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## Ecological Status of the Lion-tailed Macaque and its Rainforest Habitats in Karnataka, India

### Introduction

The lion-tailed macaque (*Macaca silenus*, Linn.: Fig. 1) is a rare primate whose distribution is now confined to the tropical wet evergreen forests of the Western Ghat mountain chain in the southern Indian states of Karnataka, Kerala and Tamil Nadu. This highly arboreal macaque has evolved to occupy a specialized ecological niche in these rainforests (Fooden, 1975). Being an indicator species for this habitat, the lion-tailed macaque can be focused on in developing a conservation strategy for the biologically diverse forests of southern India.



Fig. 1: The lion-tailed macaque (*Macaca silenus*) is an arboreal primate confined to the tropical moist evergreen forests of the Western Ghats in India (photo by R. A. Mittermeier).

In recent times the lion-tail's distribution and conservation status in the wild has been assessed by Sugiyama from 1961-63, Daniel and Kannan in 1967, Kurup from 1971-77, Green and Mikowski from 1971-77 and Bhat from 1978-81 (Kurup, 1978; Bhat, 1982). Except for the systematic survey by Bhat (1982) in the Uttara Kannada and Shimoga Districts of Karnataka, the other surveys have concentrated primarily on habitats in Kerala and Tamil Nadu, neglecting Karnataka. Green and Minkowski (1977), in their pioneering survey which highlighted the precarious status of the lion-tailed macaque, stated that, "Though 800 km<sup>2</sup> of Dipterocarpus dominant evergreen forests were available in Kar-

nataka. . . these Karnatak forests nowhere comprise a single tract of undisturbed *shola* large enough to support a viable population of monkeys and remote enough from human interference to make their long term preservation feasible." This view has been generally accepted by other primatologists and the lion-tailed macaque is stated to "have become rare in its northern range and is now probably confined to Kerala (Krishnan, 1972) and scattered areas in the hills of southern Tamil Nadu" (Roonwal and Mohnot, 1977). Consequently, specific conservation efforts have virtually bypassed the state of Karnataka. At the 1982 Lion-tailed Macaque Symposium in Baltimore no participants were familiar with this species in its Karnataka habitats. However, at this symposium, based partly on incidental data that I collected, Rauf Ali (1982) placed the Karnataka population of lion-tailed macaques at about 12 troops. This figure contrasts with that of 2-3 troops estimated by Green and Minkowski (1977) and Kurup (1978) several years earlier. According to the consensus at the Symposium, the total wild population was estimated to be somewhere between 915-2,000 animals, though Ali felt the higher figure was impossible based upon existing information (Ali, 1982).

In view of the lion-tail's endangered status, I approached the Government of Karnataka (Department of Ecology and Environment) to sponsor my status survey of this species in Karnataka, to the south of a small area surveyed by Bhat earlier (Fig. 2). The results of the survey are reported here. They form the basis of a management plan for the concentration of the lion-tailed macaque and its habitats, which I will also

