STATUS AND CONSERVATION OF LION-TAILED MACAQUES AND OTHER ARBOREAL MAMMALS IN TROPICAL RAINFORESTS OF SRINGERI FOREST RANGE, WESTERN GHATS, KARNATAKA, INDIA. SINGH, M., KUMARA, H.N., ANANDA KUMAR, M., SHARMA, A.K. AND DEFALCO, K.

Key words: Lion-tailed macaque, tropical rainforest, Western Ghats, Sringeri, Karnataka, India, conservation

Abstract

The lion-tailed macaque (*Macaca silenus*), an endangered primate species, was surveyed in the tropical rainforests of Sringeri in the state of Karnataka, south India. A total of 10 groups and a solitary adult male were found in approximately 90 square kilometers of rainforest. The other sympatric arboreal mammals found included common langurs, bonnet macaques and Malabar giant squirrels. The lion-tailed macaques are sympatric with other primates and giant squirrels in the undisturbed core areas. More towards the human habitations and disturbed areas, the lion-tailed macaques are absent and the forest is occupied by commensal species. The habitat features and the population structure indicate that this region is a potential area for maintaining a biologically viable population of lion-tailed macaques. However, a number of factors such as extraction of fuel wood, collection of minor forest produce, grazing by domestic livestock and plantation of commercial tree species are causing a serious threat to the habitat. The effect of habitat degradation on arboreal wildlife is discussed and the steps are suggested to minimize the effect of human disturbance on habitat.

Introduction

Lion-tailed macaque (*Macaca silenus*), endemic to the Western Ghats mountains of southern India, is one of the most endangered species of primates. The population at present is estimated to be less than 3500 individuals (LACY et al., 1996). KUMAR (1997) reported that the species has low birth rate (0.28/female/year), long interbirth interval (29.7 months) and a high age at first reproduction (6.6. years). The survival rates were calculated to be 0.95/individual/year for immatures, 0.97/female /year and 0.92/male/year for adults. Due to these types of life history parameters and highly specialized food habitats, this species probably was never abundant. The number has also been reduced by the continued loss of rainforest habitat in the Western Ghats and hunting (GREEN and MINKOWSKI, 1977; KARANTH, 1992).

The Western Ghats mountains of southern India are divided into northern and southern ranges by the Palghat Gap in the state of Kerala (refer to map in ASHRAF, 2000). The distribution, ecology and behavior of lion-tailed macaques have been well documented in the rainforest regions of the Western Ghats south of the Palghat Gap (GREEN and MINKOWSKI, 1977; KURUP, 1978; KUMAR, 1987; KUMAR et al., 1995; MENON and POIRIER, 1996; SINGH et al., 1997a,b). However, little information is available regarding its habitat and distribution in northern ranges, especially in the state of Karnataka (BHAT, 1982; KARANTH, 1985). KARANTH (1985) sur-

veyed 28 forest ranges in Karnataka but the information was based on secondary data, and indicated only the possible presence of lion-tailed macaques in different rainforest ranges. No information was provided on the density, demography or distribution. Other survey by Kumar (person. comm.) was limited to a few ranges and no attempt was made to actually locate the groups and gather data on demographic parameters. Due to this lack of information, we undertook surveys on lion-tailed macaques in Karnataka to locate the groups and obtain information on group size, age-sex ratios, and distribution patterns.

Except for two viable and large rainforest habitats of Silent Valley in Kerala and Kalakkad in Tamil Nadu, the lion-tailed macaques in most of the southern ranges of the Western Ghats inhabit fragments of rainforest (SINGH et al., 1997a,b; KUMAR, 1998). The rainforest in Karnataka, though narrow in width from West to East, is generally contiguous from North to South (KARANTH, 1992). The climax rainforest in Karnataka extends from about sea level up to about 950 meters a.s.l. The rainforest in areas south of Palghat Gap occurs between about 600 meters a.s.l. to almost 1800 meters a.s.l. Due to these altitudinal as well as latitudinal differences, the forest types in these regions differ. In Karnataka, the low elevation rainforest is primarily *Dipterocarpus-Humboldtia-Poeciloneuron* type, whereas, in the more southern region, the medium elevation rainforest is of *Cullenia-Mesua-Palaquium* type (PASCAL, 1996). Our surveys on lion-tailed macaques in the rainforests of Karnataka were conducted with the following specific objectives:

