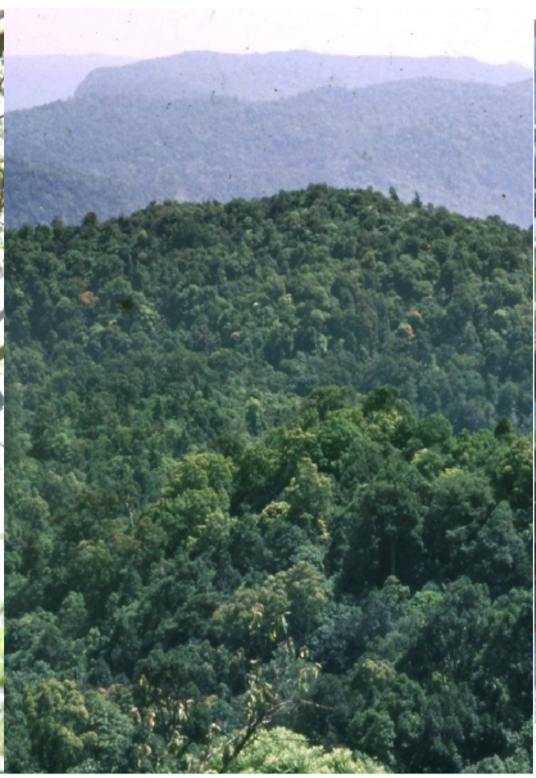
Development of conservation strategy for a newly discovered lion-tailed macaque *Macaca silenus* population in Sirsi-Honnavara, Western Ghats: II. Understanding the impact of NTFP collection on lion-tailed macaque

Technical Report

Honnavalli N. Kumara and Kumar Santhosh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Submitted to

CEPF-ATREE Small Grants

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Contents

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Kumara and Santhosh

Introduction

The lion-tailed macaque ranges through three southern Indian states: Karnataka, Tamil Nadu and Kerala. Due to its highly selective feeding habits, limited range of occupancy (about 2500 km^2), delayed sexual maturity, long inter-birth intervals, low population turnover and a small remaining wild population, this species has been classified as endangered (IUCN, 2003). Based on the collective opinion of several experts during a population assessment exercise, Kumar (1995) estimated 3500-4000 lion-tailed macaques for the entire Western Ghats, a number later put at 3500 in a similar exercise (Molur *et al*., 2003). These individuals were believed to consist of 49 subpopulations isolated in rainforest fragments scattered over eight locations (Molur *et al*., 2003). Karanth (1992), while outlining the conservation prospects for the Western Ghats, emphasized the importance of the lion-tailed macaque as a flagship species of the rapidly declining rainforests of this biodiversity hotspot. Large contiguous populations of the lion-tailed macaque are expected to occur only in very few regions over the entire Western Ghats and the conservation status of the species is likely to differ across these sparse populations. The Kalakad-Mundanthurai Tiger Reserve in southern Tamil Nadu, for example, has large tracts of rainforest, amounting to about 400 km^2, and is believed to have a good population of the species (Molur *et al*., 2003) although a status survey has never been conducted there. The Indira Gandhi Wildlife Sanctuary in the Anamalai hills in the state of Tamil Nadu has about 32 groups of lion-tailed macaques, all of which are restricted to severely fragmented forests (Singh *et al*., 2002) and, hence, the future of this population is unpredictable. The Silent Valley National Park in the state of Kerala has, however, received the attention of the entire country because of its 14 groups of lion-tailed macaques (Joseph and Ramachandran, 1998). Ten groups of lion-tailed macaques were reported from the Brahmagiri Wildlife Sanctuary in the Western Ghats (Karanth, 1985); our studies have, however, revealed the virtual local extinction of this population due to extensive hunting (Kumara and Singh, 2004a, b; Kumara, 2005). We have observed similar drastic declines, sometimes leading to the loss of even 65 % of the existing groups, during our recent surveys of the Talakaveri

WLS, Pushpagiri WLS, Sharavathi Valley WLS and the adjacent ranges of each of these Protected Areas (Kumara, 2007; Kumara and Sinha, 2009). In the light of this dismal scenario, the large, recently discovered population of the species in the forests of Sirsi-Honnavara in southern Karnataka possibly represents the largest, contiguous population of the macaque in its natural habitat (Kumara and Singh, 2004a; Kumara, 2005). Which we confirmed existence of more than 30 groups with estimated population size of about 638 monkeys through sweep sampling (Kumara *et al.,* 2008), and also fixed the boundaries to notify the region as protected area. However, conservation requires baseline information on various aspects more than the just identification of the population. Since the proposed protected area harbour high density of people and large extant of agricultural land, it is necessary to understand the interaction of people and the forest to properly manage the region.

Taking into account of findings from studies on ecology of lion-tailed macaques in the forests at south of Palghat in southern Western Ghats (Ashambu hills, Anamali hills and Silent valley) Krishnamani and Kumar (2000) have listed many possible food trees (218 species) and their status for few locations (Sharavathi Valley, Kodachadri hills, Someshwara, Kudremukh hills and Brahmagiri hills) in Karnataka. Though many species of food trees are been reported, but no studies have been done to show the use of same food trees by the monkeys in the state. Pascal (1988) has pointed out change in the plant species composition for change in every degree of coordinates. Further the major food tree for lion-tailed macaque in southern Western Ghats is *Cullenia exarillata* (Kumar, 1987; Ramachandra and Joseph, 2000; Umapathy and Kumar, 2000; Singh *et al.,* 2000; Singh *et al.*, 2001, Sushma and Singh, 2006), which is totally absent at north of Brahmagiri in Karnataka (Pascal, 1988). Thus, it is apparent that the crucial food trees are not the same in the forests of Sirsi-Honnavara as in the southern Western Ghats. Many food trees listed for lion-tailed macaques (Krishnamani and Kumar, 2000) are also considered as trees of NTFPs (Amit and Correa, 1997; Rai and Uhl, 2004; Hegde, 2008) in the district. In Uttara Kannada, many low income class people lead their livelihood using forest products, and also most of the communities in the forest area have tendency to collect the forest produce (Gaonkar *et al.*, 1998; Hegde *et al.*, 2000; Rai, 2003; Rai and Uhl, 2004). Hence, NTFP collection has been the integral part of the life system of the local people. However, no studies on NTFP collection and related aspects are available from the habitat of the lion-tailed macaque. To understand the impact of NTFP collection on the ecology of lion-tailed macaques, studies on availability of forest produce and its use by both monkeys and people has to be studied together. Since productivity of many species vary significantly between years, or phenophases of some trees may be longer than a year and have unique cycle system, two year study and monitoring is ideal to address the proposed problem. Thus this study provides newer insights into the ecology of the macaques along with information on resource utilization by man.

Study Site

The study area form the part of the Central Western Ghats in the district of Uttara Kannada in Karnataka State in South India, and lie between $74^{0}35'$-$74^{0}47'$E and $14^{0}15'$-$14^{0}25'$N in the district of Uttara Kannada (Fig. 1). The area included five Forest Ranges viz. Kyadagi and Siddapura in Sirsi Forest Division, and Kumta, Honnavara and Gersoppa in Honnavara Forest Division. The official status of the forest was Reserve Forest with interspersed revenue lands but it is now given protected area status based on our previous work and it is now called “Aghanashini-Lion tailed macaque Conservation Reserve” (ACR). The study area is located in the ridge of the Ghats extending in the westerly direction towards the west coast. The altitude varies from 300 m asl to 800 m asl. The terrain being the part of the ridge of the Western Ghats is generally undulating; the terrain forms the primary watershed for the origin of many streams and rivers. The area is densely covered with Southern Tropical Evergreen and Southern Tropical semi-evergreen forests with many layers of vegetation. The terrain is highly undulating and slope of the study area varies from 20% to >35% in general. A number of villages with large areas under cultivation of commercial crops (areca nut and paddy) are scattered inside.

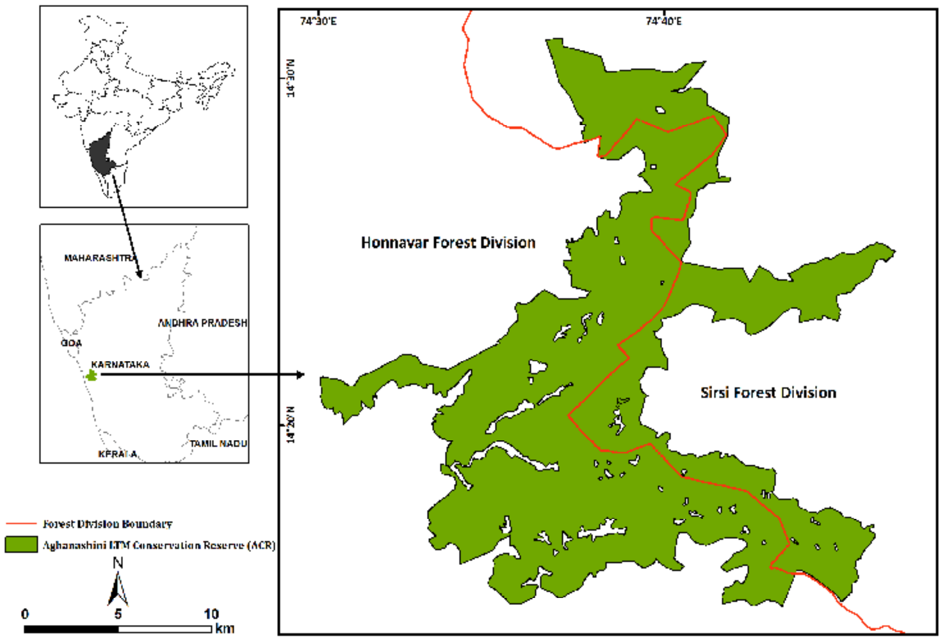


Figure 1 Map of the study area showing two forest divisions with Aghanashini lion-tailed macaque Conservation Reserve (ACR)

Methods

One group of lion-tailed macaque at northern part of the population was followed and habituated. Subsequently, the second group was also selected which was adjacent to this group and habituated and data collected for comparative purposes. The data on food plant use was collected using scan sampling method. At the end of each fourth month, local people were interviewed for NTFP collection using questionnaire survey. The nearer villages / hamlets to the range of study group were selected to interview the people. The data collection on feeding ecology of the lion-tailed macaque gave the total food plant species used in the region. Then the vegetation assessment was done to compare the proportion of food plant species available and their spatial distribution. Further, through interview season wise collection of NTFP by local people was monitored to study market dynamics and quantification was done village wise.

Report

The study attempted to understand the ecology of the lion-tailed macaque to identify the crucial food resources for their survival. On the other hand, local people collect many forest species as NTFP for their livelihood. We presume an overlap in the resource use by local people and lion-tailed macaque in the forests of Sirsi-Honnavara. Identifying a common resources and their management in the region is important from the point of management. Chapter 1 give a background and need for the study. Chapter 2 comes out of large set of data on feeding ecology of lion-tailed macaque highlighting the activity pattern, food resources, food type and preference of food species in the forests of Sirsi-Honnavara. Chapter 3 discuss the social status of local people and their dependency on NTFP, species collected as NTFP and their market value. Chapter 4 synthesizes the information on overlap in the resource uses by local people and lion-tailed macaque, and address conservation and management issues.

References

Altmann, J. (1974). Observational study of behavior: Sampling methods. B*ehavior,* 49:227-267.

Amit, M. and Correa, M. (1997). Uttara Kannada an evaluation of the first phase of work on non timber forest produce in support of the KFD/DFID Western Ghats forestry project, Oxfam (India) trust, New Delhi.

Chandran, M.D.S., Mesta, D.K., Rao, G.R., Ali, S., Gururaj, K.V. and Ramachandra T.V. (2008). Discovery of two critically endangered tree species and issues related to relic forests of the Western Ghats. *The Open Conservation Biology Journal*, 2:1-8.

