Resource Sharing by Hoolock Gibbon (*Bunopithecus hoolock*) with two primate species in Gibbon Wildlife Sanctuary, Assam, India

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1. Introduction

Tropical evergreen forests accounting for 40% forest cover, are home to ca. 90% of the world's primate population. NE is one of the known hot spots for primates and supports 10 of the 15 primate species found in India. Most of the species here are rare and endangered, and the future looks bleak, given the scarce resources undergoing further deterioration and loss. They are struggling hard to survive with the scarce resources as their habitats are fast disappearing due to ever increasing human induced disturbances.

Shifting cultivation, tree felling, expansion of human settlements, expansion of agriculture around the forest lands, poaching for self consumption and commercial trade in wildlife and its products are among the major reasons attributed to decline of primate populations.

Currently, only few virgin patches of suitable habitat are left for primates. Consequently, these species are packed into small area and are forced to compete for the limited resources available to them. Resource limitation is the fundamental driving force determining the social system and structure of competing species and populations. A focused study targetting resources use pattern provide a strong lead to conservation needs of the species. In the past, different primate species tend to utilize different layers of multistoried dense forest patches to meet their varied needs in northeast India. Now that the resource is limited, it could affect the species with specialised niche in a much severe way compared to the generalists. The gibbon is a specialist, largely restricted to certain canopy forest and thus, the survival of gibbons would depend upon the few resources available to them in the face of competing generalist primate species. This study is, basically, in line with this background, and quantified the conservation status of gibbon, focussing on resource(s) sharing by capped langur (*Trachypithecus pileatus*) and pig tailed macaque (*Macaca nemestrina*) in Gibbon WLS(GWS), Assam.

1.1 The Gibbon Wildlife Sanctuary

Gibbon WLS, (26^0 40'-26^0 45' N, 94^0 20'-94^0 25' E. and Alt 100-120 m) constituted in 1997 which comes under the civil district of Jorhat within the state of Assam. It got the status of Reserve forest in the year 1881 and during this period, the sanctuary was an integral part of the foothill forests of Patkai range **(Fig. 1 and Fig. 2).**

Fig. 1 : Map of Assam showing the location of Gibbon Wildlife Sanctuary

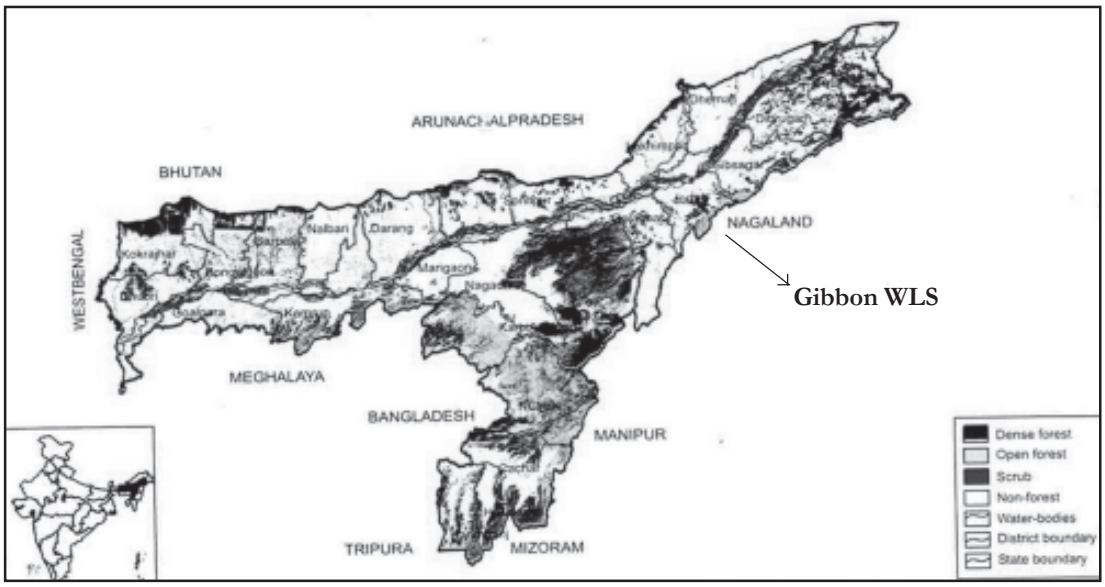
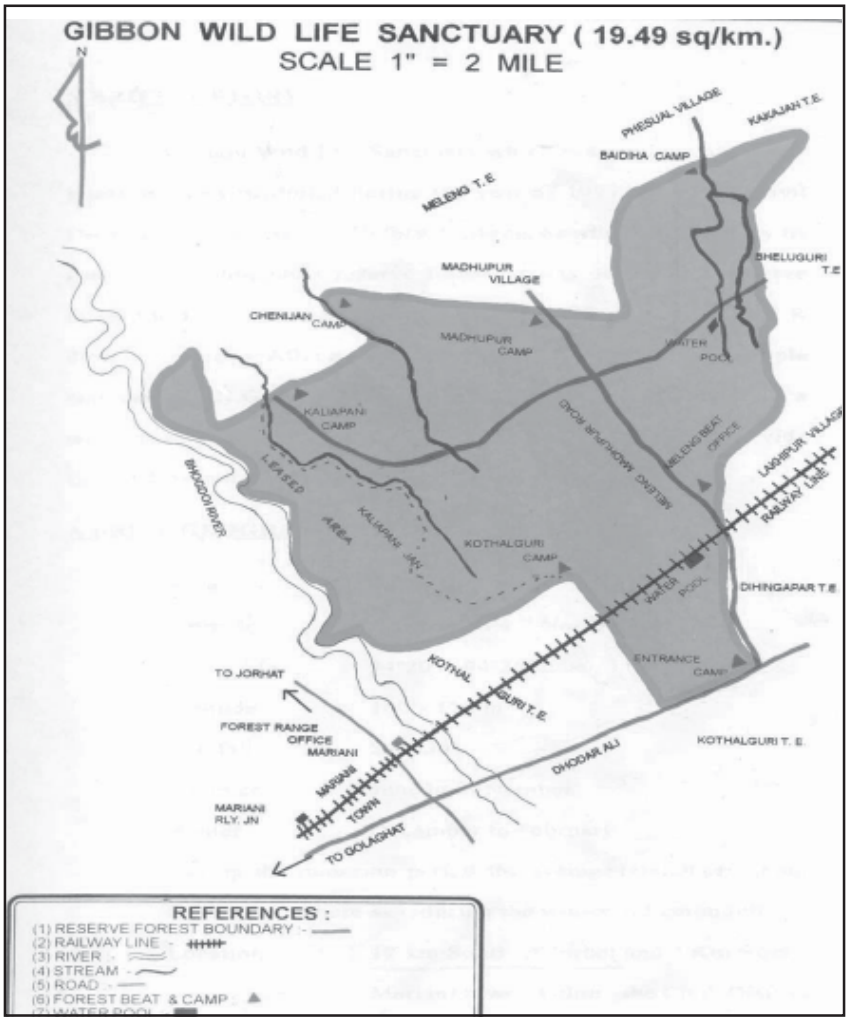


Fig. 2 : Gibbon Wildlife Sanctuary and Fragmented Forest Patches



After the establishment of tea gardens during 1880- 1920, the forest became disconnected from other forest of the foothills. In the past, the forests were covered by sporadic evergreen trees with dense Bojal bamboos (*Pseudodactylum sp*). In an attempt to grow well stocked even aged regular foerst, artificial regeneration was introduced in the year 1924, leading to regular plantations. The plantation together with the natural vegetation became a well-stocked forest, which encouraged many life forms in the subsequent years. This Sanctuary has the rare distinction of holding one of the highest densities of gibbon populations in Assam. This is the only sanctuary in the country named after the only ape species in India.