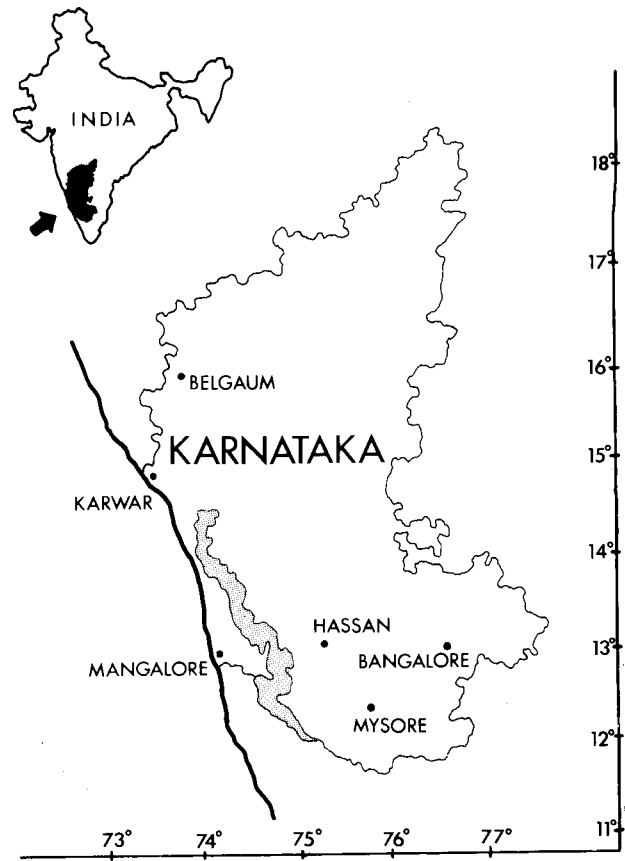


Fig. 2: The location of Karnataka state in southwestern India and extent of the forest tracts depicted in Figure 3 (map by Stephen Nash from author's original).

present to the Government of Karnataka. A brief outline of recommended conservation measures is included, in addition to the data collected by Bhat (1982), thus presenting a consolidated picture of Karnatakian habitats.

**Table 1: Local Names Used for Different Monkey Species Within the Lion-tailed Macaques Range in Karnataka**

Bonnet macaque	<i>Kapi, Kothi, Manga</i> (in Kannada, Tulu and Kodava); <i>Mankad</i> (in Konkani)
Hanuman langur	<i>Musiya, Muchcha, Bukka, Book Manga, Koda</i> (in Kannada); <i>Muju</i> (in Tulu); <i>Bommuchcha*</i> (in Kodava)
Nilgiri langur	<i>Karimuchcha*</i> (in Kodava)
Lion-tailed macaque	<i>Singalika</i> (in general in Kannada); <i>Karikodiya</i> (in Kannada); <i>Kaggadaka</i> (in Mudugere and Koppa Forest Ranges); <i>Chingalika, Bali, Evo</i> (in Tulu - the latter two names being specific to the Subramanya and Naravi areas); <i>Karingada, Monnamuchcha*</i> (in Kodava in the northern and southern portions of the Kodagu District, respectively); <i>Neela</i> (in Konkani/Marati among Kunbi tribals)

\*: In Kodagu District, where all four species occur, the Hanuman langur is known as "white langur", the Nilgiri langur as "black langur" and the lion-tailed macaque as "stump-tailed langur" or "black macaque".

The Kannada name for the lion-tailed macaque literally means "lion-like" or "black macaque".

### Objectives and Methods

The objectives of this survey were to: 1) locate as many surviving troops of lion-tailed macaques in Karnataka as possible, assessing the population status and distribution; 2) assess the availability of potential lion-tailed macaque habitat, as well as the degree of pressure exerted by poaching and habitat destruction; and 3) based on the above, prepare an overall management plan that identifies key conservation areas.

In view of the large tract (approximately 5,000 km<sup>2</sup> PT) to be covered (Fig. 2) and considering the recommendations of other field primatologists familiar with lion-tailed macaque ecology and behavior (Ali, 1982; Ajith Kumar, pers. comm.), direct methods using line transects were ruled out for this survey. Instead, the survey was based on local informants who reported troop sightings within the past two to three years, coupled with personal assessment of the habitat. Information was collected systematically, ensuring the following:

1. Most of the informants belonged to the Tribes/Castes/Occupational groups who spent most of their time in the Ghat forests collecting minor forest produce items like fruits, nuts, myrobolans, resins, bark, climbers, canes, leaves and honey, rather than cultivators and foresters who tend to be less knowledgeable about forest animals.

2. The identity of the lion-tailed macaque was clearly established at the outset of the interview by careful questioning in the local languages/dialects, utilizing photographs of different primate species and the common local names (Table 1). This was generally an easy process because neither the Nilgiri langur (*Presbytis johnii*) nor any other black monkey likely to be confused with the lion-tail occur in Karnataka, except in the extreme southern part of the state.