- To identify areas with contiguous rainforest where biologically viable populations of lion-tailed macaques are present and could be preserved.
- To identify the existing disturbance factors in such areas.
- To determine the presence and distribution pattern of other sympatric arboreal mammals including bonnet macaque, Hanuman langur, and Malabar giant squirrel, as indicators of the health of the habitat. The presumption is that (i) the resource rich areas would support a larger number of arboreal mammals, and (ii) the sensitive species such as Malabar giant squirrel would be affected by habitat disturbance whereas the habitat generalists and commensal species such as bonnet macaques could occupy even the disturbed habitats.
- To determine the demographic parameters , especially the number of adult males, in groups of lion-tailed macaques.

As a first step we initiated the surveys in the Sringeri Forest Range. In the earlier survey, KARANTH (1985) mentioned a possibility of 9 groups of lion-tailed macaques in this range. On the basis of the presence of typical lion-tailed macaque habitats, and also the information obtained from the officials of Forest Department and local people, we expected this range to have populations of this species. Therefore. an intensive survey was conducted in this range. In addition to lion-tailed macaques, data were gathered on other sympatric arboreal mammals regarding their presence and distribution patterns.

Study Area

The study was limited to the Sringeri Forest Range (Fig. 1). This range is one of five ranges of the proposed Kudremukh National Park in the districts of Chikkamagalur and South Canara in the state of Karnataka. The range borders Kudremukh,

Karakala and Someshwara ranges that also harbor rainforest. The range covers an area of 203 square kilometers. Of the total area, about 115 square kilometers comes under climax rainforest which is a suitable habitat for lion-tailed macaques. The forest types in this range include moist deciduous forest (secondary forest due to manipulations in the past) at lower altitudes, climax rainforest at middle altitude, and typical shola vegetation and rolling grasslands at higher altitudes. The altitude ranges from 600 meters a.s.l. at Kerekatte (Fig. location B) to about 980 meters a.s.l. at Manikyabetta (Fig. location I). The rainfall is above 5000 mm per year. The rainforest is a typical dense evergreen forest with predominance of *Dipterocarpus indicus*, *Humboldtia brunonis*, *Poeciloneuron indicum* species (PASCAL, 1988). In addition to lion-tailed macaques, the arboreal mammals include bonnet macaque (*Macaca radiata*), common langur (*Presbytis entellus*), and Malabar giant squirrel (*Ratufa indica*). The major terrestrial fauna includes mouse deer (*Tragulus meminna*), sambar (*Cervus unicolor*), barking deer (*Muntiacus muntjak*), wild pig (*Sus scrofa*), dhole (*Cuon alpinus*), leopard (*Panthera pardus*), tiger (*P. tigris*), sloth bear (*Melursus ursinus*), civets, small cats, king cobra, vipers, Uropeltids, Varanus, turtle.