Gaonkar, D.S., Shivanagowda, S. and Harrison, M. (1998). A review of NTFP management in Kanara Circle: Policy and institutional changes to improve resource management and rural livelihoods, Bangalore: Western Ghats Forestry Project, Karnataka Forest Department.

Hegde, N. (2008). Women and management of non timber forest products: Conservation and livelihood issues of indigenous women in the Western Ghats, India. Sirsi, India.

Hegde, P., Hegde, B. and Hegde, N.R. (2000). Non-timber forest products in Uttara Kannada district. Report submitted to international union for the conservation of nature and natural resources. Gland, Switzerland: IUCN.

IUCN (2003). 2003 Red List of Threatened Species. *www.redlist.org*, accessed on October 15, 2004.

Joseph, G.K. and Ramachandran, K.K. (1998). Recent population trends and management of lion-tailed macaque (*Macaca silenus*) in Silent Valley National Park, Kerala, India. *Indian Forester*, 124: 833-840.

Karanth, K.U. (1985). Ecological status of the lion-tailed macaque and its rainforest habitats in Karnataka, India. *Primate Conservation*, 6: 73-84.

Karanth, K.U. (1992). Conservation prospects for lion-tailed macaques in Karnataka, India. *Zoo Biology*, 11: 33-41.

Krishnamani, R. and Kumar, A. (2000). Phyto-ecology of the lion-tailed macaque (*Macaca silenus*) habitats in Karnataka, India: Floristic structure and diversity of food trees. *Primate Report*, 58:27-66.

Kumar, A. (1987). *Ecology and population dynamics of the lion-tailed macaque (Macaca silenus) in south India*. Ph.D. Dissertation, Cambridge University, Cambridge.

Kumar, A. (1995). The life history, ecology, distribution and conservation problems in the wild. In *The Lion-tailed Macaque: Population and Habitat Viability Assessment Workshop* (eds. Kumar, A., Molur, S. and Walker, S.). Zoo Outreach Organization, Coimbatore, India, pp. 1-11.

Kumara, H.N. (2005). *An Ecological Assessment of Mammals in Non-sanctuary Areas of Karnataka*. PhD Thesis, University of Mysore, Mysore, India.

Kumara, H.N. (2007). *Impact of Local Hunting on Abundance of Large Mammals in Three Protected Areas of the Western Ghats, Karnataka*. Technical Report, submitted to Rufford Maurice Laing Foundation, UK. National Institute of Advanced Studies, Bangalore.

Kumara, H.N. and Singh, M. (2004a). Distribution of primates and conservation of *Macaca silenus* in rainforests of the Western Ghats, Karnataka, India. *International Journal of Primatology*, 25: 1001-1018.

Kumara, H.N. and Singh, M. (2004b). The influence of differing hunting practices on the relative abundance of mammals in two rainforest areas of the Western Ghats, India. *Oryx*, 38: 321-327.

Kumara, H.N. and Sinha, A. (2009). Decline of lion-tailed macaque populations in the Western Ghats, India: Identification of a viable population and its conservation in Karnataka state. *Oryx*, 43:292-298.

Kumara, H.N., Raj, V.M. and Santhosh, K. (2008). Assessment of the important wildlife habitat in Sirsi-Honnavara forest divisions, Karnataka: with special emphasis on estimation of lion-tailed macaque *Macaca silenus* population. Technical Report 1, submitted to Karnataka Forest Department, Sirsi, India.

Molur, S., Brandon-Jones, D., Dittus, W., Eudey, A., Kumar, A., Singh, M., Feeroz, M.M., Chalise, M., Priya, P. and Walker, S. (2003). *Status of South Asian Primates: Conservation Assessment and Management Plan (C.A.M.P.) Workshop Report, 2003*. Zoo Outreach Organization/CBSG-South Asia, Coimbatore, India.

Pascal, J.P. (1988). *Wet Evergreen Forests of the Western Ghats of India*, Institut Francais De Pondicherry, Pondicherry, India, p. 345.

Ramachandran, K.K. and Joseph, G. (2001). Habitat utilization of lion-tailed macaque (*Macaca silenus*) in Silent Valley National Park, Kerala, India. *Primate Report*, 58: 17-26.

Rai, N.D. (2003). Human use, reproductive ecology, and life history of *Garcinia gummai-gatta*, a non timber forestry product, in the Western Ghats, India. PhD thesis, University Park, Pennsylvania State University.

Rai, N.D. and Uhl, C.F. (2004). Forest product use, conservation and livelihoods: The case of

Uppage fruit harvest in the Western Ghats, India. *Conservation and Society*, 2: 289-313.

Singh, M., Singh, M., Kumar, M.A., Kumara, H.N., Sharma, A.K. and Sushma, H.S. (2000). Niche separation in sympatric lion-tailed macaque (*Macaca silenus*) and Nilgiri langur (*Presbytes johnii*) in an Indian tropical rainforest. *Primate Report,* 58: 83-95.

Singh, M., Kumara, H.N., Ananda Kumar, M. and Sharma, A.K. (2001). Behavioral responses of lion-tailed macaque to a changing habitat in a tropical rainforest fragment in Western Ghats, India. *Folia Primatologica,* 72:278-291.

Singh, M., Singh, M., Kumar, M.A., Kumara, H.N., Sharma, A.K. and Kaumanns, W. (2002). Distribution, population structure and conservation of lion-tailed macaque (*Macaca silenus*) in Anaimalai Hills, Western Ghats, India. *American Journal of Primatology*, 57: 91-102.

Sushma, H.S. and Singh, M. (2006). Resource partitioning and interspecific interactions among sympatric rain forest arboreal mammals of the Western Ghats, India. *Behavioural Ecology*, 17:479-490.

Umapathy, G. and Kumar, A. (2000). Impacts of the habitat fragmentation on time budget and feeding ecology of lion-tailed macaque (*Macaca silenus*) in rain forest fragments of Anamalai hills, south India. *Primate Report*, 58:67-82.

Feeding ecology of lion-tailed macaque

Introduction

The basic understanding of the quantitative natural history of a species is very much required to plan the conservation activities for the long term survival of the species in a particular area (Caro 1998, 2007; Fashing, 2007b). ACR, a newly notified conservation reserve has high human density in which LTM is considered as flagship species for conservation. It is known that when a primate species specialises in its diet, it faces a greater risk of extinction (Harcourt et al. 2002). Thus the importance of studying the feeding ecology for an endangered and endemic species will give valuable insights into its dietary specialization (Caro, 1998). This will also help in assigning the conservation priorities to their habitats (Mittermeier and van Roosemalen, 1981) that is indeed very essential for the habitat such as ACR which has high density of humans and high degree of anthropogenic interference.

Lion-tailed macaque

Studies conducted in other locations of LTM's range revealed some quantitative and qualitative information on the diet of LTM. LTM feed largely on fruits >60% (Kumar, 1987), mainly *Ficus* spp. which is aseasonal, patchy in distribution and rare (Kumar, 1987; Sushma, 2004) or fruits and flowers of *Cullenia exarillata* which are abundant and very important resource (Kumar, 1987; Sushma, 2004) in Anamalai Hills. Studies in Varagaliar forests of Anamalai Wildlife Sanctuary ascertained that there were two annual peaks for feeding during the months of December to February and May to July and the months which had the least feeding and most foraging activities from September to April (Kurup and Kumar, 1991). A significant difference was also established in terms of more fruit consumption and less insect feeding in the wet season as compared to drier months in Andiparai shola of Anamalai hills (Singh *et al*., 2000). The study in Silent Valley NP, Kerala has revealed that the propriety food species are *Cullinea exarillata, Palaquium ellipticum, Ficus beddomi* and *Dryptes elata* respectively (Ramachandran and Joseph, 2000) and the studies in different sites of Indira Gandhi Wildlife Sanctuary was also found *Cullenia exarillata* as one of the high priority food species for lion-tailed macaque (Umapathy and Kumar, 2000 and Sushma and Singh, 2006). This clearly shows that the *Cullenia exarillata* is one of the major food species for lion-tailed macaque in southern Western Ghats (Kumar, 1987; Ramachandra and Joseph, 2000; Umapathy and Kumar, 2000; Singh *et al.,* 2000; Singh *et al.*, 2001, Sushma and Singh, 2006), which is absent north of Brahmagiri Wildlife Sanctuary in Karnataka (Pascal, 1988). However, based on findings from these studies Krishnamani and Kumar (2000) listed possible food tree species (218) for entire geographical range of lion-tailed macaque in Western Ghats, and their status for few locations including Brahmagiri, Kudremukha, Someshwara, Kodachadri and Sharavathi in Karnataka. Pascal (1988) pointed out change in plant species composition for change in every degree coordinate. Although many species of food trees have been reported for the entire range of LTM, it is difficult to develop the conservation action plan and the management plan due to lack of studies on use of plant species as food by LTM at each priority areas. Further, the use of tree species as food varies according to change in plant species composition. Thus it is not only apparent that the crucial food trees are not the same, as most of them do not have their distribution in the area and thus the preferred plant species by monkeys in the area are also expected to change. The newly framed ACR in central Western Ghats marks the northern limit of the evergreen forests of the plains and low elevations (Pascal, 1988), and these forests have been facing a drastic change in plant species composition over the period due to various anthropogenic activities and exploitation. Thus the present study has got its importance in finding the plant species used by LTM and prioritising the plant species for conservation and management of the park. The feeding ecology and plant species use by LTM in ACR are discussed in the present chapter.

Study Site

Aghanashini Lion-tailed macaque Conservation Reserve (ACR) lies between N14° 23' - 14° 23' 38" and E 74° 48' - 74° 38' in central Western Ghats in the district of Uttara Kannada in the state of Karnataka. ACR extends from the north of Sharavathi River to the Valley of Aghanashini River, and falls under the jurisdiction of Sirsi and Honnavara forest division under the administrative control of Kanara Forest Circle. The temperature in the area varies from 15° C in the winter to maximum of 36° C in the summer. The average temperature however is about 23°C. Though the region receives both monsoons, the south-west monsoon (June to October) is predominant although the retreating rains are also witnessed in November. The dry season is for about six months with occasional summer showers in April and pre-monsoon showers during May. The average annual precipitation recorded was 5000 mm (Nilkund rain station).

ACR and surrounding lion-tailed macaque habitat hold high human density of more than 15000 people with large extant of agricultural fields. The present study was conducted at northern part of the lion-tailed macaque population at in and around the village Surgaal, in the Kyadagi range of Sirsi forest division.

About 268 species of plants have been documented from the ACR and surrounding evergreen forests, which include 116 trees, 14 lianas, 35 climbers, 33 herbs, 59 shrubs, 4 palms, 2 grass and 5 species of orchids (Vasudev, unpublished checklist). Among them, two species are critically endangered, five species are endangered and 16 species are vulnerable (IUCN Redlist, 2003). The region has many Myristica swamps which are a home for many endemic plant species. Faunal diversity in the region includes 65 species of butterflies, 35 species of amphibians (26 species are endemic to these Ghats), at least 182 species of birds and 33 species of mammals. The major mammal species of the area include gaur *Bos gaurus*, muntjac *Muntiacus muntjak*, Indian chevrotain *Tragulus meminna*, sambar *Cervus unicolor* and wild pig *Sus scrofa*. Primates are more abundant in the study area than all other mammals which include Malabar slender loris *Loris lydekkerianus malabaricus*, lion-tailed macaque *Macaca silenus*, bonnet macaque *Macaca radiata*, Hanuman langur *Semnopithecus dussumieri*. The two species of squirrels in the area are Indian giant squirrel *Ratufa indica* and giant flying squirrel *Petaurista petaurista*. The large carnivores in the area include tiger *Panthera tigris*, leopard *Panthera pardus*, wild dog *Cuon alpines* and Jackal *Canis aureus*. Small carnivores like brown palm civet *Paradoxurus jerdoni*, Asian palm civet *Paradoxurus hermophroditus* and small Indian civet *Vivericula indica* are known to occur in the study site.

