dense/Closed forest	Open forest	Grazing land	Scrub forest	Abandoned jhum	Current jhum	Barren rocky	Open shrub
Damparengpui	283.80	1536.01	1794.04	356.53	2386.64	939.60	450.93	82.52	206.23
Chhippui	147.82	1808.35	1490.60	0.0	2459.64	166.16	139.98	0.0	438.59
Serhmun	129.68	1204.44	1387.01	621.41	1625.27	880.99	562.23	0.0	52.04
Tuipuibari	0.0	120.03	1639.44	0.0	3877.62	272.73	256.73	0.0	389.40
West Phaileng	319.02	1544.43	2850.23	0.0	3122.85	367.14	540.22	12.62	580.24
Phuldungsei	0.0	5743.53	3451.12	0.0	4355.98	365.33	240.61	0.0	346.59
Saithah	186.87	4458.07	1709.37	0.0	2203.62	161.98	112.83	0.0	163.43
Silsuri	0.0	1095.04	1067.13	0.0	2539.53	881.17	815.90	103.89	292.51

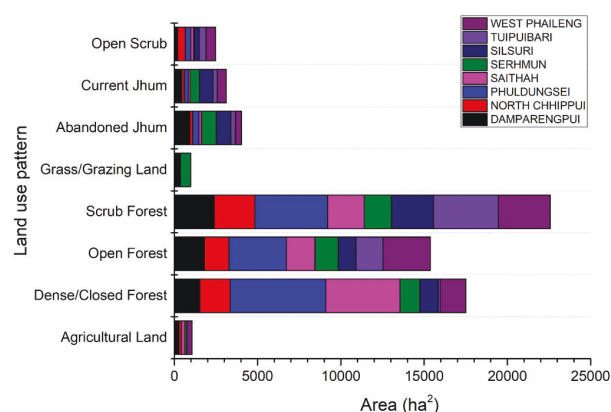


Figure 1. Land use pattern in surrounding areas of Dampa Tiger Reserve.

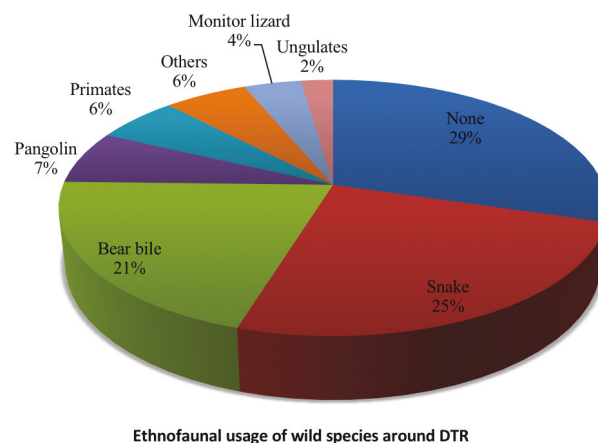


Figure 2. Usage of faunal resources by locals from villages around Dampa Tiger Reserve.

requirement can be attributed to the low temperature around DTR during winter and also the fact that Mizoram receives heavy rainfall in the monsoon that leads the local villagers to stock up woods during winters for their use in monsoon season. In two divisions of DTR, Teirei and Phuldungsei forest divisions, the frequency of lopped trees varied considerably with p value of <0.004 , $\chi^2 = 89.16$, $df = 5$.

In the survey it was found that while some animals were hunted for medicinal value, the Malayan Sun Bear was generally considered to be a 'pest' that feeds on maize, cucumber, sweet potato, and pumpkins grown in adjacent areas of the reserve (Sethy & Chauhan 2013). A few cases of bear attacks on humans in jhum crop fields were reported in the region before and during the study period. Bear species were hunted mainly for their bile and as retaliation for crop-raiding and crop depredation. Bile of both Asiatic Black Bear *Ursus tibetanus* and Malayan Sun Bear were found to be used for the treatment of appendix pain and other stomach problems by local

medicine men. Different parts of animals like fats of snakes (*Python molurus*), bear bile, pancreas of monitor lizard (*Varanus Indicus*) and porcupine (*Hystrix cristata*), were often used against different health ailments. The hunting accounts and the ethno-zoological usage of bear and other wild animals are shown in Figure 2.