3. The troop locations were identified with the help of prominent geographical features and forest logging compartments on Survey of India Topographic Maps of 1:50,000 scale. Since the recorded home range for the lion-tailed macaque is reported to be 2-4 km<sup>2</sup> (Green and Minkowski, 1977; Ajith Kumar, pers. comm.), troops sighted more than 5 km apart on the ground were considered as distinct troops. This cautious approach is likely to have underestimated total troop numbers.

4. Information was collected on relative abundance now as compared to 10-15 years prior, troop size and the presence of young animals, numbers of different troops seen on any single day, and the pressure from traditional hunting.

5. The habitat was assessed by on-site visits and by discussions with local foresters, reference being made to maps prepared by the French Institute, Pondicherry (Pascal *et al.*, 1982) and the State Forest Depart-

ment.

The field work required approximately 60 days between November 1983 and May 1984.

### Study Area

The tract surveyed stretched through the Western Ghats between 14° 15' - 11° 55' north latitude and covered a length of about 220 km, the average width varying from 15-25 km. The tract is administered under various forest divisions and ranges (Table 2). During the last few centuries, the lion-tailed macaque habitats have shrunk to this remnant strip, receding from the coastal plains because of agricultural expansion, shifting cultivation, exploitation in the forms of overgrazing, burning, timber removal, and fuel wood and forest product gathering, and major forestry operations (Stebbing, 1929; Davis, 1934). Despite a forest reservation policy of the late 19th century, which protected Reserved Forests from earlier onslaughts, many of these pressures continue at an intensifying rate. The habitat of the lion-tailed macaque is now confined to the Reserved Forests of the Western Ghats, primarily on the western slopes. These dense forests generally occur at elevations ranging between 100-1,800 m, the higher elevations having Shola Montane forests. The annual precipitation varies locally between 2,500-8,000 mm and is received primarily in the June-September monsoon period. The length of the dry season increases progressively from south to north. The soils are inherently poor in nutrients, the bulk of which are stored in the living vegetation and litter. When the forest cover is disturbed there is a rapid loss of nutrients due to leaching (Rai, 1982).

**Table 2: Forest Administration Within Lion-tailed Macaque Habitats in Karnataka**

Forest Division	Ranges Covering Past/Present Lion-tailed Macaque Habitat Within Division
Karwar	Anshi*, Kumbarawada*
Yellapur	Vajrahalli*, Jannana*
Sirsi	Siddapur
Honnavar	Kumta, Honnavar*, Gersoppa, Manki*, Bhatkal
Bagar	Sagar, Hosanagar
Shimoga	Agumbe
Kundapur	Baindur, Kundapur, Shankaranarayan, Hebri, Karkal, Mudabidre, Venur
Koppa	Sringeri, Kalasa
Chicknagalur	Mudugere
Hassan	Sakaleshpur, Yenalur
Mangalere	Belthangadi, Uppinangadi*, Subramanya, Sullya*
Madikeri	Sampaja, Bhagamandala, Mundrote, Makut, Srimangala

\*: No recent sightings reported from these ranges; lion-tailed macaque is probably extinct.

The lion-tailed macaque occurs in dense evergreen forests and sometimes utilizes semi-evergreen formations. The Karnataka habitats have been mapped and described in detail by Pascal *et al.* (1982) and Puri *et al.* (1983), according to the Holistic classification system. Descriptions of the different forest types are given below:

### Forest

Type	Description
22:	<i>Schleffera</i> spp.- <i>Gordonia obtusa</i> - <i>Meliosma arnottiana</i> type Shola Montane forest at 1,250-1,800m elevation
25:	<i>Persea macarantha</i> - <i>Diospyros</i> spp.- <i>Holigarna</i> spp. type dense evergreen forest at 0-850m elevation
26/1:	<i>Dipterocarpus indicus</i> - <i>Kingiodendron pinnatum</i> - <i>Humboldtia brunonis</i> type dense evergreen forest at 0-850m elevation
26/2:	<i>Poeciloneuron indicum</i> facies of the above type at 0-850m elevation
26/3:	<i>Dipterocarpus indicus</i> - <i>Humboldtia brunonis</i> - <i>Poeciloneuron indicum</i> type dense evergreen forest at 0-850m elevation
26/4:	<i>Dipterocarpus indicus</i> - <i>Diospyros candolleana</i> - <i>Diospyros oocarpa</i> type dense evergreen forest at 0-850m elevation