Methods

Two groups of LTM (group 1: Hosathota, group 2: Chiksuli) in the northern most part of the reserve were selected for the study keeping logistics and effective tracking into consideration (Table 2.1). Data on Hosthota group was collected from June 2009 to February 2011 and the data on adjacent Chiksuli group was collected from April 2010 to February 2011 for five days for each group in a month. The group once tracked was followed continuously from dawn to dusk. During the follow of the group geocoordinates were recorded at half an hour intervals from the starting point to till the end of day's follow using handheld GPS. Additionally geo-coordinates of locations of important feeding sites, conflict areas with adjacent groups and rare encounters of other animals with LTM were recorded. Group Scan Sampling (Altmann, 1974) was done to study the time activity budget and feeding ecology of the study groups. Group scans were taken on all visible members for a period of 5 minute at every 15-min interval. At each scan the data on identity or age/sex class, height of the tree and animal height on that tree, activity and the distance and identity of its nearest individual was recorded. The groups were mostly followed for consecutive days in order to keep continuous track for the month.

Table 2.1 Table showing the demography of the study groups

Sl. No.	Group name	Adult male	Adult female	Subadult Male	Subadult female	Juv	Infant (2)	Infant (1)	Total
1	Hosthota	2	16	3	0	5	0	3	29
2	Chiksuli	2	10	2	0	10	5	1	30

Table 2.2 Table showing descriptions of activities of LTM

(Based on Sushma and Singh, 2006)

Activity	Description
Rest	When an individual showed passivity either sitting, masticating or sleeping. In feeding bouts, if the individual was inactive, it was recorded as resting only if it lasted for more than 5s (Struhsaker, 1975).
Move	Any movement between feeding trees or continuous travel was recorded as move. Movement within the same tree for feeding were excluded.
Eat	When an individual ingested either plant food or faunals excluding the food manipulation was considered as eat.
Explore	When an individual either searched for food or when stationed at a place searching for food, manipulation of food and handling time of either food or insects were considered as explore.
Social	Behaviours such as grooming, play (contact and non-contact), inter group or intra group aggressions and affiliations or agonistic interactions were considered as social

The activities of LTM were broadly classified into five categories viz. Move, Rest, Eat, Explore and Social. The descriptions of the activities were followed as provided by Sushma and Singh (2006). The descriptions of the categories are summarised in the Table 2.2. The food type was broadly divided into three categories viz. Plants, Faunals and Mushroom. The data from the scan sampling was pooled according to the season (summer: February- May, Monsoon: June-September, and Post-monsoon: October-January). The plant parts eaten by

LTM were broadly classified as fruit (ripe and unripe), leaves (young and mature), resin (sap or exudates on the tree bark), flowers (entire flower, parts of flower and nectar), young leaves (young off shoots, soft young stem and soft parts of mature stems) and Pith. In the present study since our interest was to identify the plant resources used by LTMs, we pooled the data on scan sampling of both the groups and treated as single set of data for all analyses in the chapter. Data was analysed using SPSS software.

Results

The study groups spent a mean scan time of 38.4% (±0.79) on movement, 13.02% (±0.73) on resting, 19.48% (±0.93) on feeding, 24.11% (±0.75) on foraging, 4.98 %(±0.43) on social activities and 0.98% (±0.09)on self directed behaviours (Figure 2.1). Kruskal-Wallis test shown that though each activity varied between the seasons, the percent of time spent on foraging behaviour (χ^2 = 12.784, p< 0.01), movement (χ^2 = 11.062, p< 0.01) and social activity (χ^2 = 10.427, p< 0.01) varied significantly, but the difference was not significant for rest (χ^2 = 4.929, p = 0.08), feeding (χ^2 = 1.804, p = 0.41) and self directed behaviour (χ^2 = 2.367, p= 0.306). Movement (40.90%±0.85) and foraging (26.06%±0.85) was higher in the post-monsoon than in the monsoon (movement: 33.37%±2.74; foraging: 20.75%±2.57) and post monsoon (movement: 36.13%±1.43; foraging: 22.05% ±1.43) seasons, and resting (28.55% ±1.02) was more during the post-monsoon than in monsoon (20.53%±3.55) and summer (19.85% ±3.09).

The percent time spent by lion-tailed macaque on various food sources include different resources of plants was 85.21±1.33, faunal was 11.65±0.98 and fungus (mushrooms) was 2.31±0.51 (Figure 2.2). Feeding on plant resources (monsoon: 92.00±1.77; post-monsoon: 81.58±1.50; summer: 88.74±3.11), faunal (monsoon: 5.59±1.26; post-monsoon: 15.01±1.29; summer: 8.27±1.80) and mushroom (monsoon: 2.41±1.73; post-monsoon: 3.41±0.76; summer: 0.21±0.21) was varied significantly between the seasons (χ^2 = 20.038, p < 0.001, χ^2 = 19.306, p < 0.001 and χ^2 = 14.439, p < 0.001 respectively).

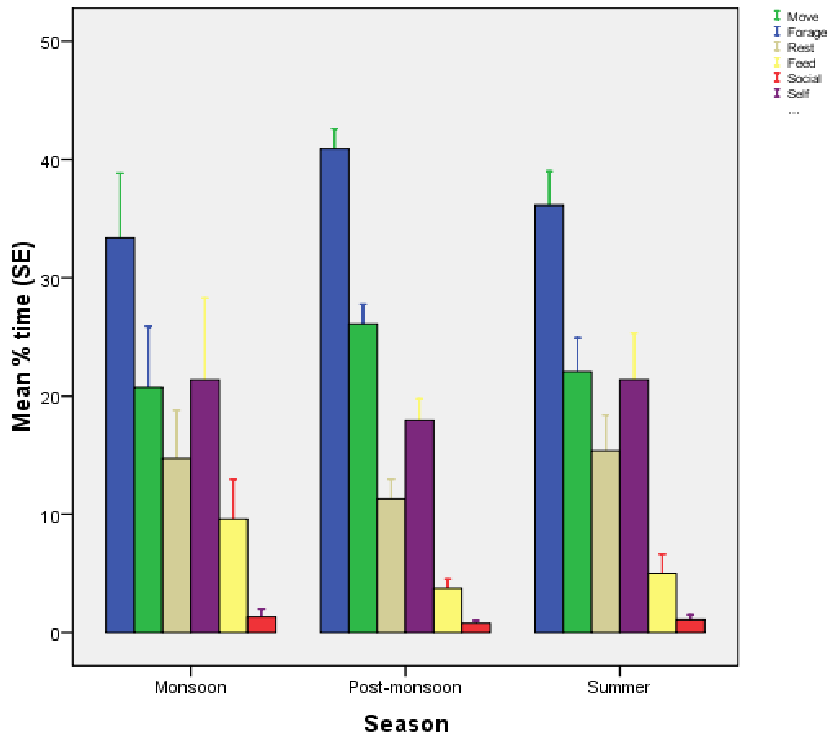


Figure 2.1 Mean percent time spent on different activities by LTM across the seasons during the study period

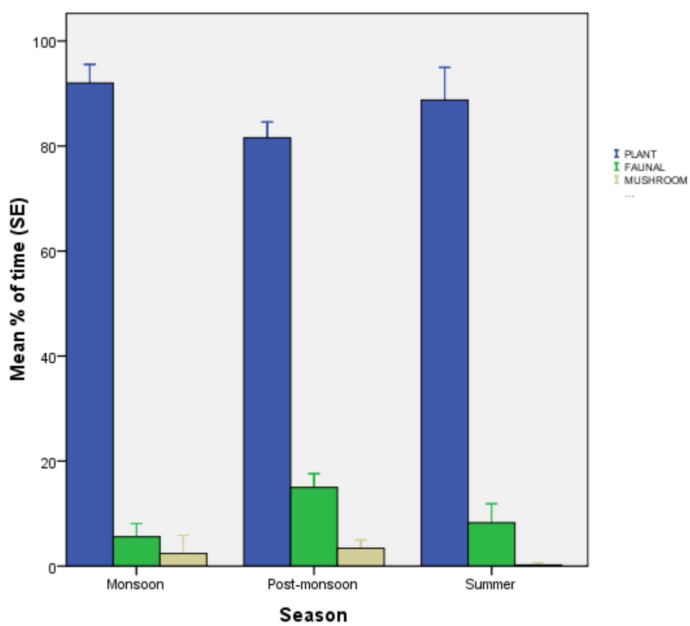


Figure 2.2 Mean percent time spent on feeding on different food sources by LTM across the seasons during the study period

Lion-tailed macaques fed on about 85 resources (fruits, young leaves, flowers, resins-exudates and pith) from 59 species of plants (Table 2.3). Table 2.4 provides percent time spent on feeding on different plant species in different seasons. The most important food plants for lion-tailed macaque in the study area include *Caryota urens* (26.91%), *Pandanus tectorius* (9.32%), *Psychotria nigra* (7.10%), *Diaspyros sylvatrica* (4.66%), *Chilocarpus atriverens* (4.45%), *Aglaia roxburghiana* (3.59%), *Ficus nervosa* (3.55%), *Artocarpus hirsutus* (3.16%), *Ficus microcarpa* (2.90), *Flacourtia montana* (2.52%), *Garcenia gummi-gutta* (2.01%), *Calamus pseudo-tenius* (1.83%), *Nathopegia recemosa* (1.79%), *Ficus infectoria* (1.58%) and *Calamus twaitessi* (1.49%). However, feeding on these plants highly varied between the seasons. The fruit of *Caryota urens* was highly used during monsoon and post monsoon, similarly different plant resources were differentially used in different seasons e.g. *Pandanus tectorius* (12.12% in post monsoon), *Psychotria nigra* (11.44% in post monsoon) *Diaspyros sylvatrica* (24.01% in monsoon), fruits of the climber *Chilocarpus atriverens* (6.54% in post monsoon), fruits of *Aglaia roxburghiana* (16.38% in monsoon), fruits of *Ficus nervosa* (15.6% in summer), *Artocarpus hirsutus* (3.16% in summer), fruits of *Garcenia gummi-gutta* (5.93% in monsoon and 4.32% in summer) and *Calamus pseudo-tenius* (2.81% in summer).

Table 2.3 Table showing the plant parts used and plant species across seasons by LTM during the study period

Sl.no.	**Plant species**	**Summer**	**Monsoon**	**Post monsoon**
1	*Chilocarpus atrivirens*	Fruit		Fruit
2	*Memycelon malabaricum*	Fruit		
3	*Holigarna arnottia*	Fruit	Fruit	
4	*Hopea ponga*			Exudates
5	*Canthium dicoccum*	Fruit		Fruit
6	*Flacourtia montana*	Fruit		Fruit
7	*Mimusops elangii*			Young leaves
8	*Diospyros montana*	Fruit, Exudates	Fruit	
9	*Piper nigrum*	Fruit		Young leaves, Leaves
10	*Pinanga dicksoni*		Young leaves	Young leaves
11	*Callicarpa tomentosa*			Young leaves
12	*Caryota urens*	Fruit	Fruit	Fruit, Young leaves, Pith
13	*Ziziphus rugosa*			Young leaves
14	*Eleocarpus serratus*			Exudates
15	*Calamus pseudo-tenuis*	Fruit, Young		Fruit, Young