DISCUSSION

Agricultural crop fields around DTR are adjacent to the reserve areas with no proper demarcation or barriers, allowing animals and humans trespass through easily. Fruits and vegetables like maize, pumpkin, papaya, sweet potato, and cucumber grown in shifting crop fields or jhum fields also act as excellent anthropogenic attractants for sun bears and other wild species (Barrueto et al. 2014; Mohanta & Chauhan 2014; Becker et al. 2018). Such attraction of wild animals



towards human inhabited areas may result in crop-raiding and depredation, or even death of humans or animals during sudden face-offs. High numbers of agriculture crop fields and abandoned jhum fields in West Phaileng and Damparengpui can be attributed to the 22,587 people whose livelihood is dependent on the forest and its resources (Sahoo et al. 2010; Mizoram population census 2011). The LULC data suggest that the forest cover was least in Tuipuibari and West Phaileng as these villages have several commercial outlets and military posts. Among the population in the fringe villages, it was noticed that 37% of locals use all types of forest product such as timber, vegetation, edible food items, followed by bamboo and fuel wood as studied previously by Sahoo et al. (2010).

In the past few decades, the fallow period of shifting cultivation has reduced to 2–3 years from 20–25 years, adding more abandoned land to the region. Areas under shifting cultivation have also declined by 58% between 1997–98 and 2010–2011, replaced by permanent wet paddy fields and farmlands (Raman 2001). The change in land use patterns around the reserve could cause serious alterations in distribution and health dynamics of bears as they move to distant regions in search of food (Nielsen et al. 2013). Monoculture plantations of Oil Palm *Elaeis guineensis*, Teak *Tectona grandis*, Rubber *Hevea brasiliensis*, and Betel *Areca catechu* have also reduced forest cover and caused forest fragmentation (Mohanta & Chauhan 2014). Garden hunting (farm-bush hunting), roads, recreation, and resource extraction are other anthropogenic disturbances that lead to biodiversity loss and negatively effect ecological processes and ecosystem services (Crooks et al. 2017). During interviews many farmers acknowledged that bears come to crop fields to forage, especially for cucumber, pumpkin, and maize; however, the damage caused is negligible compared with that of Wild Boars *Sus scrofa* and Asian Elephants *Elephas maximus*, which indeed develops a negative perspective towards conservation of wildlife. While the Malayan Sun Bear was not the prime factor of crop-raiding around DTR, accidental death of bears in traps and snares placed for Wild Boars were raised during the interview. During the study period, one black bear cub (from Tuipuibari) and one sun bear cub (from Serhmun) were rescued by the forest department, which were later released to the wild. Although, previously some amount in the form of crop damage compensation was received by local farmers, it was reported to be delayed or ignored during the study period. Lack of support from forest officials for adaptation of alternative livelihood options (non-bear food) such as the distribution of

nursery seedling for betel and rubber were some additional points highlighted by locals to mitigate bear-human interactions and other associated human-induced pressure. Development of local markets for the sale of local vegetables, ginger and chilli, were requested by villagers in the interview.

During the study period, it was found that the use of body parts of bear and other wild species had reduced as the younger generation discontinued their use. Although cases of hunting and poaching have followed a drip trend, increase in human settlement, road networks and setting up of permanent farmlands continuous to buffer areas of DTR continue to affect the movement of Malayan Sun Bears. Hence it is important to identify the levels of anthropogenic pressure and maintain the ecological integrity, especially with several wildlife species around.

CONCLUSION

Dampa Tiger Reserve is part of a complex human land-use mosaic that experiences variable forms of biotic and anthropogenic pressure. The reserve is one of the few remaining habitats of Malayan Sun Bears in India, and therefore proper knowledge on changes in ecological variables and extent of anthropogenic activities is necessary to conserve bears and their habitat. Research has shown the importance of environmental heterogeneity on the growth of individuals and populations, and understanding how these spatial and temporal dynamics affect the sun bear populations will be crucial to identify and prioritize management and conservation planning. This study can be used as a reference for similar species, and also for other natural habitats of the Malayan Sun Bear in India and throughout southeastern Asia.

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