Original Research Article

Role of Fragmented Forests in Conservation of Biota: A Study in Balipara Reserve Forest, Sonitpur District, Assam (India)

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Abstract: With the occurrence of rapid industrialization and urbanization at an inevitable rate much alternation is witnessed in forest ecosystems. The formation of fragmented forest patches surrounded by agricultural landscapes and human settlements is a crucial change that have been noticed. Because of this, fragmented landscapes are now becoming one of the most ubiquitous features of all forest ecosystems for the conservation of the species at a local landscape level. In fact, the importance of these fragmented forest stands of varying sizes have been emphasized by various authors worldwide. For accounting the same, a 5.6 ha of fragmented forest stand located within the Balipara Reserve Forest (BRF) of Sonitpur district, Assam was selected to conduct a survey on small mammalian's diversity and their habitat towards signifying the conservation value of such stands for wildlife survivorship. Both invasive (direct) and non-invasive (indirect) methods were used to record the mammalian richness and plant diversity. Our study revealed a total of 9 mammalian species belonging to 8 families and 129 plant species belonging to 49 families. This study suggests that fragmented forest stands beside harbouring high floral diversity, also have the potential to conserve and manage several threatened wildlife species that are thriving within it particularly small mammals in the present scenario. Therefore, it has become an urgent necessity to examine the value of small fragmented or isolated forest stands of the region so that they are not implicitly considered worthless and removed or converted to other land use practices.

Key words: Conservation, Fragmented forest stand, Plant diversity, Small mammals

Introduction

Forest fragmentation is the process in which division of large, continuous forest canopy results into smaller isolated habitat fragments; thereby causing habitat loss (Ranta *et al.*, 1998; Franklin *et al.*, 2002). With industrialization and urbanization taking place at an inevitable rate; persistent alternations on forest ecosystems (Harris, 1984; Hunter, 1990; Terborgh, 1992; Myers, 1996) have resulted conversion of pristine forest covers into fragmented patches (Skole and Tucker, 1993; Andern, 1994). These forest stands are surrounded by agricultural landscapes, tea gardens and human settlements. As a result, fragmented landscapes have become one of the most ubiquitous features of all forest ecosystems (Laurance and Bierregaard, 1997). In fact, it has become a central issue in conservation biology (Meffe and Carroll, 1997). Several studies carried out in fragmented forest patches of varied sizes worldwide have thus emphasized on its significance in relation to species thriving within them (as reviewed in Turner and Corlett, 1996). So, areas highly affected by fragmentation (comprising numerous fragmented forest patches) should be given special priority in its management and conservation (McLellan *et al.*, 1986).

Chiarello (2000) has reported fragmented forest stands in San Paulo, Brazil as refugee site for the preservation of native

fauna in the long run. Conservation of these highly fragmented landscapes can further aid in survivorship of the declining population of species such as Colobus monkeys (Chapman *et al.*, 2007). Similar attempt was carried out in Los Tuxtlas, Mexico for the survival of forest-dependent animals (Howler monkeys) for obtaining food resources and also as potential extensions of their home-range (Asensio *et al.*, 2009). Robert (2011) too emphasized on the conservation of such small fragments as possible winter habitat for Wood Thrushes in Costa Rica's Caribbean lowlands. In India, Kumar *et al.*, (1995) referred to the management and preservation of fragmented rainforest stands in the Western Ghats of South India for survival of small mammals. Similar work was reported in the Anamalai Hills for elephants thriving in thereby protecting them from further degradation (Kumar *et al.*, 2010). In Northeast region, Choudhury (2002) emphasized in bringing the remaining forest in Chirang, Ripu, parts of Manas Reserve Forests and Bhairab Pahar-Nakkati under Protected Area networks for conserving the threatened Golden langur (*Trachypithecus geei*). Kakati *et al.* (2009) stated the importance of preserving the fragmented forest cover of eastern Assam towards preventing extinction of Western Hoolock gibbon (*Hoolock hoolock*) populations. These fragmented forest stands have also been acknowledged to be used as movement corridors or connecting linkages; thereby maintaining continuity between forests landscapes (Rosenberg *et al.*, 1997; Lidicker, 1999; de Lima and Gascon, 1999; Lees and Peres, 2007). They can thus function like migratory routes (Midha and Mathur, 2010) for elephant, small mammals, birds etc. during seasonal migration. In addition to this, their functioning as possible "stop over points" could assist small mammals (in particular) to cover huge distances (Wijesinghe, 2012); thereby enhancing the preservation of fragmented forest covers.