		leaves		leaves
16	*Aglaia roxburghiana*	Fruit	Fruit	
17	*Salacia oblonga*		Fruit	Young leaves
18	*Diospyros sylvatica*	Flowers	Fruit	Fruit, Young leaves, Exudates
19	*Pandanus tectorius*	Young leaves	Young leaves	Fruit, Young leaves
20	*Pothos scandens*	Young leaves, Leaves	Leaves	Young leaves, Leaves
21	*Knema attenuate*	Fruit	Fruit	Young leaves
22	*Chrysophyllum roxburghii*		Fruit	Fruit
23	*Carissa spinarum*		Fruit	
24	*Litsea floribunda*	Fruit, Leaves		
25	*Smilax zeylanica*	Fruit, Young leaves		Fruit, Leaves
26	*Syzizium hemispermicum*	Flower		Flower
27	*Calophyllum tomentosum*		Fruit	Young leaves, Leaves
28	*Garcenia morella*		Young leaves	Young leaves, Leaves
29	*Gnetum ula*		Fruit	Fruit
30	*Vitex altissema*	Leaves	Fruit	Fruit
31	*Calophyllum apetalum*			Young leaves, Leaves
32	*Calamus twaitessi*	Young leaves, Leaves		Young leaves, Leaves
33	*Phychotria flavida*		Fruit	Fruit
34	*Ficus microcarpa*	Fruit		Fruit
35	*Maduca longifolia*			Flowers
36	*Desmos lawii*			Young leaves
37	*Psychotria dalzelli*			Fruit
38	*Olea dioca*	Fruit, Flowers		Fruit
39	*Diospyros buxifolia*	Exudates	Exudates	Exudates
40	*Artocarpus hirsutus*	Fruit		Young leaves
41	*Canthium aungustifolium*	Fruit		
42	*Holigarna grahmi*	Fruit		
43	*Ficus infectoria*	Fruit	Fruit	Fruit
44	*Erycibe paniculata*			Young leaves
45	*Bridelia stipularis*	Fruit		
46	*Melastoma malabathricum*	Fruit		
47	*Artocarpus heterophyllus*	Fruit	Fruit	
48	*Nathopegia racemosa*			Exudates, Leaves
49	*Cayratia reticulate*	Fruit		
50	*Symplocos racemosa*	Fruit		
51	*Mangifera indica*	Fruit		
52	*Makaranga peltata*	Fruit		Leaves
53	*Ficus nervosa*	Fruit		
54	*Trichelia connaroides*	Exudates		
55	*Syzizium cumini*	Fruit		
56	*Belsmedia whitii*			Fruit
57	*Psychotria nigra*			Fruit
58	*Syzizium gardneri*		Fruit	
59	*Garcenia gummi-gutta*	Fruit	Fruit	Leaves

Table 2.4 Table showing the percent time spent on each plant species in different seasons and overall by LTM during the study period

Sl. No.	Plant Species	Overall	Summer	Post Monsoon	Monsoon
1	*Caryota urens*	26.91	4.69	34.87	27.68
2	*Pandanus tectorius*	9.32	7.70	12.12	0.28
3	*Psychotria nigra*	7.10	0.00	11.44	0.00
4	*Diospyros sylvatica*	4.66	2.44	0.75	24.01
5	*Chilocarpus atrivirens*	4.45	1.69	6.54	0.00
6	*Aglaia roxburghiana*	3.59	4.88	0.00	16.38
7	*Ficus nervosa*	3.55	15.60	0.00	0.00
8	*Artocarpus hirsutus*	3.16	13.72	0.06	0.00
9	*Ficus microcarpa*	2.90	4.88	2.89	0.00
10	*Flacourtia montana*	2.52	8.83	0.82	0.00
11	*Garcenia gummi-gutta*	2.01	4.32	0.20	5.93
12	*Calamus pseudo-tenuis*	1.83	2.81	1.92	0.00
13	*Nathopegia racemosa*	1.79	0.00	2.89	0.00
14	*Ficus infectoria*	1.58	1.31	1.72	1.41
15	*Calamus twaitessi*	1.49	1.12	1.99	0.00
16	*Olea dioca*	1.45	5.45	0.34	0.00
17	*Maduca longifolia*	1.36	0.00	2.20	0.00
18	*Psychotria dalzelli*	1.28	0.00	2.26	0.00
19	*Vitex altissema*	1.11	0.18	0.06	6.77
20	*Makaranga peltata*	0.98	4.13	0.06	0.00
21	*Pothos scandens*	0.98	1.12	0.96	0.84
22	*Artocarpus heterophyllus*	0.81	1.50	0.00	3.10
23	*Pinanga dicksoni*	0.81	0.00	1.24	0.28
24	*Holigarna grahmi*	0.72	3.19	0.00	0.00
25	*Piper nigrum*	0.72	0.56	0.96	0.00
26	*Belsmedia whitii*	0.64	0.00	1.03	0.00
27	*Knema attenuate*	0.64	0.56	0.06	3.10
28	*Phychotria flavida*	0.55	0.00	0.82	0.28
29	*Calophyllum tomentosum*	0.55	0.00	9.23	0.28
30	*Diospyros buxifolia*	0.47	1.31	0.13	0.56
31	*Symplocos racemosa*	0.42	1.87	0.00	0.00
32	*Syzizium gardneri*	0.38	0.00	0.00	2.54
33	*Gnetum ula*	0.34	0.00	0.06	1.97
34	*Chrysophyllum roxburghii*	0.34	0.00	0.48	0.28
35	*Holigarna arnottia*	0.34	0.18	0.00	1.97
36	*Diospyros montana*	0.29	0.75	0.00	0.84
37	*Canthium dicoccum*	0.29	0.75	0.20	0.00
38	*Callicarpa tomentosa*	0.25	0.00	0.41	0.00
39	*Syzizium cumini*	0.21	0.93	0.00	0.00
40	*Cayratia reticulate*	0.17	0.75	0.00	0.00
41	*Smilax zeylanica*	0.17	0.37	0.13	0.00
42	*Carissa spinarum*	0.17	0.00	0.00	1.12
43	*Ziziphus rugosa*	0.17	0.00	0.27	0.00
44	*Trichelia connaroides*	0.12	0.56	0.00	0.00
45	*Erycibe paniculata*	0.12	0.00	0.20	0.00

46	*Calophyllum apetalum*	0.08	1.12	0.13	0.00
47	*Garcenia morella*	0.08	0.00	0.13	0.00
48	*Syzizium hemispermicum*	0.08	0.18	0.06	0.00
49	*Litsea floribunda*	0.08	0.37	0.00	0.00
50	*Salacia oblonga*	0.08	0.00	0.06	0.28
51	*Memycelon malabaricum*	0.08	0.37	0.00	0.00
52	*Mangifera indica*	0.04	0.18	0.00	0.00
53	*Melastoma malabathricum*	0.04	0.18	0.00	0.00
54	*Bridelia stipularis*	0.04	0.18	0.00	0.00
55	*Canthium aungustifolium*	0.04	0.18	0.00	0.00
56	*Desmos lawii*	0.04	0.00	0.06	0.00
57	*Eleocarpus serratus*	0.04	0.00	0.06	0.00
58	*Mimusops elangii*	0.04	0.00	0.06	0.00
59	*Hopea ponga*	0.04	0.00	0.06	0.00

Table 2.5 Table showing plant parts eaten by LTM in different season during the study period (in parenthesis - SE)

Plant part	**Monsoon (June-Sep)**	**Post Monsoon (Oct-Jan)**	**Summer (Feb-May)**	**Overall**	**Kruskal-Wallis test (N=120)**
Fruit	97.92 (1.29)	66.10 (3.62)	69.51 (4.88)	71.62 (2.68)	$\chi^2 = 1.804$, $p < 0.001$
Flower	0	4.40 (1.68)	12.24 (3.57)	5.91 (1.45)	$\chi^2 = 1.804$, $p < 0.001$
Young leaves	0.20 (0.20)	20.00 (2.44)	12.10 (2.68)	14.84 (1.70)	$\chi^2 = 1.804$, $p < 0.001$
Leaves	0.98 (0.98)	6.05 (1.84)	3.64 (1.74)	4.62 (1.17)	$\chi^2 = 1.804$, $p = 0.149$
Pith	0	0.96 (0.47)	0	0.54 (0.27)	$\chi^2 = 1.804$, $p = 0.088$
Resin	0.91 (0.91)	2.81 (0.71)	2.50 (1.22)	2.45 (0.55)	$\chi^2 = 1.804$, $p = 0.178$

Table 2.5 provide plant parts eaten by lion-tailed macaque in different seasons. Feeding on fruit (71.62±2.68) was more than all others viz. Flower (5.91±1.45), young leaves (14.84±1.70), leaves (4.62±1.17), pith (0.54±0.27) and resin (2.45±0.55). Though the feeding on different plant resources varied between the seasons, but percent time spent on feeding on fruit, flower and young leaves varied significantly than others (Table 2.5).

Discussion

The forests of ACR are under constant pressure and the vegetation structure has been under constant modification due to anthropogenic activities. Though the LTMs show some plasticity in dietary adaptation to changing food resources in fragmented forest (Singh *et al*., 2002), they consume low quality diet in fragmented areas as compared to those of continuous undisturbed forests (Menon and Poirier, 1996). This indeed indicates the quality of habitat with reference to disturbance can play an important role in their survival. Further, preferred food sources are important in such stochastic habitat for the management of the habitat, when the habitat is marginally protected.

Among the major activities, foraging was observed more by the LTMs than feeding, resting, moving and social behaviour activities. Though spatially they may have not covered large area, they spent more time on searching food. Kurup and Kumar (1993) reported the time spent on foraging and movement was relatively more than the time spent on other activities in Anagunthi and Varagaliar in Anamalai Hills. Since the LTMs are specialised feeders, they spend substantial amount of time by searching for food due to clumped food resources or insects from different substrates of the tree or ground. LTM fed on plant resources more than faunals and mushrooms, which is similar to feeding ecology reported in Anamalai hills and Silent Valley NP (Singh *et al*., 2001; Ramachandran and Joseph, 2000; Umapathy and Kumar, 2000). Among the plant resources, they preferred fruits, and which is followed by young leaves, flowers, leaves, resins, and pith, conversely flowers are highly preferred next to fruits in Anamalai hills and Silent Valley NP (Ramachandran and Joseph, 2000). Faunal intake by LTM was high due to the outburst of insects during the post monsoon period. Although mushroom is seasonal, it was a constant part of its diet all through the year as different species of them grew on variable substrates such as bark, ground and crevices.

The major food tree of the LTM in southern Western Ghats is *Cullenia exarillata* (Kumar, 1987; Ramchandran and Joseph, 2000; Umapathy and Kumar, 2000; Singh *et al*., 2000; Singh *et al*., 2001; Sushma and Singh, 2006), which is indeed totally absent north of Brahmagiri Wildlife Sanctuary in central Western Ghats (Pascal, 1988). Several species of *Ficus* and *Artocarpus heterophyllus* (Umapathy and Kumar, 2000) and *Mesopsis eminii* formed the most preferred food species after *Cullenia exarillata* in fragmented forests of Puthuthottam, however, *Mesopsis eminii* is an exotic species found only in certain forest fragments of Anamalai hills, thus the *Ficus* species and *Artocarpus heterophyllus* are the most important food species. Where in ACR, though LTM fed on different resources from many species of plants, the fruits of *Caryota urens* were indeed the most widely eaten, however, although *Caryota urens* fruiting is not seasonal, it was not preferred during drier months which was taken over by fleshy and succulent fruits of *Ficus nervosa, Artocarpus hirsutus* and *Flacourtia montana*, yet *Caryota urens* forms an important food plant in its overall diet, thus the species can be considered as most important plant species in ACR. The number of plant species used for feeding during monsoon season was few, and the most important species are *Caryota urens, Diospyros sylvatica, Aglaia roxburgiana, Garcinia gummi-gutta and Vitex altisemma.* The dietary niche is much broader during post-monsoon and summer than monsoon, thus the highly preferred species during the monsoon should be considered for the long term management of the ACR for LTM.

References

Altmann, J. (1974). Observational study of behavior: sampling methods. *Behaviour,* 49:227–267.

Caro, T. (1998). Behavioral ecology and conservation biology. New York: Oxford University Press.

Caro, T. (2007). Behavior and conservation: a bridge too far? *Trends in Ecology and Evolution,* 22: 394–400.

Fashing, P.J. (2007). Behavior, ecology and conservation of colobine monkeys: an introduction. *International Journal of Primatology*, 28: 507–511.

Harcourt, A.H., Coppeto, S.A., and Parks, S.A. (2002). Rarity, specialization and extinction in primates. *Journal of Biogeography*, 29, 445–456.

IUCN (2003). 2003 Red List of Threatened Species. *www.redlist.org*, accessed on October 15, 2004.