History: The GWLS was earlier known as "Hollongapar Reserve Forest", which was notified as a Reserve Forest vide notification No. 8 dated 27th August 1881. The original area of the Reserve Forest was 206 hectares, but in the year 1896, some of the areas of the Reserve was further de-reserved. However, subsequently, more forest areas were added to this Reserve Forest and by the year 1997 the total area of the Hoolongpar RF rose to 2098.6 ha. In 1997, this entire RF area was declared as Gibbon Wildlife Sanctuary by the Government of Assam vide notification no. FRS/37/97/13, dated 30-07-97.

The Sanctuary is now surrounded by tea gardens almost on all sides and few villages. These tea gardens are Katonibari, Murmurai, Chenijan, Koliapani, Meleng, Kakojan, Dihavelleoguri, Dihingapar, Kothalguri, Dissoi and Hoolonguri. The villages include Madhupur, Lakhipur,Rampur, Fesual A(the western Part), FesualB(the eastern Part), Katonibari, Pukhurai, Velleoguri, Afolamukh, and Kaliagaon. The tea gardens were established during the last part of 19th century whereas the villages were established during the 60's to rehabilitate the flood affected landless people of Majuli and adjoining areas.

GWLS was once contiguous with large forest tract that extended to Nagaland state. The nearest forest areas of Dissoi Valley Reserve Forests of Nagaland are now separated by a vast stretch of tea gardens presenting a kind of barrier for the effective migration of wildlife. The case in point is the straying elephants from GLWS while trying to take their age-old (as the people say) migration route to Nagaland state. In the process, many cases of elephant depredation are reported very frequently. A railway line divides the sanctuary in two unequal fragments with no effective connectivity between them. It appears that a single group of gibbon is trapped in the smaller fragment, with no opportunity to access other fragments. Moreover, the habitat in this forest is highly degraded due to continuous illegal felling and encroachment by the local people especially by the labourers of the adjoining tea gardens.

Vegetation: As per the Champion & Seth(1968) classification scheme, the forest type in the GWLS is Assam Plains Alluvial Semi Evergreen Forests /2/2B/C sparsely interspersed with wet evergreen forest patches. The vegetation is composed of several canopy layers, most of the components are evergreen in character.

Top Canopy: The top canopy is predominated by Hollong *(Dipterocarpus macrocarpas)* with clean straight boles of 12m to 30m in length. The other associated top canopy with Hollong are Sam (*Artocarps chaplasha*), Amari *(Amoora wallichi*), Sopas *(Mcheliai spp.*), Bhelu (*Tetramels*

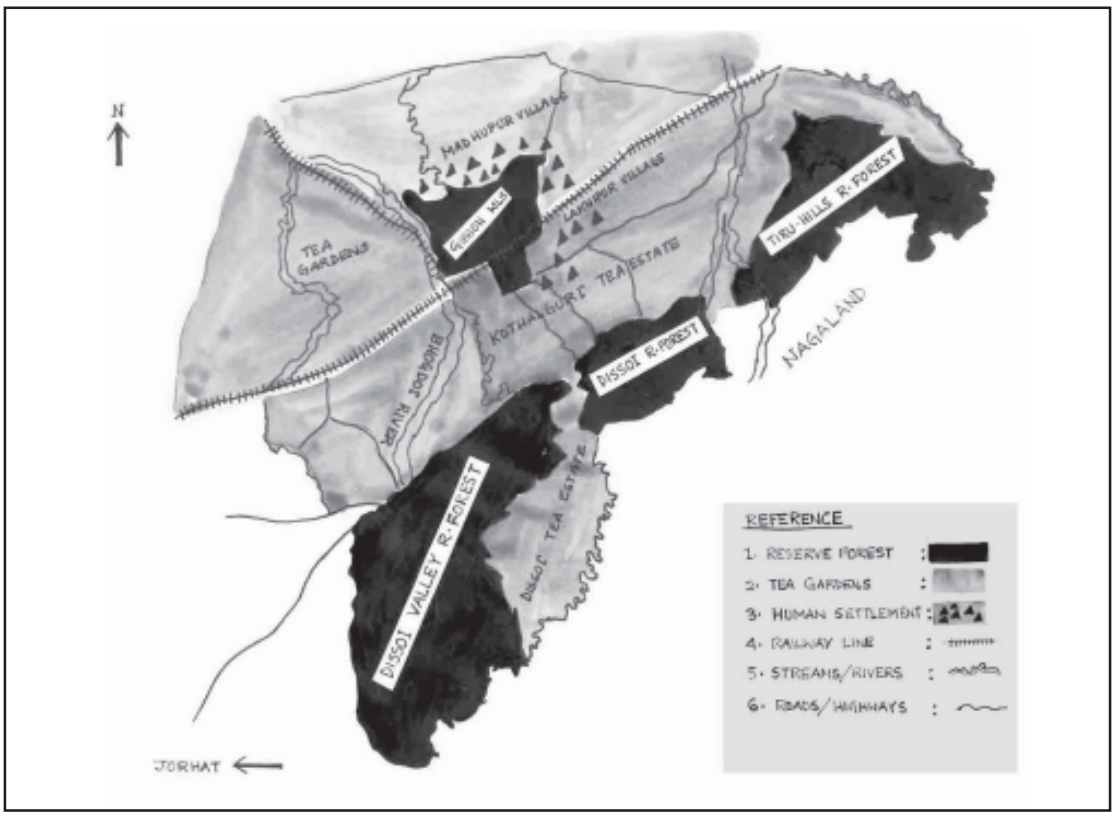
mudiflora), Udal (*Sterculia villosa)* and Hingori (*Castanopsis spp.*) (Table 1).