- 26/5: *Poeciloneuron indicum* facies of the above type at 0-850m elevation
- 26/6: *Dipterocarpus indicus-Persea macarantha* type dense evergreen forest at 0-850m elevation
- 26/7: *Poeciloneuron indicum* facies of the above type at 0-850m elevation
- 26/8: *Mesua ferrea-Palaquium ellipticum* type dense evergreen forest at 800-1,400m elevation
- 26/9: *Palaquium ellipticum-Poeciloneuron indicum-Hopea ponga* type dense evergreen forest at 800-1,400m elevation

Of the above forest types, Type 22 is found only in small patches at high elevations, the best examples occurring around Kudremukh Peak in the Kalasa Forest Range. Type 26 occurs in fragmented patches in the Gersoppa Range. All of the remaining habitats are different sub-types of the main forest Type 26 *Dipterocarpus-Mesua-Palaquium* (Puri *et al.*, 1983). In the semi-evergreen degradations of the above evergreen forest there are characteristic species like *Dysoxylum malabaricum*, *Tetrameles nudiflora*, *Bombax ceiba*, *Caryota urena*, *Lagerstroemia lanceolata*, *Xylia xylocarpa* and *Bambusa arundinacea*, not commonly found in the dense evergreen types.

According to official statistics, about 4,350 km<sup>2</sup> of evergreen forest and 1,450 km<sup>2</sup> of semi-evergreen forests are found in the Karnataka tract that I surveyed. However, a significant portion of this area is not climax vegetation. It is estimated that of the 3,521 km<sup>2</sup> of Reserved Forests in the Ghats that I surveyed, only about 1,985 km<sup>2</sup>, a little more than half, contains reasonably good evergreen forest and even this has been subjected to selective logging. An estimated 50% of the good evergreen forest is located higher up the slopes and is generally inaccessible to the village communities at the foot of the Ghats. Overall, I estimate that approximately 1,000 km<sup>2</sup> of suitable habitat remains for the lion-tailed macaque in the Western Ghats of Karnataka.

#### Status of Some Sympatric Species

The status of some sympatric species of frugivorous mammals and birds were also assessed during this survey to obtain a better idea of habitat quality. Among large frugivorous birds, Imperial pigeons (*Ducula bedia* and *D. jerdonii*) and hornbills (*Tockus griseus*) were found to be common, but the large pied hornbill (*Buceros bicornis*), an indicator species of climax evergreen forest, has become rare.

Among frugivorous mammals, the giant fruit bat (*Pteropus giganteus*), giant squirrel (*Ratufa indica*), large brown flying squirrel (*Petaurista petaurista*), and common palm civet (*Paradoxurus hermaphroditus*) are reasonably common. The Nilgiri marten (*Martes gwatkinsii*) has almost vanished from the Shiradi Ghat-Sampaje stretch of its former range, but still occurs in the Madikeri Forest Division further south.

The bonnet macaque (*Macaca radiata*) is common everywhere, but the Hanuman langur (*Presbytis entellus*) is common only to the north of Kudremukh where it is not persecuted intensively. The Nilgiri langur (*Presbytis johnii*) has become extremely rare and is probably confined to the Makut and Srimangala Ranges, where it is rarer than the lion-tailed macaque due to severe poaching.