Krishnamani, R. and Kumar, A. (2000). Phyto-ecology of the lion-tailed macaque (*Macaca silenus*) habitats in Karnataka, India: Floristic structure and diversity of food trees. *Primate Report,* 58:27-66.

Kumar, A. (1987). *Ecology and population dynamics of the lion-tailed macaque (Macaca silenus) in south India*. Ph.D. Dissertation, Cambridge University, Cambridge.

Kurup, G.U. and Kumar, A. (1993). Time budget and activity patterns of lion-tailed macaque (*Macaca silenus*). *International Journal of Primatology*, 14:

Menon, S. and Poirier, F.E. (1996). Lion-tailed macaques (*Macaca silenus*) in a disturbed forest fragment: Activity patterns and time budget. *International Journal of Primatology*, 17:

Mittermeier, R.A, and van Roosmalen, M.G.M. (1981). Preliminary observations on habitat

utilization and diet in eight Surinam monkeys. *Folia Primatologica* 36:1–39.
Pascal, J.P. (1988). *Wet Evergreen Forests of the Western Ghats of India*, Institut Francais De Pondicherry, Pondicherry, India, p. 345.
Ramachandran, K.K. and Joseph, G. (2000). Habitat utilization of lion-tailed macaque (*Macaca silenus*) in Silent Valley National Park, Kerala, India. *Primate Report*, 58: 17-26.
Singh, M., Singh, M., Kumar, M.A., Kumara, H.N., Sharma, A.K. and Sushma, H.S. (2000). Niche separation in sympatric lion-tailed macaque (*Macaca silenus*) and Nilgiri langur (*Presbytes johnii*) in an Indian tropical rainforest. *Primate Report*, 58: 83-95.
Singh, M., Kumara, H.N., Ananda Kumar, M. and Sharma, A.K. (2001). Behavioral responses of lion-tailed macaque to a changing habitat in a tropical rainforest fragment in Western Ghats, India. *Folia Primatologica*, 72: 278-291.
Singh, M., Singh, M., Kumar, M.A., Kumara, H.N., Sharma, A.K. and Kaumanns, W. (2002). Distribution population structure and conservation of lion-tailed macaque (*Macaca silenus*) in Anamalai Hills, Western Ghats, India. *American Journal of Primatology*, 57: 91-102.
Struhsaker, T.T. (1975). *The red colobus monkey*. Chicago: University of Chicago Press.
Sushma, H.S. and Singh, M. (2006). Resource partitioning and inter-specific interactions among sympatric rain forest arboreal mammals of the Western Ghats, India. *Behavioural Ecology*, 17:479-490.
Umapathy, G. and Kumar, A. (2000). Impacts of the habitat fragmentation on time budget and feeding ecology of lion-tailed macaque (*Macaca silenus*) in rain forest fragments of Anamalai hills, south India. *Primate Report*, 58:67-82.

Local people and NTFP collection

Introduction:

Humans were basically hunters and gatherers much before they became agriculturists and thus forest products make an important contribution to subsistence and market economies even today. Significance of forests in India is so prominent that it is estimated that about 50 million people depend on it directly for livelihood (Hegde et al., 1996). Several thousands of species of NTFP are collected worldwide (Myers, 1988) and in India about 3000 species yield NTFP (Saulei and Aruga, 1994). The human density in Uttara Kannada district is the lowest in the country (Census of India, 1991) and it has the largest forest cover(76%) in the state (Bhat et al., 2003). 130 species of NTFP are collected by people to varying extents in the district (Hegde et al., 2000). Significance of NTFP collection can be realized by the fact that the income is nearly twice as compared to timber collection (Murthy et al., 2005). In the district, many low income class people lead their livelihood using forest products and most communities have a tendency to collect forest produce (Gaonkar et al., 1998; Hegde et al., 2000; Rai, 2003; Rai and Uhl, 2004). Thus NTFP collection has been an integral part of their life system and its collection is extensive. Unsustainable collection of NTFP from crucial trees can deplete resources for its dependents on the long run. Extensive loss of important species due to faulty harvesting mechanisms (Parameswarappa, 1992; Murthy et al., 2005) indeed serves as warnings for policy makers.

The study area (forests of ACR) harbour high density of people and large extents of agricultural land, which is also indeed high biodiversity area including lion-tailed macaque. This work attempts to understand the interaction of people with forest thus indicating their dependence on livelihood and economy. This study also attempts to study harvesting mechanisms, rate of extraction and utilization over time and seasons indicating trends and patterns of use and yield for managing resources for administrators ensuring long term survival of NTFP for its dependents.

Study area

We selected 12 villages in and around the study area (range of two study groups of lion-tailed macaque) (Table 1). These villages were spread out in the forest area with an agriculture field. Houses in these villages interspersed with the forests. 73 households (94 % of the total households in the study area) were selected from these villages to understand their socioeconomic status and monitor the NTFP collection and use.

The major ethnic communities in the region are Naika, Vokkaliga gowda, Harijans and Brahmins who own either legal or acquired lands and practice traditional rain dependent agriculture. They depend on forests for a wide array of resources including leaf-litter, green manure, firewood, water and NTFP. Major crops of the area include areca and paddy for which they use 'organic manure' prepared locally by mixing leaf litter, green manure and cow dung.

Leaf-litter collection from the forest for organic manure

Table 1 Table showing the number of households interviewed for NTFP collection in the study area

Sl. No.	Village name	Total households	Households interviewed
1	Surgaal	30	28
2	Gurkodu	3	2
3	Kerekuli	8	8
4	Dyavingundi	2	2
5	Naaginmane	5	5
6	Kaanmane	2	2
7	Bolumane	2	2
8	Melinmane	16	14
9	Heggar	5	5
10	Kadlimane	3	3
11	Huthgaar	1	1
12	Kumrithota	1	1
	Total	78	73

Methods

Earlier we spent two years with people of the area while studying the lion-tailed macaques, and developed a good rapport with them. The present attempt of data collection was made after villagers developed a confidence on us and our study. We used the structured questionnaire (Appendix 1 and 2) to collect the data on their socioeconomic status and NTFP related aspects. To begin with one time data collection on socio-economic information and family details (family members, land and livestock holding, education, and livelihood aspects) were collected using questionnaire-1. At the end of each fourth month (the months were divided into three categories- Monsoon: June-Sept, Post-monsoon: Oct-Jan and summer: Feb-May), people were interviewed to collect the data on NTFP collection using questionnaire-2. The data was collected on species collected, harvesting technique, quantity extracted, distance travelled and number of individuals from family involved in collection. In addition to this, data on market dynamics of NTFP trading was also collected. Man days meant the mathematical multiplication of number of harvesters in a family and number of days involved in the harvest.

We developed five hypotheses for increased harvests at individual household level and applied Generalized Linear Model (Nelder and Wederburn, 1972). The criteria assumed were: i. Increase in number of people and man-days, ii. Increase in number of people only, iii. Increase in number of people and distance walked, iv. Increase in Man days and v. Increase in distance walked.

Results

The human population in 12 villages was 317 in 78 households, including 102 men, 109 women and 73 children; however, the data collected was on 73 households for the present study. Their major livelihood sources include income from agriculture, NTFP collection, daily wages and business (Fig.1). The large part of their livelihood was dependent on agriculture (67.68%) than from NTFP (13.40%) or daily wages and business (18.91%) (Fig.1). Areca (*Areca catechu*), vanilla (*Vanilla planifolia*) and pepper (*Piper nigrum*) were the major cash crops and paddy (*Oryza sativa*) was a major cultivation for the domestic purpose. Income from NTFP noticeably varied between the study years i.e. 4, 10,650 INR in 2008, 4, 56,941 INR in 2009, and 2, 64,832 INR in 2010 averaging to 3, 77,474 INR (Fig. 2).

NTFP was collected from a total of 15 species including honey from *Apis cerana* in the study area. During the monsoon, the major NTFP extracted was from *Garcenia gummi-gutta* and *Garcenia indica*, while *Myristica spp*., and *Cinnomomum malabathrum* during the post-monsoon season, and honey, *Piper nigrum*, *Calamus* spp., *Mangefera indica*, *Garcenia morella, Callophylum apetalum* and *Artocarpus lakoocha* during summer (Table 2). Two species of Calamus were extracted all through the year irrespective of seasons. Among them, largely NTFP was extracted from seven species (Fig. 4). *G. gummigutta* (91.78%) was the most widely collected species followed by *M. malabarica* (41.09%), *M. dactyloides* (38.35%), Honey (15.06%), 2 species of *Calamus* (6.84%) and *G. indica* (1.36%). Harvesters sometimes resorted to destructive harvesting practices by either cutting the branches of trees or wholly cut the resourceful tree for quick and increase harvests. Collection of *E. scandens, G. morella* and *C. apetalum* seeds were absent during the study period, while fruits of *Mangefera indica*, *Piper nigrum* and *A. lakoocha* were done in relatively smaller amounts. Information could not be obtained on extraction of *C. malabathrum* leaves and resin of *C. strictum* since people were refused to share information.

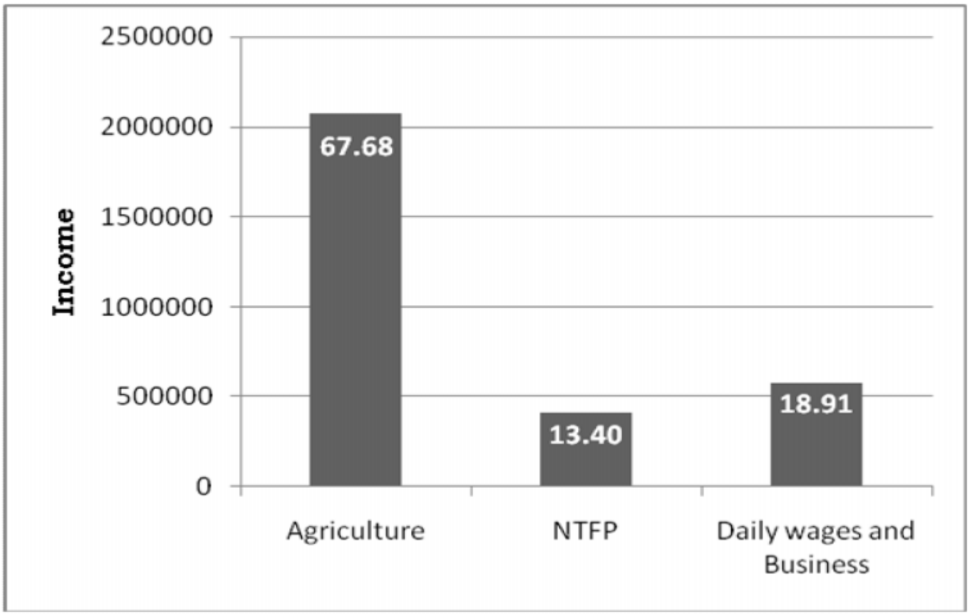


Figure 1 Overall income of people from different sources in 73 households during 2008

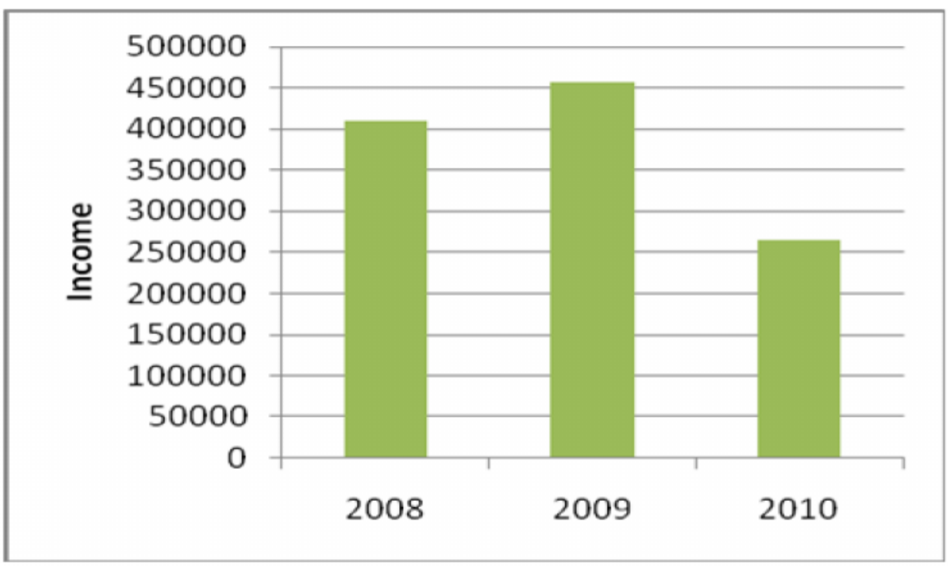


Figure 2 Income from NTFP to people of study villages during the study period (2008-2010)