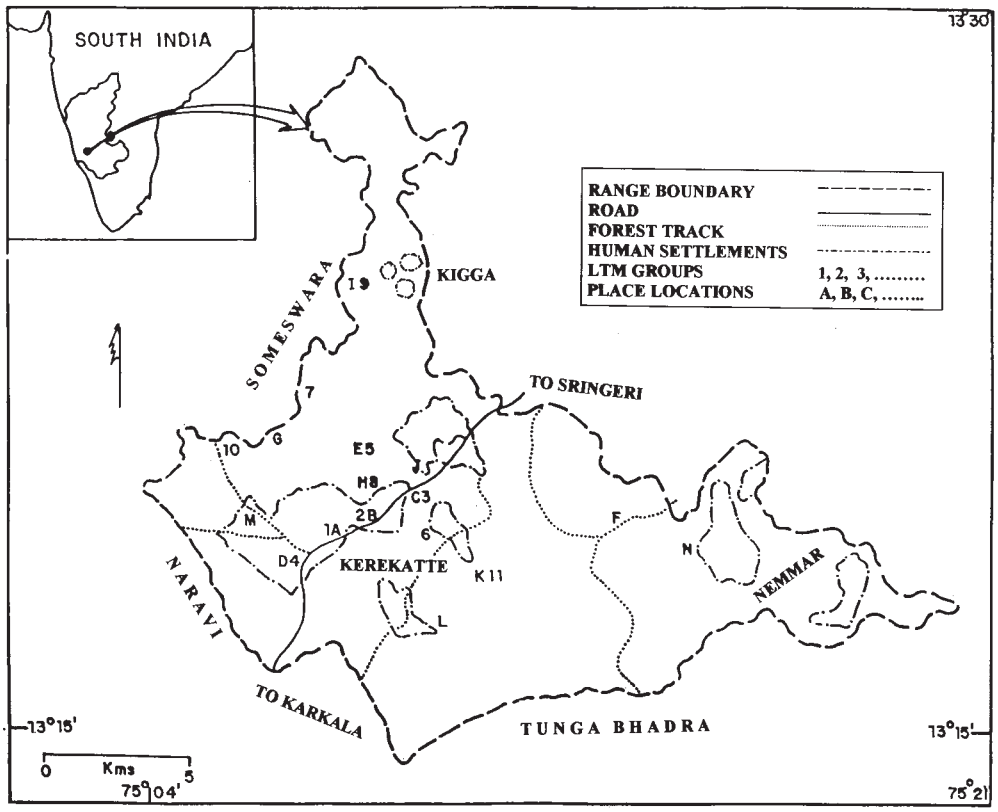

Fig. 1: Map of Sringeri Forest Range and locations of lion-tailed macaque groups and places in the range.

Fig. 2: The lion-tailed macaque (*Macaca silenus*), endemic to the Western Ghats mountains of southern India.
(Photo: C. Knogge)

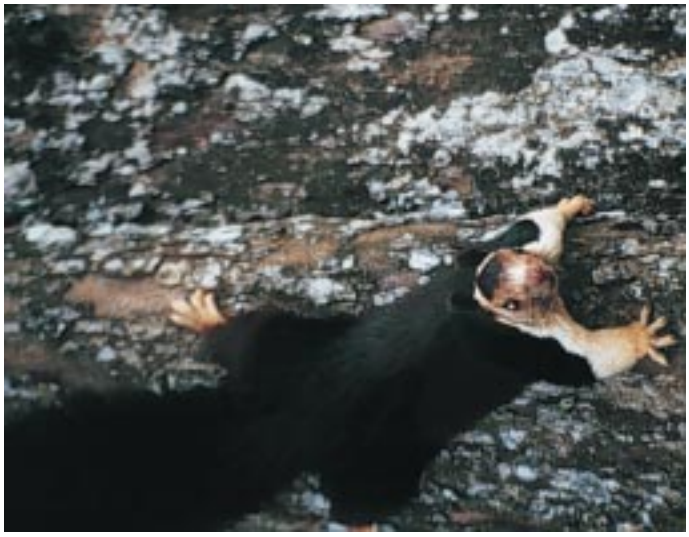

Fig. 3: Malabar giant squirrel (*Ratufa indica*).
(Photo: C. Knogge)