#### Habitat Continuity

Former lion-tailed macaque habitats in the extreme north in the Anshi, Kumbarawada, Vajrahalli, Honnavar, Janmane and Kumta forest Ranges have been almost totally degraded into semi-evergreen and deciduous forest types. The habitats in Gersoppa and Siddapur are also fragmented, though a good block exists in Mastimane Ghat (Fig. 3). South of this, the Sharavati River probably interrupts the habitat. The evergreen forests in the Gersoppa, Manki, Bhatkal and Sagar Ranges between the Sharavati River and the Bhatkal-Kogar Ghat road are also somewhat fragmented. South of Kogar Ghat the habitat runs in a thin but continuous strip to Kollur Ghat. There is reasonably good forest between Kollur Ghat and the Varahi Project where a break occurs, in spite of disturbance created by the Chakra Project. South of Varahi continuous evergreen habitat stretches to Yelaneeru at the southern end of the Kalasa

Range. In the area of the Ghats between Yelaneeru and the Bandajearbi waterfall there is a complete break in the forest due to the presence of private coffee estates, and the western face appears to have been degraded to deciduous formations. Within this tract, the Kyasanur forest, a disease lethal to primates is said to be rampant. The evergreen forest south to the Subramanya Range has been disturbed by large scale, government plantation farming projects and by the Hassan-Mangalore Railway Project. Some good evergreen forest remains, however, at the higher elevations in the Belthangad, Mudugere and Sakleshpur Ranges, as well as in the Neriya and Banjar estates. The degradation is rather severe in the Uppinagadi Range, apparently due to the Hassan-Mangalore Railway Project.

South of Subramanya, a large tract of evergreen forest remains intact in the Subramanya and Kadamakal Forest Reserves of the Sampaje Range. There is a wide break in habitat in the Sampaje and Sulya Ranges where the forest is now mainly deciduous. Further south in the Bhagamandala, Mundrote and Srimangala Ranges, the forest habitat is extensive and largely continuous, though the adjoining forests of Kerala have been almost totally cleared by the encroaching human population.

#### Pressures on the Lion-tailed Macaque and its Habitat

**Habitat.** The local communities in settlements at the foot of the Ghats exert significant pressure on the surrounding forests, resulting in steady but almost imperceptible habitat degradation. Though most of the lion-tailed macaque habitat at the middle and upper elevations in the Ghats do not seem to be adversely affected at this time, the lower elevation forests in the foothills and the coastal plains, such as the Kidu Forest Reserve in the Subramanya Range and parts of the Karkal, Kundapur and Gersoppa Ranges, are being encroached upon. At higher elevations, fires set by grazers and people collecting forest products reduce the remaining Shola forest patches. In the forests of the Madikeri Division leases have been granted for extensive cardamom cultivation.

The good evergreen forests at higher elevations are subject to pressures from logging to produce plywood, matchwood and railway sleepers. There has, however, been a noticeable decline in the general intensity of exploitation of Karnatak forests since the mid 1970's. Despite large scale forest clearance for the Chakra and Varahi Projects, the removal of forest products from Forest Reserves has declined considerably over the past decade, due largely to the use of more conservative methods of extraction. The total production of all kinds of timber and fuelwood from Karnataka forests declined from 3,219,200 m<sup>3</sup> in 1975-76 to 1,562,523 m<sup>3</sup> in 1982-83, amounting to a decline of 52%. Tree removal for plywood and matchwood, which is entirely from evergreen species, showed a similar decline of 46%; 176,000 m<sup>3</sup> to 80,956 m<sup>3</sup> in this same period. Earlier working plans allowed the removal of 15 trees greater than 1.8 m in girth per hectare. In 1976, this upper limit was reduced to 10 trees/ha and then further reduced to 5 trees/ha in 1982-83. The practice of clear felling evergreen forests to practice monoculture was also abandoned in the mid 1970's (Shyamsunder, pers. comm.).

Despite more conservative exploitation practices within Karnatak forests, it was determined that approximately 38-89 km<sup>2</sup>, or 4% of the total estimated lion-tailed macaque habitat in this region was under pressure from selective logging for the plywood and matchwood industries in 1983-84. It should be noted that these practices are the results of political and administrative decisions beyond the control of local forest and wildlife managers.