Middle Canopy: Nahar (*Mesua ferrea*) is the most prominent species in the middle canopy. It casts a fairly heavy shade on the forest floor covering a wider area on account of its spreading crown. Other common species constituting the middle canopy are Bandordima (*Dysoxylum procerum*), Dhuna (*Conarium resiniferum*), Bhomora (*Terminalia belerica*), Ful Gomari (*Gmelina Sp.*) Bonbogri (*Pterospermum lanceafolium*), Morhal (*Vatica lanceafolia*), Selleng (*Sapium baccatum*), Sassi (*Aqualari agolacha*), Otenga (*Dillenia indica)*, etc.

Lower Canopy: The lower and ground layers consist of a variety of evergreen shrubs and herbs. The most common among them are Dolu bamboo *(Teinosstachyum dullooa*), Bojal bamboo *(Pseudostachyam polymorphum*), Jengu *(Calamus erectus*), Jati bet (*Calamus spp.*), Houka bet (*Calamus spp.*), Tora (*Alpinia allughas*), Kaupat (*Phrynium imbricatum*), Sorat (*Laported cremulata*) etc.

Boundaries: The sanctuary extends up to Dissoi Valley Reserve Forest, Dissoi Reserve Forest and Tiru Hill Reserve Forest. These are the dispersal areas of animals particularly elephants. Between the Reserve Forests and the sanctuary, there are three tea gardens, that are also being used by wildlife including elephants as migration route. These tea gardens are the estates of Dissoi, Kothalguri and Hoolonguri. The growing population of the workers of these tea gardens forms a threat to the primate habitat (**Fig. 3**).

Fig. 3 : Bird-eye view of Gibbon Wildlife Sanctuary



1.2 Study Site

It was considered essential to choose an intensive study site within Gibbon WLS in order to follow the animals closely and quantify the behaviour and resource use pattern with increased sample size. Compartment 2 was chosen on account of dense forest condition and occurrence of all the three study primate species (gibbon, capped langur and pig-tailed macaque). This compartment showed favorable condition for their survival and that it reflects the actual nature of resource sharing. Besides, this compartment is easily accessible from all sides. The preliminary survey of the study site suggested that primates are present in high density. A total of 6 groups of hoolock gibbon, 2 groups of capped langur, and 1 group of pigtail macaque were present in the compartment (**Fig. 4**).

1.3 Objective

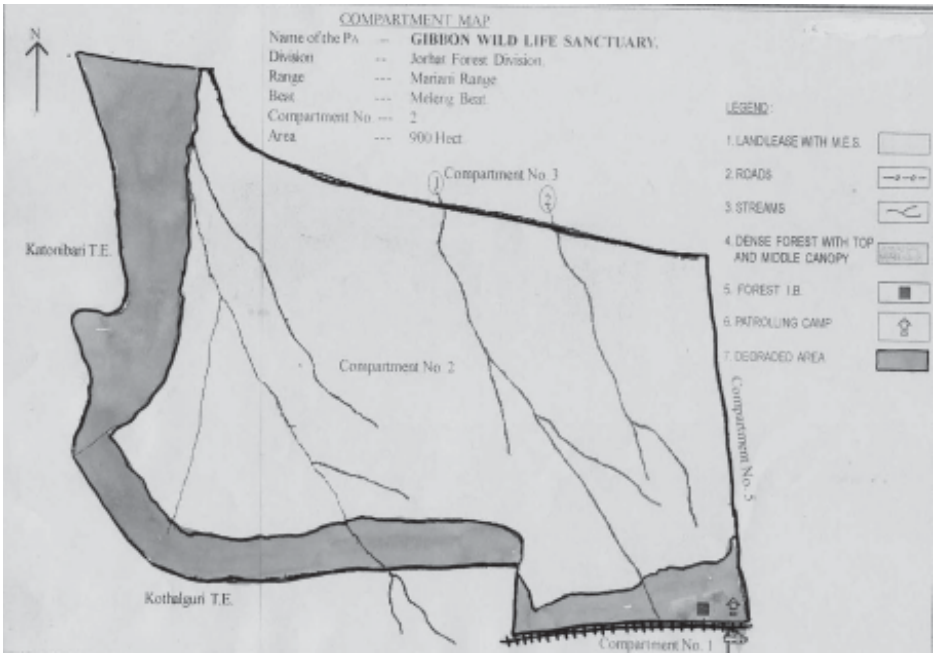
To study the feeding behavior of hoolock gibbon, capped langur and pigtailed macaque and to document whether there is any significant competition among these three primate species due to habitat degradation and limited resources.

2. Methodology

2.1 Preliminary survey

A preliminary survey was carried out in the two forest fragments to determine the number of groups, habitat type, habitat quality, home range, interaction among other members of the same species, interaction with other primate species, behavioural patterns, conservation threats etc. Morning songs were taken as indicator to ascertain the number of gibbon groups and their locations were recorded using Global Positioning system (GPS). One group each of hoolock gibbon, capped langur, and pig-tailed macaque was selected for subsequent intensive study.

Fig. 4 : Study Site in Gibbon Wildlife Sanctuary



2.2 Data collection

Intensive data collection was carried out using scan sampling (Altman 1974) during the months of February to May 2004. Following random sampling framework.

- Scan sampling was carried out for six days during the first and third week of each month in Fragment 1, and second and fourth week of each month in Fragment 2.

- Vegetation sampling was done once every month.

- Phenology study was done once in every fortnight.

***Scan sampling*:** The study group was followed from dawn (when they wake up at their roosting trees) to dusk (when they finally retire for roost). The data on different activities and other aspects of their ecology, behaviour, etc were recorded using a pre-designed format (**Annexure I**). The observations were done at every 5-minutes interval.

***Vegetation Sampling*:** Transects of 3 km length were laid in each compartment of the sanctuary randomly and species composition were quantified within 10m radius plot on either side of the line transect (**Annexure II**).

***Phenology*:** Phenology assumes importance as the chemical constituents of the leaves, stems and fruits changes with season, age and level of biotic pressure. What is regarded nutritionally important in one season may be toxic in another and almost indigestible subsequently. Phenology study was done once every fortnight. The methodology included studying the percentage presence of leaves, fruits and flower of all food plants of the gibbons in the study site. (**Annexure III**).

2.3 Study Animal

2.3.1 Hoolock gibbon (Bunopithecus hoolock)

Distribution

Global Distribution
India, Myanmar and Bangladesh

Distribution in India: Hoolock gibbon inhabits the states of Assam, Arunachal Pradesh, Mizoram, Nagaland, Meghalaya, Manipur and Tripura in northeast India. It occurs between 100m and 1400 m altitudes. The northern, northeastern and northwestern limit of its range is the river Brahmaputra (Dibang in Arunachal Pradesh) which act as physical barrier for its distribution.

Habitat and behaviour: Gibbons inhabit primary evergreen and less seasonal parts of semi-evergreen rain forest, and very rarely semi-deciduous forests. Gibbons are prototypical brachiates with flexible forelimb joints and use their long hands and legs to collect food selectively.