Table 2 NTFP collected in the study area, part used and season of collection by people during the recent years

Sl. No.	Vernacular name	Latin name	Part used by people	Season of collection
1	Uppage	*Garcenia gummi-gutta*	Fruits and seeds	Monsoon
2	Rampathre	*Myristica malabarica*	Aril	Post-monsoon
3	Sannapathre	*Myristica dactyloides*	Aril	Post-monsoon
4	Kalu menasu	*Piper nigrum*	Seeds	Summer
5	Dalchinni	*Cinnomomum malabathrum*	Leaves, buds, bark	Post-monsoon
6	Halbettha	*Calamus spp.*	Mature stem	All through
7	Handibettha	*Calamus spp.*	Mature stem	All through
8	Maavu	*Mangifera indica*	Unripe fruits	Summer
9	Arsnalli	*Garcenia morella*	Fallen seeds	Summer
10	Muruglu	*Garcenia indica*	Mature fruits	Monsoon
11	Babbi	*Callophyllum apetalum*	Fallen seeds	Summer
12	Vaate	*Artocarpus lakoocha*	Unripe fruit	Summer
13	Rala dhoopa	*Canerium strictum*	Sap	All through
14	Kanabe/Ganape	*Entada scandens*	Seeds	Post-Monsoon
15	Jenu thuppa	*Apis cerana*	Honey, larvae, eggs	Summer

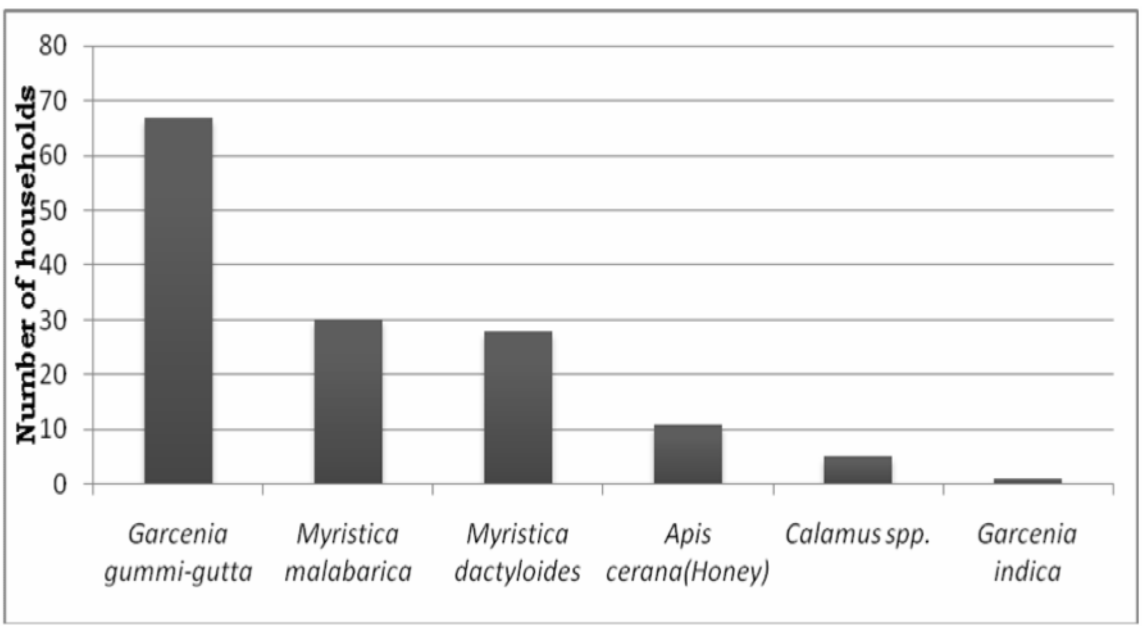
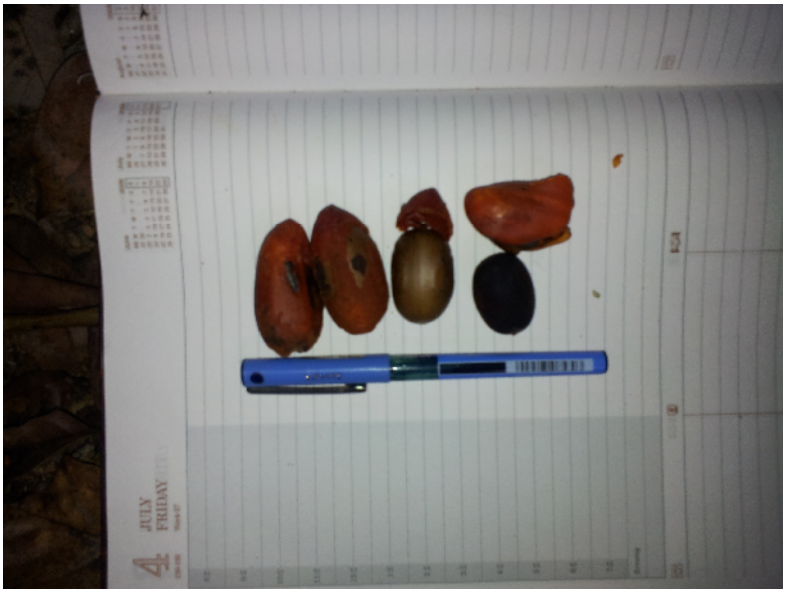


Figure 4 Graph showing the total number of households that extracted specific NTFP in the study area during 2008

Harvesting and processing mechanism of NTFP

Garcenia gummi-gutta:

Local people use different strategies to harvest *Garcenia gummi-gutta* fruits from forests and backyards or around their farmlands. People wait for the fruits to mature on trees which are claimed to be their own i.e. in backyard or around farmlands; on the other hand the unripe fruits are harvested from the forest. The date of harvest of fruits from the forest was decided upon from village meetings headed by only representatives of the village, and accordingly people venture out to the forest all at the same day. The date of collection is highly variable every year and it is based on demand and price of the product in the market. If there is a high price for dried fruits in a particular year, the tendency of people is towards quicker and maximized collections even though in unripe condition. Uppage is extracted by climbing trees or by collection of fallen fruits. The fruits are plucked down using *'dhotee'* (a long stick with a hook at the end). There have been instances where fruiting trees that are far from settlements have seen to be cut down for facilitating quicker harvests .The fruits from their backyard are left to completely ripen, and an only fallen fruit was collected. Once the fruits were carried back home, they are cut, deseeded and dried in a open oven fuelled by fire wood over night until the greenish yellow fruit dries and turns blackish completely. The seeds are also dried to extract oil.



Ripe fruits of *Garcenia gummi-gutta*   Aril extracted from the fruits of Myristica spp

Myristica spp.

Two species of Myristica i.e. *M. malabarica* and *M. dactyloides* were harvested between December and February. People make small teams of two to three individuals to search for fruiting trees and walk long distances (to 10 km). Mostly unripe fruits are harvested, and harvest is by climbing the tree and using *dhotee*. We have also witnessed lopping of branches and cutting of trees to harvest this fruit. The aril part of the fruit is extracted by breaking the fruits, and aril is separated from the seeds and dried for a day in shade, and taken care to retain appropriate moisture for gaining more weight. Though there is the knowledge among extractors that aril of ripe fruits weigh more than the ones of unripe fruits, the former is extracted due to competition.

Calamus spp.

Two species of *Calamus* are present in the study area; local people harvest both the species. Thorny stems of Calamus are cut carefully and de-thorned in the forest, slit into half and sliced off its surfaces, and carried back home. The thin sliced *Calamus* are then dried in sun light for couple of hours and these flexible stems are woven to make attractive products of utility such as baskets of different sizes.

Product made from *Calamus* spp

Local harvester using *dhotee*

Artocarpus lakoocha

The unripe fruits from *Artocarpus lakoocha* are used as souring agent in the local food-recipe. The fruit is extracted using *dhotee* by climbing the tree. The unripe fruits are brought back home chopped into small pieces, mixed with common salt as a mode of preservation and dried in direct sun light. The processed fruits are stored in air tight containers.

Garcenia morella

The fallen seeds of *Garcenia morella* are ground collected from the forest floor. Seeds are washed with water, cleaned and dried to extract the oil. Extraction is usually done in homes or in a local refinery mill. Purified oil is not consumed as food due to its bitter taste and it is used as fuel for lighting lamps for daily use and religious purposes.

Honey (*Apis cerana* indica)

Usually harvesters enter the forest very early in the morning and easily locate the hives by observing bee movements against the angle of sunlight. Honey is collected only of *Apis cerana* indica by smoking through the entrance of the hive and extracting the combs. The combs with honey that are removed are squeezed and raw honey is collected in containers. Hives with larvae and eggs are consumed raw and is considered delicacy. During the process of collection, extractors take care to not dismantle the crevices of the hive for the bees construct the hives in the same place successfully in the coming years. Some extractors make their own small parties to the forest and may sometimes camp over night as they go for long distances specifically searching for previously extracted crevices or tree holes which they claim to go year after year to same places for extraction.

Other NTFPs

Pepper is extracted by plucking the fruits from the creepers by climbing the corresponding trees. The harvested fruit is dried in sunlight for about a week and marketed. Mango unripe fruits which are used at households for domestic consumption are mostly found in '*bettas*' or backyards of houses. Fruits are plucked in unripe condition and stored in concentrated salt solution for preservation. Fruits of *Garcenia indica* are used as a souring agent in food.

The ripe fruits which are dried are used as a medicine in addition to it being a flavouring agent in food.

Dried fruits of *Garcenia indica*

Factors affecting the income from NTFP

Table 3 Table showing the descriptions of assumptions for GLM model and their respective values

Sl. No.	Criteria	AIC	Δi	wi
1	Increase in number of people and man days	296.9	0	0.5877
2	Increase in number of people	298.4	1.52	0.2744
3	Increase in number of people and distance walked	300.0	3.21	0.1179
4	Increase in man-days	303.7	6.77	0.0198
5	Increase in distance walked	319.7	20.83	0.00002

We considered some criteria that are helped in maximizing the income from the NTFP extraction among people in the study area, and used GLM model to find what has influenced people to get high income (Table 3). The most parsimonious GLM model was the increase in number of people going for harvest in the family and number of days (Man days) of harvest maximizing the income from NTFP.

Discussion

The collection of NTFP by human's dates back to historical times (Moegenburg, 2002; Posey, 1982). Conservation of forests through NTFP management has been stressed in recent years and has been considered seriously (Hiremath, 2004). However, the challenge lies in assessment and quantification of benefits from NTFP, to lead them to a socially and ecologically viable use for the purpose of livelihood and development of dependent people (Saulei and Aruga, 1994). Markets locally and globally remain unstable along with variations in NTFP productivity where harvesters and their dependents get direct effects (Arnold and Perez, 2001; Gopalakrishnan et. al., 2005; Mahapatra et. al., 2005; Rai and Uhl, 2004). NTFP collection also positively contributes to sustainable forest management by providing monetary incentives to economically weaker communities (Peters, 1989; Shahabuddin and Prasad, 2004; Kaushal and Melkani, 2005; Mahapatra et.al., 2005).