The north-eastern forest regions of Indian sub-continent have been facing similar deforestation resulting in formation of several fragmented and isolated forest stands. One of the most massive deforestation in northeast region is reported in the Sonitpur district of Assam (Roy and Joshi, 2001; Srivastava *et al.*, 2002). Despite the causes mentioned, these extensively fragmented forest patches are found to harbour a rich diversity of floral and faunal species (Kushwaha and Hazarika, 2004). It has also been one of the preferred migratory routes for elephants (Choudhury, 2004) in north bank of Assam.

Though a lot of work has been carried out towards conserving fragmented forest stands for survival of wildlife species globally as well as in India; very limited work has been done in the north-eastern region. Thus, the study was conducted in the fragmented forest stands of Balipara Reserve Forest (BRF) of Sonitpur district, Assam to link its conservation value with the small mammalian species residing in it.

Materials and methods

Study site

The study was carried out from January - May, 2011 at the Pygmy Hog pre-release center at Potasali (26°55′14′′- 26°55′26′′ N Latitude and 92°49′37′′- 92°49′48′′ E Longitude). It covers 5.6 ha of total area as a fragmented forest stand within the BRF of Sonitpur district, Assam, India (Fig. 1). It is bounded by Jia Bharali River in the east, Mansiri River in the west, Arunachal Pradesh in the north and Singlimari reserve forest in the south. The area experienced monsoon type of climate with an average temperature of 23.4°c (min- 18.9°c

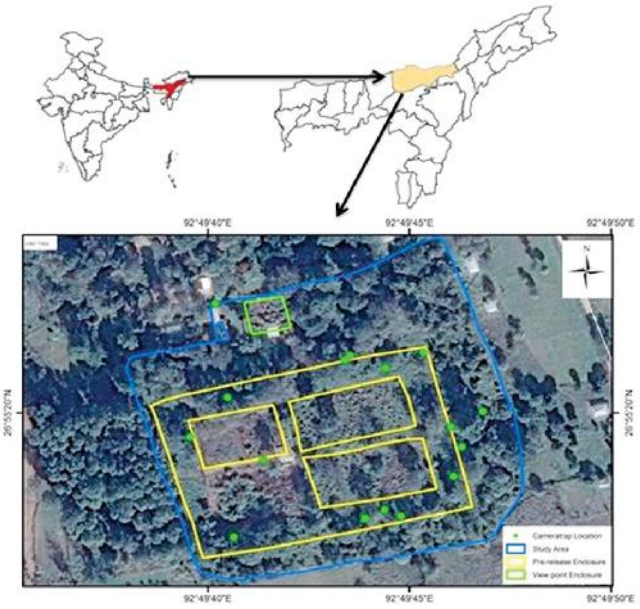

Fig. 1. Map of the Study Area (PHPRC) at Balipara Reserve Forest, Sonitpur

and max- 29.4°c). The average annual rainfall was 2163 mm. Human settlements and agricultural landscapes surrounded the site.

Faunal survey

Both invasive (direct) and non-invasive (indirect) methods were employed. Direct count method (Silveira *et al.*, 2003) was carried out for animals that could be easily sighted and were less perilous. Indirect methods was used to detect mammals that were rare, elusive, in small densities and difficult to capture repetitively (Erb, 2005) such as the sign survey (tracks, dens, burrows and scratches) as described by Gese (2001) and camera trapping (Coldwell, 2008). Identification of species was carried out in the field with the help of guide prepared by Menon (2003).