Gibbons spend 25-40% of the total activity time in feeding; 15-20% in locomotion; and 24% resting (Alfred and Sati, 1986; Islam and Feeroz, 1992). Their feeding strategy is "feeding all along the way" up to the fruit trees and back to a suitable roosting tree. It is quite

likely that their travel and feeding is goal directed. They mostly feed on ripe, sugar rich juicy fruits and also figs. There is no difference in feeding by sex in adults and juveniles (Choudhury, 1991). The typical diet of gibbons consists of 51- 65% fruits, 5-23% leaves, 13% - buds, 12% - flowers, and 0.1% and animal prey (including insects and bird eggs) (Tilson, 1979; Gittins and Tilson, 1984). Climbers also play an equally important role in their diet, at least in the dry season. This is altered to a great extent in degraded habitats such as Gibbon Wildlife Sanctuary, Assam. In this degraded habitat, they have been observed feeding on bamboo shoots. They spend 40% of time feeding on fruits, 40% on young leaves, 14% on leaf buds and 5% on mature leaf. *Artocarpus chalasha*, *Anthocephalus kadamba, Bischofia javanica, Amoora wallichara*, etc. are most preferred fruit bearing food plant species. *Dipterocarpus macrocarpus, Mesua ferae* and *Castonopsis indica* are preferred roosting trees (Choudhury, 1991). Like other gibbons, the hoolock is an arboreal and a diurnal species. It prefers the upper canopy of the forest, and sleeps and rests in emergent trees (Leighton, 1987). Similarly, hoolock eat mostly fruits (51-89%), with the main supplement being leaves (6-32%); besides consuming smaller quantities of flowers and insects (Alfred, 1992; Feeroz & Islam, 1992; Gittins & Tilson, 1984; Islam & Feeroz, 1992; Tilson, 1979). Mukherjee (1986) found lower quantities of fruits (30-40%) compared to leaves (40-60%) in the diet of Hoolock in Tripura (India). Among fruits, figs appear to be the most important food item and make up for about 60% of the fruits consumed by them (Alfred, 1992) and about 38% of their total diet (Feeroz & Islam, 1992; Islam & Feeroz, 1992).

2.3.2 Capped langur (Trachypiyhecus pileatus)

Distribution

Global Distribution

India, Myanmar, Bangladesh and China.

Distribution in India: Capped langur inhabits the states of Assam, Arunachal Pradesh, Mizoram, Nagaland, Meghalaya, Manipur, and Tripura in northeast India. It is distributed from sea level to about 2000 m altitudes. It ranges from east of the Brahmaputra river, south to the Manas river and eastward through the hills of Northeast India, as far as the Upper Chindwin river in North Myanmar.

Habitat and behaviour: The capped langur are found in the subtropical, broadleaf, evergreen, deciduous and bamboo forests as well as teak and sal plantations. The staple diet of capped langurs consist of fruit (24%), young leaves (22%), mature leaves (20%), seeds (9%), flowers (7%) and animal prey (1.6%) (Standford, 1998). These langurs are reported to feed on about 35 species of plant and 1 species of caterpillar. During the rainy season when fruit is abundant, 50% of their feeding is on fruits, particularly figs. In the dry season, they survive on mature leaves and some seeds. Occasionally, they eat gum and termite soil trail. They come to the ground to drink water from streams and water bodies (Standford, 1998). In North Cachar Hill Reserve forests and other reserves of the Cachar division, Assam they spend considerable time feeding on bamboo shoots. Due to the enormous amount of foliage dropped by these langurs deer species are often found associated with them (Standford, 1998). This kind of association is explained to be advantageous to

both the parties in predation detection. The home range and day travel distance of this species is the smallest for any species of colobines with 21.6 hectares and 325m respectively. The day range has significant correlation with percentage of mature leaves in the diet. The home ranges of capped langurs overlap considerably, and inter-group encounters are common with jumping displays. (Shrivastav, 1998; Standford, 1998).

2.3.3 Pig-tailed macaque (Macaca nemenstrina)

Distribution

Global Distribution

India, Myanmar, Bangladesh, Thailand, Cambodia, Laos, Malaysia, and the Island of Borneo and Sumatra.

Distribution in India : Pig tailed macaques inhabit the states of Assam Arunachal Pradesh , Mizoram, Nagaland, Meghalaya, Manipur, and Tripura in northeast India, These are distributed from sea level to about 1200 m attitude. The northwestern limits of its range lies in the south of the river Brahmaputra.

Habitat and behaviour: The habitat of Pigtailed macaque is quite variable from lowland primary and secondary forests to coastal, swamp, dry land and montane forest (Caldecott, 1986). The staple diet is composed of mainly fruits and seeds (73.8%) (Rowe, 1996). The second most important diet component is the animal prey (including insect, nestling fruit, termite egg and larva and river crabs). Besides, the macque spent about, 12.2% of the total feeding time on Leaves, 5.4% on buds, 3% on flowers, and 1.1% on other plant matter, including fungus (Caldecott, 1986). The macaques spend about 48% of their total activity time in the middle canopy and over 34% in the lower canopy with just about 10% on ground and remaining 8% in the upper canopy (Caldecott, 1986). However, they have been reported to directly compete for fruit sources with Lar gibbons (Whitington, 1992). An approximate overall average activity budget for this species is 23% resting, 61% locomotion, and 16% feeding (Caldecott, 1986). The average day range length may vary from 1000 m to 3000 m (Caldecott , 1986). A typical group of pig-tailed macaque comprises of 15-40 individuals. The inter-group relation is peaceful with extensive overlap of home range and occasional group fission and associations (Rowe, 1996). Pig- tailed macaques are trained to harvest ripe coconut in Malaysia.

3. Results

The data obtained from three months of field study was compiled and analyzed using the statistical software SPSS. The results thus obtained are presented in the following paragraphs.

3.1 Activity pattern

Hoolock gibbon

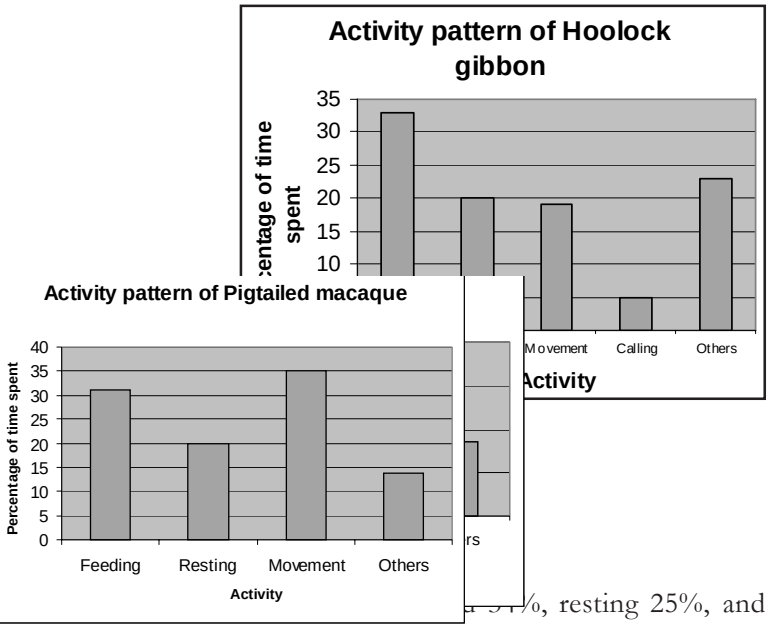
A total of 16 groups of gibbons were located in different compartments of the GWLS (**Table 1**).