Agriculture is considered as a backbone of India and it is known that NTFP collection does not compete with agriculture in a country where major economy depends on it (Sharma, 1992). In India, there are about 15,000 plant species out of which nearly 3000 species (20%) yield NTFPs (Maithani, 1994). In the country, sustainable NTFP collection and its management with better markets have been promoted as a strategy to increase the economy of dependent people and also help conservation of wildlife (Hiremath, 2004; Mahapatra and Mitchell, 1997; Mahapatra et. al., 2005; Shaanker et.al., 2004a, 2004b; Shanker et. al., 2005).

In Uttara Kannada district, earlier studies indicate that NTFPs were extracted from 59 different species which are used for food, household articles, fencing, medicinal uses and commercial purposes (Murthy et.al. 2005). In the recent years at the study site people collected 15 NTFPs but during the study period it was reduced to only 7 species. Though the demand for all NTFPs were the same in the market, the resource availability probably played a major role in deciding the quantity of collection which varied from 91.7% (*Garcenia gummi-gutta*) to 1.36% (*Garcenia indica*). In the present study, findings suggest that Uppage was the most widely extracted NTFP in the recent years due to continual demand from pharmaceutical industries. Dried rind of Uppage is an additive and fish preservative (Samarajeewa and Shanmugapirabu, 1983) whose demand in market increased due to Hydroxy citric acid discovery for management of obesity (Majeed et.al., 1994; Sergio, 1988). In case of *Myristica malabarica* (n=30) and *Myristica dactyloides* (n=28) the demand for the product was such that the extractions happened much before the ripening of fruits due to competition among harvesters in addition to destructive harvesting practices. The dried aril of *Myristica* spp. is a chief constituent of Indian soups as spice, and also an additive in the Indian culinary. Although it was observed the collection of *Cinnamomum malabathrum* and *Canerium strictum* took place, the quantification of this was not possible because of their less-availability in the forest and also probably ban on extraction of these species. The rest of the NTFPs like *Piper nigrum, Mangefera indica, Garcenia morella, Callophyllum apetalum, Artocarpus lakoocha, Entada scandens* had no extractions during the study thus details into their harvest mechanism are not discussed.

If the people possessed time and labour required for collection of any commercial NTFP, they would maximize their income if the opportunity arise. Increase in effort of distance walked for harvest showed no significance to the income obtained. This was probably due to: a. the intense competition for harvesting that exists during a short period of time, b. the resource although evenly distributed, people walking longer distances had less chance of maximizing their harvest due to ease of access for that area by nearby villagers who also compete to maximize their income, and c. Some of the NTFP like Uppage which need quick processing in the given weather conditions making distance a limiting factor for increased harvesting because of several trips harvester has to make to and fro from the harvesting tree to processing place.

In most NTFP species the predictive ability of yield was difficult showing a significant difference in yield between two consecutive years due to environmental attributes (Bhat et.al., 2003) leading to changes in income from NTFP. When the NTFP resources are sparse, price shoots up and vice versa. This was exactly the case in the present study where the quantity of production, harvest and associated income which varied across years. Thus it can be easily ascertained that NTFP is a good part of income locally and thus play an important part in livelihood. Although the income from NTFP is not the highest compared to agriculture, NTFPs provide financial support for livelihoods continuously all throughout the year in smaller amounts in contrast to agriculture which benefits only one time in a year. The income from agriculture did not influence NTFP collections in the area. Banning and implementation of stringent rules against NTFP collection without proper scientific understanding may bring about socio-economic crisis. This may adversely affect the chain of events associated with NTFP trade and bring black market leading to loss of many important species of NTFP. A system to ensure proper monitoring of NTFP collection keeping long term incentives to people are strongly recommended.

References

Arnold, J.E.M. and Perez, M.R. (2001). Can non-timber forest products match tropical forest conservation and development objectives? *Ecological Economics*, 39: 437–447.

Bhat, P.R., Murali, K.S., Hegde, G.T., Shastri, C.M., Bhat, D.M., Murthy, I.K., and Ravindranath, N.H. (2003). Annual variation in non-timber forest product yield in the Western Ghats, Karnataka, India. *Current Science*, 85: 1350-1355

Census of India. (1991). District Profile 1991: Karnataka. New Delhi: Office of the Registrar General and Census Commissioner.

Gaonkar, D.S., Shivanagowda, S. and Harrison, M. (1998). *A Review of NTFP Management in Kanara Circle: Policy and Institutional Changes to Improve Resource Management and Rural Livelihoods*. Bangalore: Western Ghats Forestry Project, Karnataka Forest Department.

Hegde, P., Hegde, B. and Hegde, N.R. (2000). *Non-Timber Forest Products in Uttara Kannada District*., report submitted to International Union for the Conservation of Nature and Natural Resources. Gland, Switzerland: IUCN.

Hegde, R., Suryaprakash, S., Achoth, L. and Bawa, K.S. (1996). Extraction of Non-Timber Forest Products in the Forests of Biligiri Rangan Hills, India, 1: Contribution to Rural Income. *Economic Botany*, 50: 243-51.

Hiremath, A.J. (2004). The ecological consequences of managing forests for non-timber products. *Conservation and Society*, 2: 211–216.

Kaushal, K.K. and Melkani, V.K. (2005). India: Achieving the millennium development goals through non-timber forest products, *International Forestry Review* 7: 128-134.

Mahapatra, A.K., Albers, H.J, and Robinson, E.J.Z. (2005). The impact of NTFP sales on rural households' cash income in India's dry deciduous forest. *Environmental Management*, 35: 258-265

Mahapathra, A. and Mitchell, C.P. (1997). Sustainable development of non-timber forest products: implication for forest management in India. *Forest Ecology and Management*, 94: 15–29.

Maithani, G. P. (1994). Management perspectives of minor forest produce. *MFP News*.

Majeed, M., Rosen, R., McCarty, M., Conte, A., Patil, D. and Butrym, E. (1994). *Citrin: A Revolutionary Herbal Approach to Weight Management*. Burlingame, CA: New Editions Publishing.

Moegenburg, S.M. (2002). *Harvest and Management of Forest Fruits by Humans: Implications for Fruit-Frugivore Interactions*. In Levey, D.J., Silva, W.R. and Galetti, M. (eds.), Seed Dispersal and Frugivorry: Ecology, Evolution and Conservation, Wallingford, UK: CAB International, pp. 479-494.

Murthy, I.K., Bhat, P.R., Ravindranath, N.H., and Sukumar, R. (2005). Financial evaluation of non-timber forest product flows in Uttara Kannada district, Western Ghats, Karnataka, *Current Science*, 88: 1573-1579.

Myers, N. (1988). Tropical forests: much more than stocks of wood. *Journal of Tropical Ecology*, 4: 209-221.

Nelder, J.A, and Wedderburn, R.W.M. (1972). Generalized Linear Models, *Journal of Royal Statistical Society* 135: 370.

Peters, C.M., Gentry. A.H. and Mendelsohn, R.O. (1989). Valuation of an Amazonian Rainforest. *Nature*, 339: 655-56.

Posey, D. (1982). Keepers of the Forest. *Garden*, 6: 18-24.

Rai, N.D. (2003). *Human Use, Reproductive Ecology, and Life History of Garcinia gummi-gutta, a Non-Timber Forest Product, in the Western Ghats, India*., Ph.D. thesis. University Park: Pennsylvania State University.

Rai, N.D. and Uhl, C.F. (2004). Forest product use, conservation and livelihoods: the case of Uppage fruit harvest in the Western Ghats, India. *Conservation and Society*, 2: 289–313.

Sergio, W. (1988). A natural food, the Malabar tamarind, may be effective in the treatment of obesity. *Medical Hypotheses*, 27: 39-40.

Shaanker, R.U., Ganeshaiah, K.N., Krishnan, S., Ramya, R., Meera, C., and Aravind, N.A. (2004a). Livelihood gains and ecological costs of non-timber forest product dependence: assessing the roles of dependence, ecological knowledge and market structure in three contrasting human and ecological settings in south India. *Environmental Conservation,* 31: 242–253.

Shaanker, R.U., Ganeshaiah, K.N., Krishnan, S., Ramya, R., Meera, C., and Aravind, N.A. (2004b) Ecological consequences of forest use: from genes to ecosystem - a case study in the Biligiri Rangaswamy Temple Wildlife Sanctuary, South India. *Conservation and Society*, 2: 347–363.

Shahabuddin, G. and Prasad, S. (2004). Assessing ecological sustainability of non-timber forest produce extraction: the Indian scenario. *Conservation and Society*, 2: 235–250.

Shanker, K., Hiremath, A. and Bawa, K. (2005). Linking biodiversity conservation and livelihoods in India. *PLoS Biology*, 3: 394.

Sharma, N.P. (1992). Managing the World Forest: Looking for Balance between Conservation and Development, Kendall Hunt Publishing Company, Iowa, pp. 605.

Resource use between lion-tailed macaque and local people, and its conservation implications

Introduction

Dependence of people on forest resources dates back to historical times (Ticktin, 2004). Even today people residing in-and-around forests have a great dependence on forests for subsistence (Bawa et.al., 1993). Large amount of time and labour is invested for collecting resources in the forest which is indeed a profession of some inhabitants (Gubbi et.al., 1998). People have evolved improvised strategies for increased harvesting over the years and thus are gradually gaining upper hand on resources that are of commercial importance (Kuipers, 1997; Lange, 1998). Though, globally there has been a leading concern on the impacts of NTFP collections on the ecosystem (Bawa, 1992; Bhatnagar, 2002; Lambert, 1998; Shankar et al., 1996, 1998; Tictin, 2004; Vasquez and Gentry, 1989), studies on impact of NTFP collection on dependent fauna and ecosystem is scanty. In some instances, these resources have been over-exploited leading to many ecological effects like hampered productivity, decreased density and regeneration of respective species (Cunningham, 2001; Peters, 1994). In India, commercially valuable resources in the forest have been exploited to such an extent that the adverse ecological impacts on the species itself have been obvious (Murali et. al., 1996; Negi, 2003; Shankar et. al., 1998). On the other hand, animals dependent on these food resources have had to adapt to changing environment leading to irreversible changes in its ecology, physiology and behaviour. Ticktin (2004) stresses the impact of NTFP extractions may happen at many levels from individuals, population, community and ecosystem.

To a habitat specialist, these changes on long term might have an impact on the population dynamics, which can also lead to decline in the population size. As some of the food species are critical at particular season, long term changes might irreversibly affect the ecological chain of many fauna dependent on them. It is indeed important to understand the resource utilization by people and depended fauna keeping sustainability on long term into consideration, as there is a global demand for natural products from forests due to its various uses in medicine, crafts and culinary.

Results

During the study, various NTFP were extracted from a total of 15 tree species (Table 1), among them, 11 species were used as food by LTM. The details on NTFP species, part of the species and phenophase preferred by LTM and people are summarised in Table 1. Among them, only seven species have a large overlap in utilization by people and LTM viz. *Garcenia gummi-gutta, Myristica malabarica, Myristica dactyloides, Calamus pseudo-tenuis, Calamus twaitessi, Mangefera indica* and *Artocarpus lakoocha.*

Garcenia gummi-gutta which constituted 2.01% of overall time spent on feeding by LTM was the fifth most widely consumed resource during wet season (5.93% in monsoon). On the other hand it was the most extracted NTFP among all the NTFP extracted from the region.

Myristica malabarica and *Myristica dactyloides* did not constitute any proportion of LTM diet, however while it showed high extraction by people. *Calamus pseudo-tenuis* (1.83% in overall diet) and *Calamus twaitessi* (1.49% in overall diet) were the next most widely eaten NTFP species which had notable extractions by people. Fruits of *Mangefera indica* (0.04% in overall diet), *Piper nigrum* (0.72% in overall diet) and *A. lakoocha* (nil) were extracted in negligible amounts. During the study period, Honey of *Apis cerana* and fruits of *Garcenia indica* did not contribute to diet of LTM while their extractions by people contributed to their income by 15.06% and 1.36% respectively.