Camera trapping is widely used in wildlife studies (Wemmer *et al.*, 1996) and have indeed proven to be a very potent and simple method for detecting the presence, diversity and abundance of species of a particular area (Yasuda, 2004; Tobler *et al.*, 2008). It is basically used to capture species that are elusive in nature (Coldwell, 2008). During our study period, two remotely triggered passive infrared digital camera-traps (Bushnell) were used. It was modified to take 1 photo in 1 minute with a minimum delay of 5 seconds when an animal passed in front of the sensor. It could be operated for 24 hours. The camera traps were positioned at 16 selected locations for a minimum of 3-4 days within the study area depending on signs, foraging marks, faeces, remains of food resources, trails etc. used by animals and previous sighting places. The animals were lured towards the camera traps with various kinds of baits (Rovero *et al.*, 2010) such as maize seeds, banana, apple, dry fish, live chicken and soya bean. It was attached either to a tree or pole at about 0.5 m above ground, kept at a distance of about 2 m from the targeted location and slightly off perpendicular (about 60^0) to the trail (Rovero *et al.*, 2010).

One successful camera trap meant at least one picture of an individual animal. Trapping success was presented as percent success by taking into account the number of successful traps and the total number of traps. The area was initially divided into grids each of 20×20 m^2. Two camera traps were laid down for 58 days in the study site. Each of the two camera traps was placed in (20 x 20) m^2 per unit area at 8 selected locations respectively. Relative frequency (%) of a species meant the percentage of individuals of that species photographed amongst all individuals of all species.

Relative Frequency (%) = (No. of Photo) x 100/ Total photo of mammals

Photographs of individual animals were distinguished on a combination of factors such as distinct features, time lag between successive photographs and time of capture of the same species in the adjoining cameras. With these methods, the biological value and importance of a particular area can be acknowledged (Shaw, 1985).

Vegetation survey

To study the plant diversity in the selected fragmented forest stand, the random quadrate method was used. This was done to cover all representative portions of the area. A total of 40 sample plots were plotted for tree species each of 10m x 10m size. For herb, shrub and climber species, 2m x 2m sample plots were nested within plots of tree species. Species identification was done through field inventories and vernacular names. Plants that could not be identified were collected and made into herbarium following standard methodology of Jain and Rao (1977) and identified with the help of various floras and in consultation with herbaria of Department of Forestry, North Eastern Regional Institute of Science and Technology (NERIST). As per Misra, (1968) quantitative analysis of vegetation was done. For IVI of trees, three values (relative frequency, relative density and relative dominance) and for shrubs, herbs and climbers two values (relative frequency and relative density) were summed up. To calculate the relative dominance of trees with girth ≥ 15 cm at 1.37 DBH above ground were taken into consideration.

Results

Mammals

Total nine mammalian species belonging to 8 families were recorded (Table: 1). It consisted of two primates, three rodents, three carnivores and one insectivore. Among them,

Table 1. List of mammals recorded through direct and indirect methods

Scientific name	Family	Conservation status IUCN, 2012	WPA,1972	Method
Trachypithecus pileatus	Cercopithecidae	V	I (Part 1)	D.S
Macaca mulatta	Cercopithecidae	L. C	II (Part I)	D.S
Callosciurus pygerythrus	Sciuridae	L. C	II (Part 1)	D.S & C.T
Viverricula indica	Viverridae	L. C	II(Part1)	C.T
Herpestes urva	Herpestidae	L. C	IV	C.T
Hystrix brachyura	Hystricidae	L. C	II (Part I)	C.T
Felis chaus	Felidae	L. C	II(Part1)	S.S (Scat)
Rattus nitidus	Muridae	L. C	V	C.T
Talpa micrura	Talpidae	L. C	II(Part 1)	S.S (Burrow)

*L.C = Least concern, D.S = Direct sighting, C.T = Camera trapping, S.S = Sign survey, Lo. C = Locally common, V= Vulnerable