Hoolock gibbons in the study area were found to spend 33% of the total activity time in feeding and time spent calling and resting accounted for 5% and 20% of the total activity budget, respectively (**Fig 5**). These findings match earlier observations by Leighton *et al* (1986).

Table 1: Distribution of gibbon groups in different compartments in the GWLS

Compartment Number	Gibbon Groups (N)
1	1
2	6
3	4
4	3
5	2
TOTAL	**16 Groups**

Fig. 5 : Activity Pattern of gibbon in Compartment 2 of GWLS



…%, resting 25%, and activities like grooming , playing and other social interactions made up to 17% of the total activity budget (**Fig. 6**). The langurs utilized the mid and upper canopy but in the degraded areas of the sanctuary the langurs were seen descending down the trees and to negotiate the gap in canopy through walking on the ground. In a study in Bangladesh, Standford (1998) observed the langurs spending about 35% of the total activity time on feeding, 40% time on resting, and 18% on ranging . The study group in the Gibbon Wildlife Sanctuary was found to

Fig. 6 : Activity Pattern of capped langur in Compartment 2 of GWLS

spend less time in resting. This may be an indicator of degradation of habitat quality and food availability as the gibbons have to range longer distance to meet their food requirement.

Pigtailed Macaque

Pigtail macaques were observed spending 31% of the total activity time feeding, 20% time on resting and 25% time on movement. They move in a bigger and widely dispersed group formation. The home ranges of gibbon and pigtailed macaque overlapped. However, it was also observed that on arrival of the macaque group and occupation of the same home range area, the gibbon group used to retreat to a safer distance away from the macaque group. Therefore, in spite of overlap in the use of home range, there was temporal avoidance. (**Fig. 7**).

Fig. 7 : Activity Pattern of pigtailed macaque in Compartment 2 of GWLS

3.2 Feeding

Food Plant, Plant Parts and Feeding Height

Hoolock gibbon

The most preferred food plant for gibbons in the study area was *Artocarpus chaplasha, Castanopsis indica, Ficus sp, Dysoxylum procerum* etc. All these species were found present quite abundantly in the study area (**Table2**).

But, due to canopy gaps the accessibility to food plants have decreased. This probably has forced the gibbons to take recourse to a folivory diet more than its usual preference as frugivorous (**Fig. 8**).

Fruits constitute 52-55% of the diet of the gibbons. However, unlike other studies, the time spent feeding on leaves was very high. As stated earlier, although the gibbons are frugivorous, yet, in this study they spent almost equal time feeding leaf diet (**Fig 9**).

Table 2: Status of Food Plant species in GWLS

Plant species	Frequency (N)	Percent
Dipterocarpus retusa	3	0.2
Artocarpus chaplasha	196	13.0
Amoora wallichi	28	1.9
Michelia champaka	14	0.9
Tetramelus nudiflora	26	1.7
Castanopsis indica	60	4.3
Mesua ferrae	46	3.1
Dysoxylum procerum	143	9.5
Terminalia bellerica	26	1.8
Gmelina arborea	20	1.3
Dillenia indica	9	0.6
Lagerstromia flosreginae	4	0.3
Spondias mangifera	54	3.6
Sapium baccatum	23	1.5
Garcinia morella	133	8.9
Gmelina sp	24	1.6
Eleocarpus robustus	45	3.0
Ficus bengalensis	83	5.5
Artocarpus lakoocha	145	9.7
Talauma hodgsonii	26	1.7
Eugenia jambulana	40	2.7
Anthocephalus kadamba	40	3.1
Baceaurea sapeda	12	0.8
Ficus racemosa	104	7.0
Litsea polyantha	9	0.6
Sterospermun chelonoides	7	0.5
Hoya parasitica	98	6.5
Michenia species	71	4.7
Total	**1489**	100.00

Fig. 8 : Preferred Food Plant Species used by Gibbons in GWLS

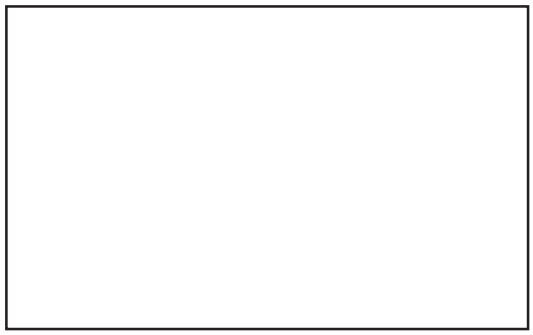
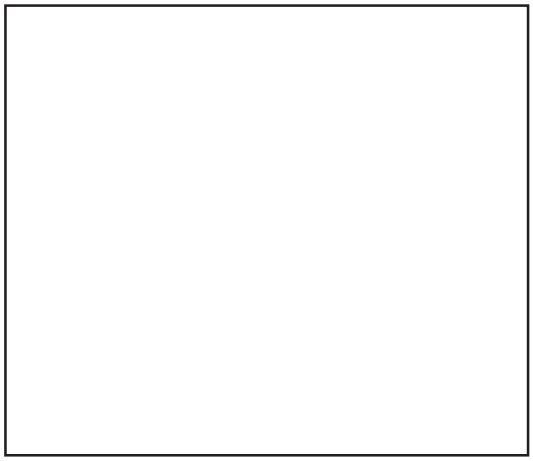


Fig. 9 : Proportion of different plant parts in the diet of gibbons



Tree height in the study area : Maximum number of trees had the height range of 21-25 m. Similarly the most common feeding height was also 25 m (**Table 3**). There was, therefore, no significant dearth of trees with appropriate height range for the three primate species.

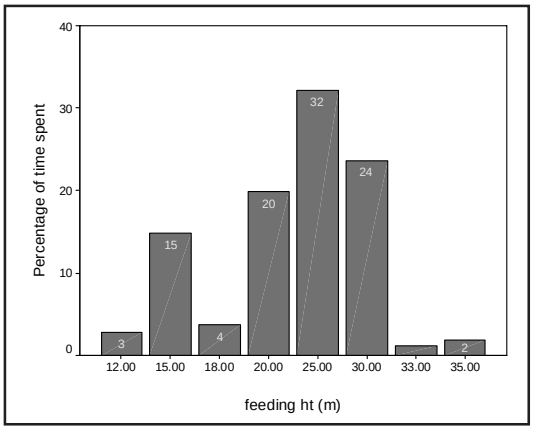
The feeding height of Hoolock gibbons in the study area was found to be 25-30 m. Gibbons generally utilized the top canopy of the forest . Top canopy in the study area ranged between 25 - 35m. So there was no apparent shortage

Table 3: Tree Height in the Study Area

Height class (m)	Frequency	Percentage
0-5	10	0.30
6-10	26	0.77
11-15	843	25.17
16-20	793	23.67
21-25	1042	31.12
26-30	492	14.69
31-35	143	4.28
Total	**3349**	**100.00**

of trees with required height for gibbons to feed on. Hoolock gibbons in the study area were found to utilize mostly the tree heights between 25-30m. The gibbons were generally the top canopy dwellers (**Fig. 10**).