Method

The area was surveyed using the 'Total Counts' method as it was found to be a more reliable method of estimating primate populations in our earlier surveys in the Western Ghats (SINGH et al., 1997a,b). The alternative Line Transect method is more suitable for surveying solitary living species in relatively flat terrain, and thus was not employed. To begin with, secondary information of sightings of lion-tailed macaques was gathered from the beat watchers (forest guards who routinely patrol the forest) and people residing inside the forest. A systematic search was then made to find the groups of lion-tailed macaques. Many trackers were asked to simulta-

neously spread around and keep a check on the nearby groups so that a group was not counted twice. Each group, when located, was followed for a sufficient period of time to get (if possible) the count of individuals and data on age-sex ratios. The demographic data allowed the groups to be differentiated and given names and identities. Simultaneously, data were also collected on the presence of other primates as well as on Malabar giant squirrels. On the basis of the presence of humans and cattle, the area was roughly divided into (a) undisturbed core, (b) disturbed core, and (c) disturbed outer zone. In order to comparatively quantify the extent of disturbance, data were gathered on several habitat parameters. Twelve plots of 10 x 10 meters each at every 100 meters along a transect line of 1200 meters in each of the three representative areas were evaluated for habitat parameters.

Results

Biotic pressure and habitat parameters

One of the significant factors in the Sringeri Forest Range is the presence of human settlements deep inside the forests. The human settlements are divided into 3 sections by the Revenue Department:

1. Kerekatte Section (in Fig. 1: central part of the range around the main road): This section has five villages, with 223 houses.
2. Nemmar Section (in the Eastern part of the range): This area has three villages with 150 households.
3. Kigga Section (in the Northern part of the range): This area also has three villages with 90 houses.

The total human population in these villages in 1999 was 6331 individuals. They maintained 5067 heads of domestic cattle. The area cultivated for arecanut, paddy, sugarcane, cashew nut etc. amounts to about 13.40 square kilometers. Another about 14.25 square kilometers area is planted with *Acacia mangium*, *A. auriculeformis* and *Cassurina* species by the Mysore Paper Mills. The major occupation of the villagers is daily wage labor and agriculture.

Table 1 presents the data on various habitat parameters collected from undisturbed core, disturbed core and disturbed outer zones. The parameters including the number of trees per plot, per cent canopy contiguity, girth at breast height (GBH) per plot, presence of young trees and stumps per plot, and per cent plots without trees indicate an increasing disturbance from undisturbed core to disturbed outer zone.

Locations and number of individuals

Table 2 presents the primary data on lion-tailed macaque groups found in the Sringeri Forest Range. A total of 10 groups and a solitary adult male (either a member of another group or a migratory male) were found in this range. The group identities (1 to 11) and the locations (A to N) of prominent places in the range are shown in Tables 2 and 3 respectively and in Fig. 1. The groups are located from an altitude of 625 meters to 930 meters. Since the individuals in a group of lion-tailed macaques are always dispersed, it requires days to obtain a complete count of all the individu-

als in a group. The numbers presented in Table 2, therefore, may not be fully correct but reflect at least the minimum numbers present in each group. The range harbors at least 184 lion-tailed macaques in 10 groups. Most of these groups are packed in the core area (Fig. 1). Lion-tailed macaques were not found at the eastern edge of the range. Full demographic data could be gathered only on 6 groups. The group size ranged from 8 to 40 individuals with an average group size of 21.8 individuals. The adult male to adult female ratio was 1:9.87. Adult to young ratio was 1.98:1 and adult female to young ratio was 1.79:1.

Table 1: Habitat parameters in Sringeri Forest Range.

Area	**Trees per plot**	**Upper***	**Lower***	**Total GBH per plot (meters)**	**Mean tree height (meters)**	**Young trees per plot**	**Stumps per plot**	**% plots without trees**
Undisturbed core	8.42	94.92	45.83	5.75	12.47	63.92	0.67	Nil
Disturbed core	9.17	38.92	38.25	4.33	9.55	42.50	0.52	16.66
Disturbed outer	4.33	45.00	0	2.84	12.05	15.75	1.17	41.70
* % Canopy contiguity								

Table 2: Group identities and number of individuals in lion-tailed macaque groups in Sringeri.