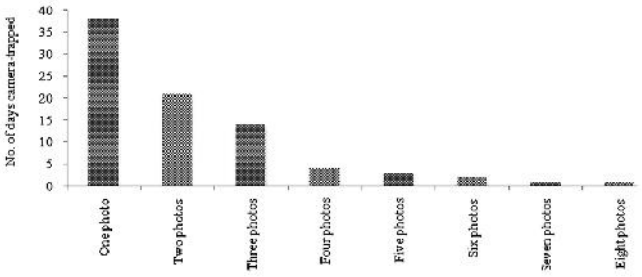

Fig. 2. Number of images captured during successful camera-traps

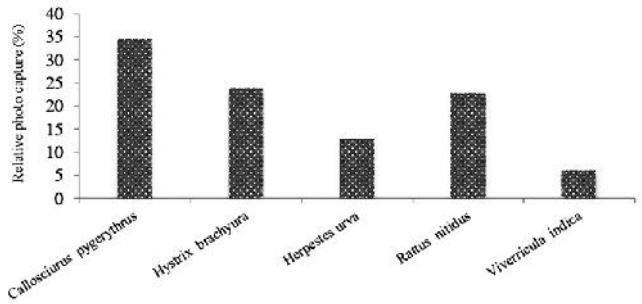

Fig. 3. Relative frequency of mammal's camera trapped in study site

Trachypithecus pileatus is categorised vulnerable as per IUCN (2012) and is listed in Schedule I.

Trachypithecus pileatus and Macaca mulatta were sighted directly. *Trachypithecus pileatus* (Fig. 7a) was found to have the highest number of individuals in a single troop i.e. 17 (Adult Male- 2; Adult Female- 3; Sub-adult- 4; Juvenile- 3 and Infant- 5). *Macaca mulatta* comprised of only 3 individuals (Adult Male- 3). Through sign survey, the occurrence of *Felis chaus* and *Talpa micrura* (Fig. 7b and 7c) were noted. *Viverricula indica, Herpestes urva, Hystrix brachyura*, *Callosciurus pygerythrus* and *Rattus nitidus* (Fig. 7d to h) were camera trapped in the area.

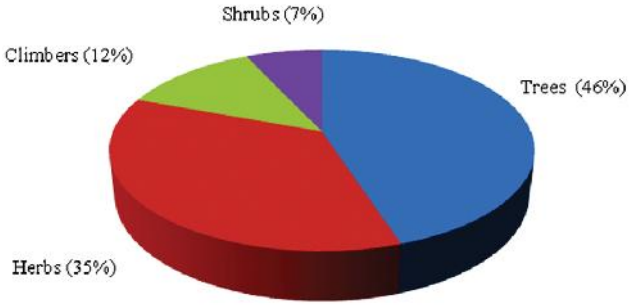

Fig. 4. Plant species recorded from the study site

Relative Frequency of photo captures

A total of 180 photographs of 135 individuals of 5 mammalian species in 35 successful camera trap nights were recorded. The average number of images of mammals photo-captured whenever they came in front of the camera varied according to species. During successful camera traps, the average number of photos taken of an individual mammal was found to be high for *Callosciurus pygerythrus* (1.4) and *Hystrix brachyura* (1.4) respectively, followed by *Herpestes urva* (1.3), *Rattus nitidus* (1.2) and *Viverricula indica* (1.1). The average number of images captured during the 35 successful traps was around 1.3 (Table: 2).

Number of images captured of individual mammals during successful traps is shown in (Fig. 2). The frequency came down for every further increase in the number of images taken per day. With respect to species, the maximum number of species photographed in a single trap was two. It happened twice; containing images of Himalayan rat and Himalayan crestless porcupine and capped langur and hoary-bellied Himalayan squirrel. From Fig. 3, the maximum relative photo-capture (%) was that of hoary bellied Himalayan squirrel (34.4%) with minimum that of small Indian civet (6.1 %).