Fig. 10 : Feeding height of gibbons in GWLS



Capped langur

Fruits and leaves of *Amoora wallichi, Castanopsis indica, Dyso xylum procerum* and *Gmelina sp.* were the most preferred by Capped langur in the study area (**Fig. 11**).

Capped langur are folivorous but they were found to consume a considerable percentage of fruits (41.6% ripe fruits and 8.2% unripe fruits). The study was carried out during dry period (February to May), and inspite of low availability of fruits, there was a high intake of fruits in the diet (**Fig. 12**).

Fig. 11 : Food species of capped langur in GWLS

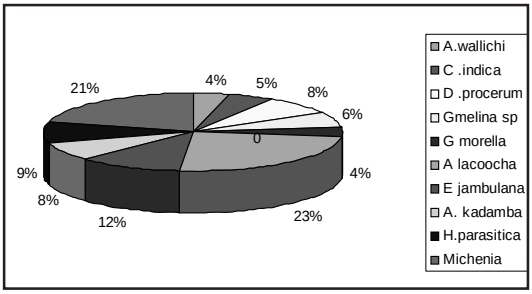
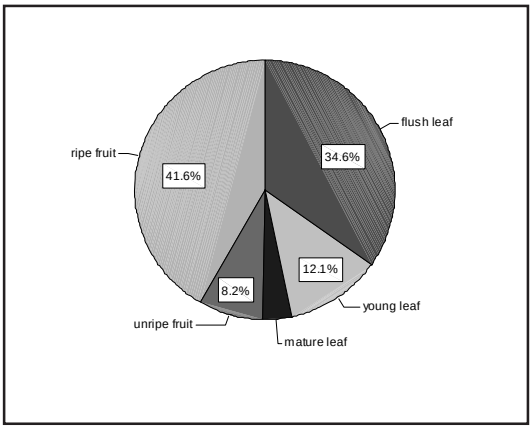


Fig. 12 : Plant parts consumed by capped langurs in GWLS



Capped langurs were mid canopy dwellers and fed at a height of 15 to 20m (**Fig. 13**). But sometimes, the animals also ascend up to a height of 30 to 35m on trees like *Artocarpus lakoocha*. In the study area, 23.6% of the trees had height range of 15-20 m (**Table 2**), supporting substantial trees suitable height range.

Pigtailed macaque

Pigtailed macaque preferred mostly leaves of *Michelia champaca*, *Artoca rpus lakoocha*, *Hoya parasitica*, and fruits of *Dysoxylum procerum*, *Gmelina* sp., *Eugenia jambolenna*, etc. (**Fig. 14**). These plants were plenty in the study area (**Table 2**).

Fig. 13 : Feeding Height of Capped langur in GWLS

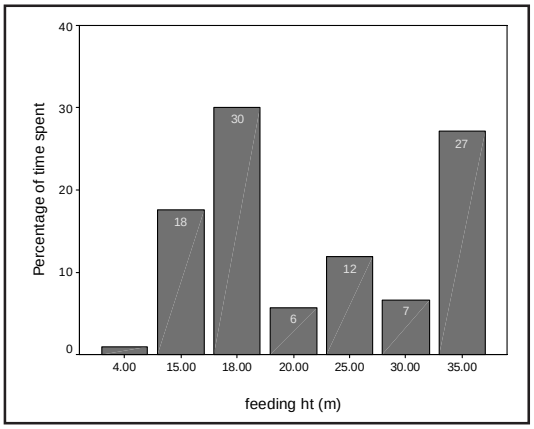
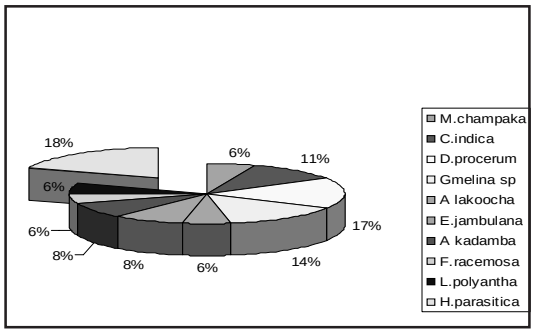


Fig. 14 : Food Plant species of Pig-tailed macaque

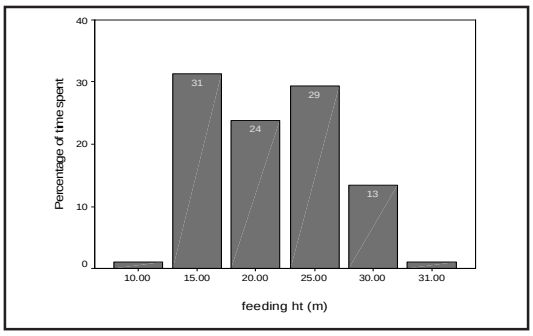


Pigtailed macaques were predominantly frugivorous and leaf constituted about 45.7% of the diet. Compared to the earlier studies by Caldecott (1986), leaves constituted higher proportion in their diet of pig-tailed macaques (**Fig. 15**).

Fig. 15 : Parts consumed by pig-tailed macaques

Pigtailed macaques are light weight animals and move around in large groups, often widely dispersed. They mostly fed on trees with height of 15 to 25 m (**Fig. 16**). The macaques were rarely noticed descending on the ground. In the study area, maximum number of trees had height range of 21-25 m(**Table 3**) offering suitable conditions for pigtailed macaque in terms of food plants.