Group	**No. in Fig. 1**	**Adult males**	**Adult females**	**Juveniles**	**Infants**	**Uniden-tified**	**Total**	**Altitude (Mtrs)**
Pandrumukki	1	2	22	8	5	-	37	625
Kerekatte	2	2	23	7	8	-	40	650
Gulganjimane-I	3	1	12	5	2	-	20	650
MPCA	4	1	4	2	1	-	8	660
Elakkimanekadu	5	1	8	2	1	-	12	630
Gulganjimane-II	6	?	?	?	?	8	8+	650
Gulmanehadya-I	7	?	?	?	?	12	12+	900
Billiyanamanekadu	8	2	?	?	3	25	30+	670
Manikyabetta	9	?	?	?	?	3	3+	930
Gulmanehadya-II	10	1	?	?	?	-	1	900
Suthinguddakadu	11	1	10	2	1	-	14	730
+ Possible presence of more group members								

Other arboreal mammals

Data on the presence of other arboreal mammals found in the Sringeri range are presented in Tables 3 and 4. These mammals include bonnet macaques, common langurs and Malabar giant squirrels. In addition to 10 groups of lion-tailed macaques, we observed 17 groups of common langurs, 9 groups of bonnet macaques, and 66 individual giant squirrels (Table 3). Table 3 also presents the locations where these animals were seen (also see Fig. 1). When the information on the habitat parameters including altitude and other features such as disturbance was pooled (Table 4), it turned out that lion-tailed macaques, common langurs, bonnet macaques, and giant squirrels were sympatric in undisturbed core areas at an altitude of 630 to 700 meters at Pandrumukhi, Kerekatte, Gulganjimane, MPCA, Elakkimanekadu, and Biliyanamanekadu. At a slightly higher altitude, but still in undisturbed core areas, lion-tailed macaques were sympatric with common langurs and giant squirrels at Gulmanehadya, Manikyabetta, and Suthinguddakadu. The lion-tailed macaques were never found in disturbed areas. In the disturbed areas lying inside the core regions, common langurs, bonnet macaques and giant squirrels were sympatric at Seerlu. However, in the disturbed core areas and towards the forest fringes, only bonnet macaques and giant squirrels were present at Matholi, Eradumoorikadu, Muduba and Edgaru.

Table 3: Locations and other features of sympatric arboreal mammals.

Place	**Map location**	**Altitude m a.s.l.**	**Kilometers walked**	**No. of LTM groups**	**No. of common langur groups**	**No. of bonnet macaque groups**	**No. of giant squirrels seen**
Pandrumukki	A	630	8	1	2	1	14
Kerekatte	B	630	2	1	1	1	2
Gulganjimane	C	650	5	2	3	1	10
MPCA	D	640	4	1	2	1	13
Elakkimanekadu	E	630	3	1	1	1	2
Matholi	F	680	3	-	-	1	1
Gulmanehadya	G	880	7	2	3	-	3
Biliyanamanekadu	H	650	3	1	1	1	3
Manikyabetta	I	900	6	1	2	-	4
Eradumoorikadu	J	630	2	-	-	Present	2
Suthinagudakadu	K	700	3	1	Present	-	2
Seeralu	L	650	19	-	2	2	6
Muduba	M	650	8	-	-	Present	1
Edgaru	N	680	5	-	-	Present	2
Total			78	11	17	9	65

LTM – Lion-tailed macaque; m a.s.l. – Meters above average sea level; Present – Either heard or from local information

Table 4: Habitat types of sympatric arboreal mammals.

Sympatricity	Altitude	Map location	Habitat type
LTM+CL+BM+GS	630-700 m a.s.l.	A,B,C,D,E,H	Undisturbed core areas
LTM+CL+GS	700+ m a.s.l.	G,I,K	Undisturbed core areas
CL+BM+GS	630 m a.s.l.	L	Disturbed core area
BM+GS	630 m a.s.l.	F,J,M,N	Disturbed core areas and forest fringes
LTM – Lion-tailed macaque; CL – Common langur; BM – Bonnet macaque; GS – Malabar giant squirrel; m a.s.l. – Meters from average sea level			

Clustering of giant squirrel populations

Table 5 presents data on the clustering of the population of giant squirrels in the Sringeri range. In the undisturbed core region including Pandrumukki, Kerekatte, Gulganjimane and MPCA, the relative population density of giant squirrels was not only high but also clustered as indicated by a high number of sightings within smaller distances. In the Eastern side of the above mentioned core, and in Muduba to the West, the disturbance by humans in the forest habitats gradually increases. As a result, the relative population density of giant squirrel not only gradually declines, but also becomes sparse and scattered.