Vegetation

A total of 1568 individuals belonging to 129 plant species of 103 genera and 49 families were recorded from the study site. Of these, 7 species were identified till generic level and 5 species remained

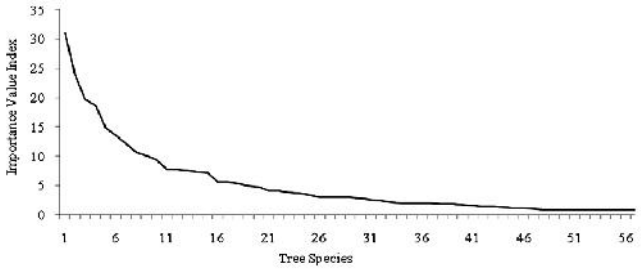

Fig. 5. Dominance diversity curve of trees in the study site

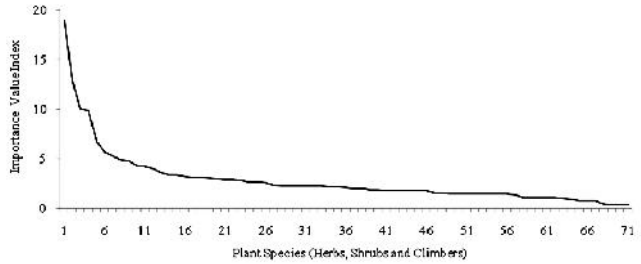

Fig. 6. Dominance diversity curve of herbs, shrubs and climbers

Table 2. No. of Individuals and photographs of mammals through camera-trap

Mammals	No. of Individuals	No. of Photos	Avg. no. of Photos
Callosciurus pygerythrus	43	62	1.4
Hystrix brachyura	31	43	1.4
Herpestes urva	17	23	1.3
Rattus nitidus	34	41	1.2
Viverricula indica	10	11	1.1
Total	135	180	1.3

quality of an area (Oates *et al*., 1990; Peres, 1997). The direct sighting of 17 individuals in a single troop of *Trachypithecus pileatus* was momentous as Kumar and Solanki (2008) had recorded 13 individuals in Pakui wildlife sanctuary, Arunachal Pradesh. This could be due to fragmentation that prevented their movement to adjoining areas; resulting in an increase in density within the isolated forest area (Chiarello, 2000). The presence of new born infants and juveniles signifies these sites

Fig. 7. a. Direct count; b and c. Sign survey; d, e, f, g and h. Camera trapped.

unidentified. Among growth forms, trees contributed 46% (n=58), followed by herbs 35% (n=46), climbers 12% (n=16) and shrubs 7% (n=9) to the area (Fig. 4). A detailed quantitative data of all individuals of each plant species are given in Table 3. and 4.

Discussion

During our survey period nine small mammalian species were recorded from the area. This is significant due to the fragmented forest stand been relatively small. Thus, indicating the habitat to be functioning as breeding site (de Lima and Gascon, 1999) for them which is a good indicator. Similar conditions was reported to occur in linear rainforest remnants in Tropical Queensland by Laurance (1996) where some arboreal mammal species were seen with their young ones. *Macaca mullata* from adjoining areas were occasionally seen to visit the study area. In camera trap, the success rates of photo captures percentage mainly depended on the set up of the camera locations along

Table 3. Total no. of individuals of species, density/ha, and Importance Value Index (IVI) of trees of Balipara Reserve Forest, Potasali