Fig. 16 : Feeding height of pig-tailed macaque in GWLS



4. Discussion

4.1 Sharing of Food Plant Species

There exist species specific preference, but most of the plant species were shared by all the three primate species as described below (**Table 4).**

4.2 Biotic Disturbance

Felling is the serious human disturbance in the study area. Other activites adversely affecting the habitat are collection of firewood, small wood and other non-timber forest products. Lopping of trees is also one of the most serious biotic disturbance in the study area. Rampant illegal felling of important food trees of gibbon such as *Artocarpus chaplasha* and *Michelia champaca* has caused a scarcity of food resources in the

Table 4: Sharing of key food plants by three species of primates in Gibbon Wildlife Sanctuary

Plant species	Hoolock gibbon	Pigtailed gibbon	Capped langur
Terminelia chebula	*		*
Lagerstromia flos regina	*		*
Terminalia belerica	*		
Michelia champaka		*	
Albizzia lebbec			*
Litsaea anguistifolia			*
Sterospermum chelonoides			*
Castonopsis indica	*	*	*
Dysoxylum procerum			*
Messua ferrae	*		
Dillenia indica	*		
Sapium baccatum	*		
Artocarpus chaplasa	*	*	*
Garcinia Morella	*		*
Gmelina arborea		*	*
Hoya parasitica	*		*
Pseudodactylum polymorphum	*	*	
Ficus religiosa	*	*	*
Amoora wallichi	*		*
Mangifera sylvatica	*		*
Alstonia scholaris	*		*
Ficusbenjamine	*	*	
Litsaea polyantha		*	
Ficus racemosa	*	*	*

habitat. The study area, surrounded by villages and tea gardens, offers ideal condition for illegal fellers. Grazing was relatively less, encountered only in compartment 1 (**Fig. 17**).

Fig. 17 : Human Disturbance in GWLS

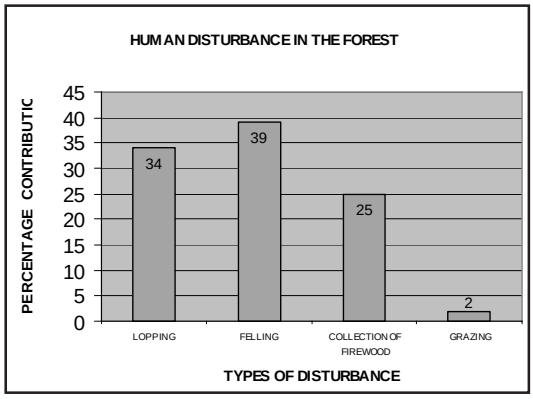


Table 5: Economically Important Plant Species in GWLS

Local Name	Scientific name	Parts used
Sassi	*Aqualaria allogacha*	Stem
Sam kathal	*Artocarpus chaplasha*	Timber and fruits
Sopa	*Michelia champaka*	Timber
Gomari	*Gmelina Sp*	Timber
koroi	*Terminelia bellerica*	Timber and barks

Some of the plant species, useful to gibbons for food, cover and movement are also extremely useful for the local people to meet their subsistence economy. A list of few such plant species is presented in **Table 5**.

4.3 Degradation of habitat

Compartment 1

- The total area is 260 hectare, of which 65 hectare (25%) is degraded along the Southern and western parts.

- The disturbance on the Western boundary is due to the presence of sharp edge with Kothalguri Tea Estate.

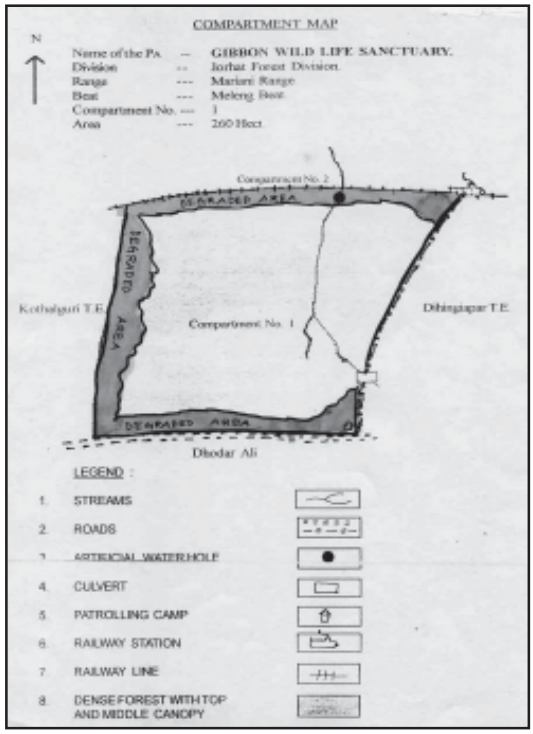
- The remaining 185 hectare is considerably a good habitat with dense patches of *Artocarpus chaplasha* plantation. This species contributes substantially in gibbon's diet in the habitat.

- The gibbons are seen to avoid the area up to 500 m distance from the National Highway. Therefore, rich food and canopy found here are inaccessible to them.

- One gibbon group of 4 individuals inhabit an area of ca. 0.3 km^2 on the Northern side of this compartment. Although, there is no competition to this group in this compartment, this group is forced to confine to this small area due to biotic pressures. It is indicative that presence of good habitat and other resources is irrelevant if these are inaccessible.

  The presence of railway track has caused destruction over an area of about 2.6 km^2, which includes the effective buffer along the track potentially impacted due to the track. On top of it, this railway track has already isolated the gibbon group in compartment 1 (**Fig 18**).

Fig. 18 : Compartment Number 1



Compartment 2

- Total area of this compartment is 900.6 hectare (9.0 km^2) Of this total area, about 1.8 km^2 along the western and southern border is degraded due to its formation of sharp edge with Kothalguri and Kotanibari tea estates

- The primate density is very high in the this compartment. There are 6 groups of hoolock gibbon, two groups of capped langur , and one group of pigtail macaque.

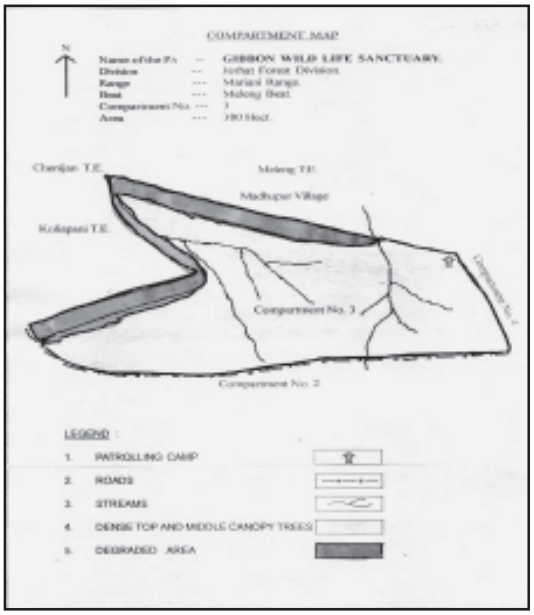
- The presence of many primate species in good density pose a stiff competition for the resources.

- The gibbons of this compartment migrate occasionally to compartment 5 (**Fig. 4**).

Compartment 3

- The total area of this compartment is about 380 hectare (3.8 km^2). Of this, about 10% area (40 hectare) along the northern boundary is highly degraded.
- This compartment has the most degraded habitat on its edge with Madhupur village.
- There are 3 gibbon groups in this compartment. These groups were seen migrating to other compartment at times (**Fig. 19**).