Table 5: Clustering of Malabar giant squirrel in different locations.

Place	< 100M *	100-200M*	200-300M*	300-400M*	400-500M*	> 500M *	Animals seen Per Km
Pandrumukki	2	3	2	1	2	4	1.75
Kerekatte	1	1	0	0	0	0	1.00
Gulganjimane	2	2	0	4	1	1	2.00
MPCA	5	4	2	1	1	0	3.25
Elakkimanekadu	0	0	0	0	0	2	0.67
Matholi	0	0	0	0	0	1	0.33
Gulmanehadya	0	0	0	0	1	2	0.43
Biliyanamanekadu	0	0	0	0	1	2	1.00
Manikyabetta	0	0	0	1	0	3	0.67
Eradumoorikadu	0	0	1	0	1	0	1.00
Suthingudakadu	0	0	0	1	1	0	0.67
Seerlu	0	0	0	0	1	5	0.32
Muduba	0	0	0	0	0	1	0.12
Edgaru	0	0	0	0	0	2	0.40
Total	10	10	5	8	9	23	0.84
*Number of animals seen within a distance of							

Discussion

Despite the fact that a considerable amount of research has now been carried out on lion-tailed macaques, a clear picture about its presence and relative densities, especially in the rainforests of the state of Karnataka, is still not available. Elsewhere (e.g. in Anaimalai Hills in Tamil Nadu), the major threat to the lion-tailed macaque is the fragmentation of its rainforest habitat and isolation of demes (KUMAR et al., 1995). In Karnataka, the rainforest is contiguous over long, though narrow, stretches, and so, it may serve as a suitable area for the maintenance of populations with a large effective breeding size. It is essential that we also determine what threats lion-tailed macaques face in this area.

In order to indicate the value of lion-tailed macaque population in Sringeri, we compare it with the population in Anaimalai Hills reported by KUMAR et al. (1995) and SINGH et al. (1997a,b). In Anaimalai Hills, 7 groups of lion-tailed macaques now inhabit one forest fragment each and each group has remained isolated for more than 7 decades. Four fragments contain two groups each, and two large fragments contain 5 and 15 groups each. The rainforest in Sringeri is not fragmented and is contiguous with the other adjoining ranges. Lion-tailed macaques have been reported in these adjoining ranges as well (KARANTH, 1985). The entire population, therefore, can be considered as one breeding population. The conservation of such a large, potentially interbreeding population is important from the point of gene flow and biological viability.

The 10 groups of Sringeri inhabit at least 85-90 square kilometers of rainforest. In the Anaimalai Hills, the 15 groups of Varagaliyar complex do not have more than 35-40 square kilometers of rainforest available. The animals in the fragments of Anaimalai Hills (e.g. 2 groups with 67 monkeys in 0.67 square kilometers in Puduthotam) have abnormally high densities. For an animal which is a highly specialized feeder and has a low population turnover due to delayed sexual maturity and long inter-birth intervals, a low but sustainable population density is the key to a long-term survivorship. The Sringeri population comes closer to this ideal making it even more valuable as a conservation target.

Lion-tailed macaque societies are characterized by the presence of usually one, and occasionally two, adult males per group. In the fragmented habitats of Anaimalai Hills, the number of adult males in a group is sometimes several, resulting in a highly skewed demographic structure. The data presented in Table 2 reveal that in the Sringeri forest groups there was only one, or occasionally two, adult males characterizing the normal demographic pattern for lion-tailed macaques.