Scientific name	Family	Total individuals	Density/ha	IVI
Albizzia lucida	Leguminosae	36	90.00	31.05
Amoora wallichii	Meliaceae	11	27.50	23.91
Tetrameles nudiflora	Datiscaceae	48	120.00	19.68
Mangnolia hodgsonii	Magnoliaceae	16	40.00	18.59
Altingia excelsa	Hamamelidaceae	16	40.00	14.81
Ficus hispida	Moraceae	31	77.50	13.61
Emblica officinalis	Euphorbiaceae	18	45.00	12.22
Toona ciliata	Meliaceae	7	17.50	10.59
Psidium guajava	Myrtaceae	24	60.00	10.01
Macaranga dendiculata	Euphorbiaceae	21	52.50	9.43
Gmelina arborea	Verbenaceae	11	27.50	7.74
Ficus benjamina	Moraceae	3	7.50	7.72
Litsea monopetala	Lauraceae	16	40.00	7.51
Canarium bengalense	Burseraceae	4	10.00	7.34
Bauhinia variegata	Leguminosae	8	20.00	7.20
Melia azedarach	Meliaceae	11	27.50	5.60
Anthocephalus cadamba	Rubiaceae	3	7.50	5.59
Bombax ceiba	Malvaceae	10	25.00	5.34
Sterculia villosa	Sterculiaceae	8	20.00	4.93
Litsaea sebifera	Lauraceae	3	7.50	4.78
Trewia nudiflora	Euphorbiaceae	4	10.00	4.06
Albizzia lebbek	Leguminosae	4	10.00	4.05
Dysoxylum hamiltonii	Meliaceae	3	7.50	3.86
Unidentified spp. 1	-	4	10.00	3.60
Duabanga grandiflora	Lythraceae	1	2.50	3.43
Alstonia scholaris	Apocynaceae	2	5.00	3.00
Dillenia indica	Dilleniaceae	3	7.50	3.00
Bischofia javanica	Euphorbiaceae	3	7.50	2.96
Manglietia insignis	Magnoliaceae	2	5.00	2.90
Lagerstroemia flosreginae	Lythraceae	3	7.50	2.86
Artocarpus chaplasha	Moraceae	3	7.50	2.54
Aesculus assamica	Sapindaceae	2	5.00	2.43
Oroxylum indicum	Boignoniaceae	3	7.50	2.17
Ailanthus grandis	Simarubaceae	1	2.50	2.01
Phoebe goalparensis	Lauraceae	2	5.00	2.00
Dysoxylum binectariferum	Meliaceae	2	5.00	1.99
Syzygium grande	Myrtaceae	1	2.50	1.94
Syzygium fruticosum	Myrtaceae	2	5.00	1.81
Albizzia procera	Leguminosae	2	5.00	1.80
Spondia spinnata	Anacardiaceae	2	5.00	1.71
Stereospermum chelonoides	Bignoniaceae	1	2.50	1.50
Gynocardia ordata	Flacourtiaceae	1	2.50	1.45
Amoora rahituka	Meliaceae	1	2.50	1.41
Elaeocarpus robustus	Elaeocarpaceae	1	2.50	1.30
Artocarpus lackoocha	Moraceae	2	5.00	1.16
Kydia calycina	Malvaceae	1	2.50	1.10
Chukrasia velutina	Meliaceae	1	2.50	1.04
Hydnocarpus kurzii	Flacourtiaceae	1	2.50	0.93
Erythrina stricta	Leguminosae	1	2.50	0.91
Ficus bengalensis	Moraceae	1	2.50	0.91
Cryptocarya amygdalina	Lauraceae	1	2.50	0.86
Baccaurea sapida	Euphorbiaceae	1	2.50	0.84
Morus laevigata	Moraceae	1	2.50	0.80
Ficus elastica	Moraceae	1	2.50	0.80
Phoebe cooperiana	Lauraceae	1	2.50	0.80
Morus alba	Moraceae	1	2.50	0.80
Unidentified spp. 2	-	1	2.50	0.80
Unidentified spp. 3	-	1	2.50	0.80
Total		**373**		**300**

Table 4. Total no. of individuals of species, density, and Importance Value Index (IVI) of herbs, shrubs and climbers of Balipara Reserve Forest, Potasali