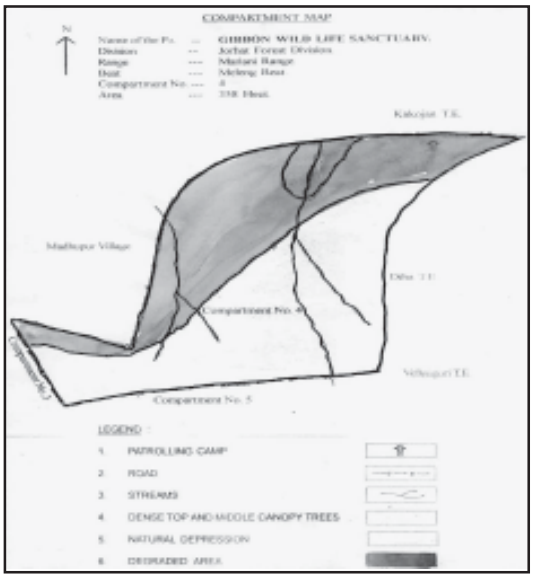
Fig. 19 : Compartment Number 3



Compartment 4

- The total area of this compartment is about 358 hectare (3.6 km^2)
- Almost 60% (214 hectare) of this total area along the Northeastern boundary with

Fig. 20 : Compartment Number 4



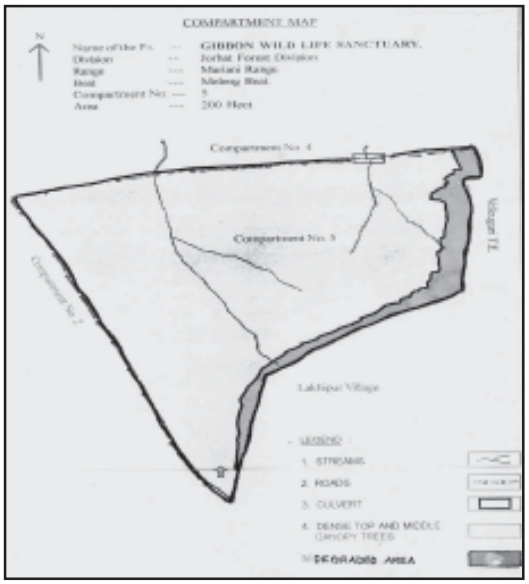
Madhupur village and Kakojan tea estate is highly degraded (**Fig. 20**).

- This Compartment has 3 groups of gibbon and one group of stump tail macaque (*Macaca arctoides*).

Compartment 5

- The total area of this compartment is ca. 200 hectare (2 km^2).
- It is relatively less disturbed compared to other compartments and only about 5% of the total compartment area may be counted as degraded.
- The compartment has 2 groups of gibbon which are seen migrating at times to Compartment 2.
- In this compartment, the canopy continuity is insufficient and poor, which forces gibbons to range into other areas of the forests to meet their requirements.

Fig. 21 : Compartment Number 5



4.4 Conclusion

Given the short-term nature of the study (3 months), nothing conclusive could be said about a particular trend in the resource partitioning among three species of primates. One would definitely need detailed study over a long period of time. However, the results of this study do present a general trend and there was high similarity in resource partitioning among three different species of primates. The findings on various ecological parameters for three species in this study more or less matches with the findings of the previous studies on these species at different places.

The three species of primates, the gibbon, the capped langur and the pigtail macaque share the same forest patch (compartment 2) along with other different species of primates, squirrels, birds, elephants etc. There seemed hardly any conflict among the three primate species for the resources as all of them showed spatial and temporal avoidance to each other. Even within same food tree, the different species used different canopy levels. Other possible reason is that the resources in terms of quality and magnitude are high according to the need of these species. However, it can not be ruled out that continuous anthropogenic disturbances such as logging / felling of important trees, collection of firewood, grazing by cattle etc. can lead to the destruction of forest habitat. Fragmentation can result in competition for resources among the different species in the near future. Therefore, currently looking "all is well" proposition may get disturbed in no time if the pace of resource depletion continues.

4.5 Recommendations

The Gibbon WLS, forms a very fragile habitat for some of the most endangered species listed under Schedule 1 of the Wildlife (Protection) Act, 1972 and Red Data Book of the IUCN such as hoolock gibbon, capped langur, stumped-tail macaque, and many rare bird species etc. Therefore, it is essential that this small, fragmented and almost land-locked sanctuary is given due attention by all concerned to ensure viability of the rich biodiversity here. One immediate step could be to reduce all kinds of biotic disturbance to the sanctuary being perpetrated by the local human populations who are very heavily dependent on the sanctuary resources for their sustenance. It is heartening that the department has taken up few community based development programmes in this regard. It may take some time before the ongoing conservation education programmes and participatory approaches start yielding desired results, therefore, in the mean time all out efforts are required to impart complete protection from the poachers and encroachers. The ecotourism in this area can be enhanced keeping in mind the proximity of this

sanctuary to Kaziranga National Park. This opportunity can be harnessed to provide alternative employments to the youths in this area to help them put their attention towards welfare of this area. The encroachment by the tea estates and other people is a common problem in this area, which can be sorted out through across the table discussions with the concerned authorities in a coordination committee meeting to be constituted specifically to look into the concerns of this sanctuary. The government can provide alternative employments and livelihood options to the local people based on rearing honeybees, sericulture etc. Depletion of forest area is also caused by the growing interest of the villagers to establish tea garden which is creating a sharp edge of the forest. The authorities should put a ban on this (if that would be possible) and encourage them to grow paddy and other crops. This can be achieved through provision of easily available loans and cheap but sophisticated agricultural equipments.

The forest department in collaboration with the NF Railways should attempt removing the garbage on both the sides of the tracks, generated by the frequently passing trains. A proper research station for research convenience should be established. Both long and short term research projects should be initiated and researchers should be encouraged to work on the various aspects of the sanctuary and its inhabitants. Important food plants of the primates should be identified and plantations of these tree species should be done in the areas lying vacant within the sanctuary. The forest department should refrain from leasing out forest land to any organization not even to the military establishments.

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Annexure - I

SCAN DATA SHEET

Parameters													
Time	Animal sex	Activity	Tree sps	Food plant	Tree ht	Plant part	Canopy Ht.	Canopy Width	Animal Ht.	Group Dispersal	Other primates	Other animals	Human activity

Date

Location

Weather

Group composition

Annexure - II

VEGETATION DATA SHEET

Tree Species	Number of trees	Tree Height	Canopy Cover(%)	Canopy Continuity (%)	Visibility	Undergrowth cover (%)	Species composition of Undergrowth	Number of cut stumps	Human activity

Date

Location

Weather

Annexure - III

PHENOLOGY DATA SHEET

Tree species	Flush leaf (%)	Young leaf (%)	Mature leaf (%)	Ripe fruit (%)	Unripe fruits (%)	Sour fruits (%)	Type of flowers	Type of inflorescence	Flower (%)

Date

Location

Weather