Table 1 NTFP parts and phenophase preference by LTM and people in the study area during the study period

Sl.No	NTFP species	Season of collection	Part preferred		Phenophase preferred	
			LTM	People	LTM	People
1	*Garcenia gummi-gutta**	July-Aug	Mesocarp	Rind and seeds	Ripe fruits	Unripe and Ripe fruits
2	*Myristica malabarica**	Dec-Feb	Aril	Aril	Ripe fruit	Unripe fruit
3	*Myristica dactyloides**	Dec-Feb	Aril	Aril	Ripe fruit	Unripe fruit
4	*Calamus pseudo-tenuis.**	All through	Stem, Fruit	Mature stem	Not specific	Not specific
5	*Calamus. twaitessi **	All through	Stem, Fruit	Mature stem	Not specific	Not specific
6	*Piper nigrum**	Jan-Apr	Young shoots, Fruits	Seeds	Young leaves, Unripe Fruit	Ripe fruits
7	*Cinnamomum malabathrum**	Dec-Mar	Young shoots	Mature leaves	Young leaves	Mature leaves
8	*Mangefera indica**	Mar-Jun	Fruit	Fruit	Unripe, ripe fruits	Unripe fruits
9	*Artocarpus lakoocha**	Mar-May	Fruit	Fruit	Ripe/Unripe fruits	Unripe fruits
10	*Callophylum apetalum**	Aug-Oct	Young stem, leaves	Fallen Seeds	Unripe Fruits, Mature leaves	Ripe, Fallen fruits
11	*Garcenia indica*	Jul-Aug	-	Ripe fruits	-	Ripe fruits
12	*Garcenia morella*	May-Jun	-	Fallen seeds	-	Ripe fallen fruits
13	*Entada scandens*	Oct-Jan	-	Seeds	-	Fallen ripe fruits
14	*Canerium strictum*	All through	-	Exudates	-	Not specific
15	Honey*	Apr-May	Larva, Eggs and Honey	Honey	-	-

*Food of LTM

Discussion

Though the diet of LTM include various resources from 59 plant species, about 30 species of them contribute more than 90% of its diet. On the other hand, partially livelihood of local people (~14% of their total annual income) also depends on various NTFP from about 14 species of plant species and honey in the study area. Among 14 plant species, seven of them are also food for LTM, however, only five species of them are the major common resources used by both LTM and local people i.e. *Garcenia gummi-gutta, M. malabarica, M. dactyloides, Calamus pseudo-tenuis and Calamus twaitessi*. Contribution of other species (*Mangefera indica, Piper nigrum* and *Artocarpus Lakoocha*) either to local people or to the diet of LTM was negligible, thus we consider the impact on feeding ecology of LTM may be insignificant. However, extraction of NTFP from those five common species may have notable impacts on feeding ecology of LTM.

Along with LTM, many other mammal species also depend on fruits or seeds of *G. gummi-gutta* which include brown palm civet (Paradoxurus *jerdoni*), Asian palm civet (*Paradoxurus hermaphoditus*), Hanuman langur (*Semnopithicus* sp.), bonnet macaque (*Macaca radiata*), Malabar giant squirrel (*Ratufa indica*) and flying squirrel (*Petaurista philippensis*) (Rai, 2003). If fruits of *G. gummi-gutta* are harvested at proper time (ripe fruit) or if picked up on ground during natural fall will not have any competition between dependent fauna and people (Rai, 2003). Early harvests not only hamper the feeding ecology of these animals but may have long term detrimental effects on regeneration of the species. Though the fruits of *G. gummi-gutta* do not form any proportion in the diet of LTM in other regions of the Western Ghats may be due to absence of the species or may be due to availability of many other food species (Kumar, 1985; Ramachandran et.al., 2000; Singh et.al., 2001; Sushma, 2004; Umapathy and Kumar, 2000), but, the fruits of *G. gummi-gutta* constitute a large proportion in the diet of LTM during monsoon season in the study area. Thus, we suspect a negative impact on feeding ecology of LTM in the area in the long run considering the high demand for the fruits of *G. gummi-gutta* in the market, quantity of extraction by people, and improper harvesting techniques.

In case of *Myristica* spp., which also may have formed an important food resource for the LTM, but early extractions resulted in non availability of resource during the preferred phenophase (ripe fruit) for LTM, as extractions have all happened during unripe fruit stage. *M. dactyloides* constitute 0.67% of the total diet of LTM in Silent Valley National Park (Ramachandran et. al. 2000) probably because of relatively lesser NTFP extraction in Silent

Valley National Park due to better protection and lesser human enclaves in it. This may have probably facilitated substantial resource for LTM diet compared to ACR.

Although few families extract Calamus, their collections and dependence remains constant all throughout the year. The study in Anamalais by Kumar (1985) also ascertains even rare extractions also may drastically alter food resource use by LTM. Though the skill of making baskets remains with very less number of people, utility of *Calamus spp*. is very high in every household due to their dependency on agriculture. Similarly interactions with people reveal that previously *Piper nigrum* was collected in considerable quantity. But in the recent time, according to people, the fall in the quantity of harvest was due to cutting up of most climbers for quicker and easier harvesting. Similarly, decline in *Artocarpus heterophyllus* trees over a couple of decades were probably due to its high extraction for its timber value. The high extraction was due to aesthetic value and long-lasting nature of the wood was valued for making artistic frames for doors and windows (Green and Minkowski, 1974; Ramachandran and Joseph, 2000; Umapathy and Kumar, 2000; Singh et. al., 2001).

The reduction in number of species collected by people by over the years may not only be due to fall of market value but also due to local extinction of some of the species due to over exploitation. We presume that many other species like *Canerium strictum, Cinnamomum malabathrum and Artocarpus heterophyllus* have all been severely depleted or locally endangered may be due to the same phenomenon. Taking into account the findings of present study it can be said that impact of collections may notably affect the feeding of LTM but however studies on quantification of resource availability in the forest, stand structure and density can only ascertain it. There is an increasing need to strike a balance between resource partitioning between humans and LTM keeping long term into consideration. Sustainability in resource extraction needs to be urgently addressed as a strategy in management policy. Stringent monitoring of extractions during harvest seasons by forest department along with revisions in tendering process needs to be taken up. Incentives to people for sustainable harvesting by establishment of society constituting all stake-holders might eliminate middle-men factor benefiting harvesters as well as ensuring sustainability of resources.

References

Bawa, K.S. (1992). The Riches of Tropical Forests: Non-Timber Products. *Trends in Ecology and Evolution*, 7: 361-63.

Bawa, K.S. and Godoy, R. (1993). Introduction to case studies from South Asia. *Economic Botany*, 47: 248-250.

Bhatnagar, P. (2002). Conservation and Trade of Medicinal Herbs: A Study of Safed Musli (Chlorophytum spp.) in Madhya Pradesh. *Sustainable Forestry*, 7: 11-14.

Clay, J.W. (1997). *The impact of palm heart harvesting in the Amazon estuary. Harvesting Wild species- Implications for Biodiversity Conservation* in Freese, C.H. (eds.), p. 28.

Cunningham, A.B. (1993). *African Medicinal Plants Setting Priorities at the Interface between Conservation and Primary Healthcare*. People and Plant Working Paper1 . UNESCO, Paris, France.

Cunningham, A.B. (2001). *Applied Ethnobotany: People, Wild Plant Use and Conservation*. London: Earthscan Publications.

Green, S. and Minkowski, K. (1977). *The Lion-tailed Macaque and its South Indian Rainforest Habitat*., in Prince Rainier III and Bough, G.H (eds.), Primate Conservation, NewYork: Primate Conservation Academic Press. pp. 290-338.

Gubbi, S. and MacMillan, D.C. (2008). Can non-timber forest products solve livelihood problems? A case study from Periyar Tiger Reserve, India. *Oryx,* 42: 222-228.

Kuipers, S.E. (1997). *Trade in medicinal plants. Medicinal plants for forest conservation and health care*. In Bodekar, G., Bhat, K.K.S., Burley, J. and Vantomme, P. (eds.), Food and Agriculture Organization, Rome, Italy, pp. 45-59.

Kumar, A. (1985). *Patterns of Extinction in India, Sri Lanka and Elsewhere in South East Asia: Implications for Lion-tailed Macaque Wildlife Management and the Indian Conservation System*. In P.G. Heltne (ed.), Lion-tailed Macaque: Status and Conservation,. NewYork: R. Liss, pp. 65-90.

Lambert, D. (1998). Primate Frugivory in Kibale National Park, Uganda, and its Implications for Human Use of Forest Resources. *African Journal of Ecology*, 36: 234-40.

Lange, D. (1998). *Europe's Medicinal and Aeromatic plants. Their Use, Trade and Conservation*, TRAFFIC International, Cambridge, U.K.

Murali, K.S., Shaankar, R.U., Shankar, U. Ganeshaiah K.N. and Bawa, K.S. (1996). Extraction of Non-Timber Forest Produce in the Forests of Biligiri Rangan Hills, India, 2: Impact of NTFP Extraction on Regeneration, Population Structure and Species Composition. *Economic Botany*, 50: 252-69.

Negi, C.S. (2003). 'Yar Tsa Gumba'. *Down to Earth*, pp. 49-51.

Peters, C.M. (1994). *Sustainable Harvest of Non-Timber Plant Resources in Tropical Moist Forest: An Ecological Primer*. Washington, DC: World Wildlife Fund.

Rai, N.D. (2003). *Human Use, Reproductive Ecology, and Life History of Garcinia gummi-gutta, a Non-Timber Forest Product, in the Western Ghats, India*. Ph.D. thesis. University Park: Pennsylvania State University.

Ramachandran, K.K. and Joseph, G.K. (2000). Habitat utilization of Lion tailed macaque (*Macaca silenus*) in Silent valley National park, Kerala, India. *Primate Report*, 58: 17-26

Rawat, G.S. (1997). Conservation status of forest and wildlife in the Eastern Ghats, India. *Environmental Conservation*, 24: 307-315.

Rebelo, A.G. and Holmes, PM. (1988). Commercial exploitation of Brunia albiflora (Bruniaceae). *South African Journal of Botany*, 45: 195-207.

Shankar, U., Murali, K.S., Shaanker, R.U., Ganeshaiah K.N. and Bawa, K.S. (1996). Extraction of NTFP in the Forests of Biligiri Rangan Hills, India, 3: Productivity, Extraction and Prospects of Sustainable Harvest of Amla *Phyllanthus emblica* (Euphorbiaceae). *Economic Botany*, 50: 270-79.

Shankar, U., Murali, K.S., Shaanker, R.U., Ganeshaiah K.N. and Bawa, K.S. (1998). Extraction of Non-Timber Forest Products in the Forests of Biligiri Rangan Hills,India, 4: Impact on Floristic Diversity and Population Structure in a Thorn Scrub Forest. *Economic Botany*, 52: 302-15.

Singh, M., Kumara, H.N., Ananda Kumar, M. and Sharma, A.K. (2001). Behavioral responses of lion-tailed macaque to a changing habitat in a tropical rainforest fragment in Western Ghats, India. *Folia Primatologica*, 72: 278-291.

Terborgh, J.W. (1998). *Wildlife in Managed Tropical Forests: A Neotropical Perspective*. In. A.E. Lugoand C. Lowe (eds.), Tropical Forests: Management and Ecology, New York: Springer-Verlag, pp. 331-42.

Ticktin, T. (2004). The Ecological Implications of Harvesting Non-Timber Forest Products., *Journal of Applied Ecology*, 41: 11-21.

Tiwari, B.K. (2000). Non-timber forest produces of north east India. *Journal of Human Ecology*, 11: 445-455.

Umapathy, G. and Kumar, A (2000). Impacts of habitat fragmentation on time budget and feeding ecology of Lion-tailed macaque (*Macaca silenus*) in rain forest fragments of Anamalai hills, South India, *Primate report*, 58: 67-82.

Vaisquez, R. and Gentry, A.H. (1989). Use and misuse of forest-harvested fruits in the Iquitos area. *Conservation Biology*, 3: 350-361.