Scientific name	Family	Total individuals	Density	IVI
Diplazium esculentum	Dryopteridaceae	165	4.13	18.91
Ageratum conyzoides	Asteraceae	109	2.73	12.88
Pteridium aquilinum	Polypodiaceae	78	1.95	10.02
Dicranopteris linearis	Gleicheniaceae	73	1.83	9.87
Cynodon dactylon	Poaceae	54	1.35	6.67
Oxalis corniculata	Oxalidaceae	42	1.05	5.66
Paspalum scorbiculatum	Poaceae	37	0.93	5.25
Merremia vitifolia	Convolvulaceae	19	0.48	4.82
Mikania micrantha	Asteraceae	15	0.38	4.75
Centella asiatica	Apiaceae	32	0.80	4.29
Biden pillosa	Asteraceae	34	0.85	4.19
Stephania rotunda	Menispermaceae	19	0.48	4.01
Panicum sarmentosum	Poaceae	30	0.75	3.59
Oxalis debilis	Oxalidaceae	24	0.60	3.35
Cyperus aromaticus	Cyperaceae	27	0.68	3.33
Mimosa pudica	Mimosaceae	25	0.63	3.17
Carex spp.	Cyperaceae	18	0.45	3.12
Boerhavia diffusa	Nyctaginaceae	21	0.53	3.10
Solanum khasianum	Solanaceae	17	0.43	3.04
Erechthites valerianaefolia	Asteraceae	22	0.55	2.92
Spilanthes acmella	Asteraceae	15	0.38	2.87
Euphorbia hirta	Euphorbiaceae	18	0.45	2.85
Eleusine indica	Poaceae	17	0.43	2.77
Commelina diffusa	Commelinaceae	22	0.55	2.65
Colocassia esculenta	Araceae	12	0.30	2.62
Amaranthus viridis	Scrophullariaceae	8	0.20	2.55
Carum copticum	Apiaceae	12	0.30	2.35
Solanum nigrum	Solanaceae	11	0.28	2.26
Eupatorium odoratum	Asteraceae	14	0.35	2.25
Commelina benghalensis	Commelinaceae	7	0.18	2.20

Gnaphalium indicum	Asteraceae	7	0.18	2.20
Sida cordata	Asteraceae	7	0.18	2.20
Clerodendron colebrookianum	Verbenaceae	7	0.18	2.20
Polygonum chinensis	Polygonaceae	10	0.25	2.18
Stephania spp.	Solanaceae	6	0.15	2.11
Marrubium vulgare	Labiatae	9	0.23	2.10
Myriopteron extensum	Apocynaceae	8	0.20	2.01
Dioscoria triphylla	Dioscoriaceae	11	0.28	2.00
Drynaria quercifolia	Polypodiaceae	6	0.15	1.85
Unidentified spp. 4	-	9	0.23	1.83
Scoparia dulcis	Scrophulariaceae	5	0.13	1.76
Torrenia asiatica	Scrophullariaceae	5	0.13	1.76
Sonchus aspera	Compositae	5	0.13	1.76
Laportea crenulata	Urticaceae	5	0.13	1.76
Clerodendron serratum	Verbenaceae	5	0.13	1.76
Synghonium spp.	Araceae	5	0.13	1.76
Arum italicum	Araceae	5	0.13	1.49
Lantana camara	Verbenaceae	5	0.13	1.49
Andrographis paniculata	Acanthaceae	8	0.20	1.48
Coleus forskohlii	Labiatae	4	0.10	1.41
Polygonum spp.	Polygonaceae	4	0.10	1.41
Ocimum tenuiflorum	Lamiaceae	4	0.10	1.41
Datura fastuosa	Solanaceae	4	0.10	1.41
Paederia foetida	Rubiaceae	4	0.10	1.41
Thunbergia alata	Acanthaceae	4	0.10	1.41
Dioscoria glabra	Dioscoriaceae	4	0.10	1.41
Solanum indicum	Solanaceae	7	0.18	1.39
Dalhousia bracteata	Leguminosae	3	0.08	1.06
Randia spp.	Rubiaceae	3	0.08	1.06
Unidentified spp. 5	-	3	0.08	1.06
Spatholobus roxburghii	Leguminosae	3	0.08	1.06
Smilax macrophylla	Liliaceae	3	0.08	1.06
Alocassia macrorhiza	Araceae	5	0.13	0.96
Impatiens balsamina	Balsaminaceae	4	0.10	0.87
Elephantopus scaber	Compositae	2	0.05	0.70
Hemionitis aurifloia	Hemionitidaceae	2	0.05	0.70
Piper thomsonii	Piperaceae	2	0.05	0.70
Dendrocalamus hamiltonii	Poaceae	2	0.05	0.44
Bambusa tulda	Bambuceae	1	0.03	0.35
Bauhinia spp.	Leguminosae	1	0.03	0.35
Hoya spp.	Asclepiadaceae	1	0.03	0.35
Total		**1195**		**200**