Although the Sringeri forest range is ideal for lion-tailed macaque conservation from several angles, there are also serious threats to the habitat in this range. One of the most important is forest degradation caused by the presence of humans and their exploitation of forest resources. The exploitation is in the form of extraction of fuel wood, removal of minor forest produce such as honey, cane, tubers, fruits and flowers etc., and grazing in the forest by the domestic livestock. Except in a few inaccessible areas, most of the forest in Sringeri is exploited by humans settled in several enclosures inside the forest. The fruit of *Garcinia* spp. is a favored food item of lion-tailed macaques. This fruit is systematically removed by humans because it has commercial value. The collection of cane and reeds (*Calamus* and *Ochlandra* spp.), the shoots of which are often used by lion-tailed macaques, is also severe. The natural

rainforest habitat in Sringeri is also being altered by the plantation of Acacia trees, especially on the grasslands, by the Mysore Paper Mills Limited. Since it is a large commercial activity, it requires the construction of bridges and roads for the removal of wood and also the appointment of a large number of people to work inside the forest. This type of activity eventually causes fragmentation of rainforest habitats. In Sringeri, except in Muduba on the Western side, most of this disturbance is towards the East of the main Karkala-Sringeri highway. Most of these areas are also grazed by the domestic livestock. Presently, the Government provides compensation to farmers if cattle are killed by a predator. This encourages farmers to maintain large stock of domestic cattle even if they are not milch cows. The removal of fuel wood by the cowherders is a routine activity.

Our data clearly indicate the health of the habitat in every location by the presence of lion-tailed macaques and other arboreal mammals. The lion-tailed macaques, along with common langurs, bonnet macaques and Malabar giant squirrels, are restricted only to the relatively undisturbed core areas. In the disturbed but still core areas, common langur, bonnet macaque and giant squirrel are sympatric. Bonnet macaques are usually commensal with humans in most of their habitat all over southern India. In the more disturbed areas towards the forest fringes on the eastern side, only bonnet macaque and giant squirrel are found. Giant squirrel itself is a very sensitive indicator of habitat conditions. In the undisturbed core areas around Kerekatte-MPCA region, the density of giant squirrels is high with an even distribution. As the disturbance level increases towards the East, the population of giant squirrel becomes sparse and eventually absent. In the undisturbed core areas, the giant squirrels were sighted at a rate of 1.32 animals per kilometer. This sighting rate declined to only 0.32 animals per kilometer in the disturbed areas. The impact of human disturbance on arboreal wildlife is, therefore, clearly evident. On the eastern side, KARANTH (1985) reported the presence of two groups of lion-tailed macaques which have now disappeared. The local people and the forest watchers also confirmed the presence of these groups about 10 years back, but now there is the presence of only an occasional single adult male.

Another threat to wildlife, including lion-tailed macaques, in Sringeri is hunting and poisoning. Especially at the time of special festivals such as the Kigga Festival, the relatives of people residing inside and nearby the forest are invited for traditional hunting (illegal). Large parties enter the forest and hunt herbivorous mammals, giant squirrels and occasionally lion-tailed macaques.

The population parameters of lion-tailed macaques, the presence of other sympatric arboreal mammals, and the contiguity of the rainforest in Sringeri makes it an excellent area for maintaining a biologically large and viable population of lion-tailed macaques. The conservation of this area should be a high priority. The disturbance factors discussed above, however, require serious attention. Several steps are suggested here to minimize the effect of these factors:

- The entire Kudremukh region with the adjoining ranges must immediately be declared a National Park. The region must be preserved as a high priority biodiversity region.
- The villagers who have settled inside the forest must be gradually relocated outside the forest by providing attractive alternatives. Priority for such relocation should be given to the most sensitive areas such as Muduba.

- The removal of minor forest produce (MFP) must be totally stopped, not only for the benefit of lion-tailed macaques but also for many other wild animals that consume MFP.
- A limit must be imposed on the number of domestic cattle owned by villagers, and non-milk cows should not be allowed at all.
- The rolling grassland on the hill tops is a natural feature of Western Ghats. Planting of exotic trees for commercial purposes must be stopped.

The steps suggested above are feasible and can be implemented. A comprehensive plan for conservation of this biologically viable population of lion-tailed macaques would also help conservation of the entire biodiversity of this region.

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