existing trails of target species, foraging marks, faeces, remains of food resources etc. It helped in determining the relative density of mammals based on its capture percentage. The hoary bellied Himalayan squirrel was recorded with the highest relative photo capture (34.4 %) with small Indian civet been recorded with a low relative photo capture (6.1%). This might be due to their occurrence in low abundance in the area (Mohd. Azlan and Lading, 2006). With respect to species, only two (Himalayan rat and Himalayan crestless porcupine; capped langur and hoary bellied Himalayan squirrel) were photographed in a single trap night. This signifies that no inter-specific competition is taking place among species in consideration to the biological factors. Scats and some burrows that were sighted at certain places confirmed to be that of Jungle cat (Vanak and Mukherjee, 2008) and Eastern mole (Cranbrook, 1966) respectively. Besides this, information of elephants visiting these fragmented forest stands were obtained from the local inhabitants. Studies reveal that they use forest patches during migration over long distances in search of food, water, security and use the same path for hundreds of years (Menon, 2003). However, no such incident occurred during the study period.

With respect to vegetation, the presence of 1568 individuals of plants in such a small area signifies the potentiality of the area. Among trees, *Ficus hispida* having the highest IVI emerged as a dominant species followed by *Amoora wallichii, Tetrameles nudiflora* and *Mangnolia hodsonii*. Among herbs, shrubs and climbers, *Diplazium esculentum* was seen to dominant the area followed by *Ageratum conyzoides, Pteridium aquilinum* and *Dicranopteris linearis*. It was also observed that poles of *Tetrameles nudiflora* (n=48; D/ha=120) were regenerating the fragmented forest stand. This is a noteworthy feature as it implies the unique role played by mammals in seed dispersal (Wall, 1993; Wall *et al.*, 2001); that would further facilitate in recovery of natural forests through subsidiary vegetation growth (Turner and Corlett, 1996). This would ultimately result in establishing a viable environment suitable for both floral and faunal community to thrive within.

Conclusion

The previous studies have reported the occurrence of Asian elephants, one-horned rhinoceros, Indian bison, tiger, leopard, bear, etc. till 1983 around the present study site (Anon, 2014). As reported by Kushwaha and Hazarika (2004), due to a massive

forest cover loss from 1994 -2002; enormous biodiversity destruction occurred and several small fragmented forest patches were formed in Balipara reserve forest within Sonitpur district of Assam. The present study stated that the small fragmented forest stand contributed strongly to species richness, particularly in terms of floral diversity. The results obtained thereby underline the conservation value of these isolated fragmented landscapes towards survival of forest-dependent animals, small mammals in particular. Hence, such information is crucial for the development of effective and realistic conservation and management of wildlife species inhabited in fragmented forest stands. To promote conservation and explore the contribution of small fragmented forest stands to population sustainability, further work is necessary that precisely highlights the importance of small fragmented and isolated forest stands (Fisher and Lindenmayer, 2002).

Another effective step is to create conservation awareness among the local inhabitants residing within the vicinity of these fragmented forest stands by means of educational programmes and workshops. Thus, with the active involvement of local communities along with Researchers, NGO's and State Forest Department, the initiative taken to protect these fragmented forest stands may be achieved in long terms.

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