**Poaching.** Traditional poaching of lion-tailed macaques, Nilgiri and Hanuman langurs is most severe in the Madikeri Forest Division adjoining Kerala State. The belief in alleged aphrodisiacal and medicinal properties of 'Black Monkey' flesh are firmly rooted in this region, particularly among settlers from Kerala. In the forest tract between the Sampaje and Mudugere Ranges, on either side of the ridge of the Ghats, local people are known to hunt lion-tailed macaques, though not as persistently as they do the Hanuman langur. North of the Belthangadi and Mudugere Ranges, lion-tailed macaques are not shot or eaten, though the Hanuman is shot up to the northern boundary of the Karkal Range.

Due to cultural tradition, the lion-tail enjoys some protection from hunting throughout approximately half of its range in Karnataka. It was noticed, however, that settlers from Kerala who have encroached upon the reserved forests in the Uppinangadi, Kundapur, Baidur and Sagar Ranges hold no such traditions and were reportedly poaching the lion-tailed macaque. On the whole, since implementation of the Wildlife Protection Act in 1974, there has been a considerable reduction in the level of poaching throughout the state, particularly broad daylight poaching that was common at one time. Being a diurnal species, the lion-tail has probably benefited greatly from the decline of this practice.

### Present Status of the Lion-tailed Macaque

**Relative Abundance.** Historically, the lion-tailed macaque must have been fairly well known in this tract since literary classics in the Kannada language such as "Torave Ramayana" (16th century) and "Kaushika Ramayana" (17th century) clearly mention it as being distinct from other monkey species. During the "Krishnashtami" religious festival in Udupi, Dakshina Kannada District, folk dancers masquerade as lion-tailed macaques and other animals. Locally, the lion-tailed macaque is recognized by the Kannada name "Singalika". In addition, it has several other interesting names in local languages and dialects which distinguish it from other primates (Table 1).

At the turn of the century, religious mendicants sporting lion-tailed macaques as mascots were a common sight in Dakshina Kannada (South Kanara) District (K. S. Karanth, pers. comm.). Lion-tails were reported from as far north as Anshi Ghat in 1955 (Kurup, 1978). According to data collected by Bhat (1982) and me, the lion-tailed macaque has probably become extinct in the extreme northern part of Karnataka in the Anshi, Kumbarawada, Varahalli, Janmane and Honnavar Ranges. A remnant population probably occurs in the Kumta Range (Bhat, 1982).

Of the 28 forest ranges covered in this survey, in only eight ranges did informants not notice a marked decline in lion-tail populations over the past 10-15 years. Even within these eight ranges, in the foothill forests of the Andar and Someshwar Forest Reserves in the Karkal and Hebri Ranges, some decline was noted.

In the 20 other ranges surveyed a general population decline was reported. The lion-tailed macaque has probably become extinct in the Sullya and Uppinangadi Ranges, and in most portions of the Manki and Sampaje Ranges. Similar local extinctions appear to have occurred within the Sagar, Siddapur and Gersoppa Ranges. Decline in abundance seems to have been severe in all four ranges of the Madikeri Division.

**Distributional Continuity.** From the data collected on troop sightings (Table 3) and other information, the distributional discontinuities of lion-tailed macaque populations within Karnataka appear to be closely linked to habitat discontinuities mentioned earlier. The major breaks appear to be at the Sharavati River valley, the Varahi Project, the Yelaneeru-Bandajearbi stretch and Sampaje Ghat, in addition to interrupted habitats north of the Sharavati River. The reported absence of the lion-tailed macaque in most parts of the Koratikalbare Forest Reserve of the Baidur Range is surprising since reasonably suitable habitat seems to exist and there is no local tradition of poaching. Evergreen forests occur patchily within semi-evergreen formations in the region north of the Bhatkal-Kogar Ghat road. Scattered sightings and lower reported densities indicate that this habitat distribution affects population continuity of the lion-tail.

**Troop Size.** Previous studies (Green and Minkowski, 1977) indicate troop sizes for the lion-tailed macaque to be between 6-34 individuals. Informants contacted during this survey were asked only for approximate figures (Table 3). Sightings of solitary monkeys probably indicate adult or subadult males not associated with larger troops. In many other cases it is likely that only a portion of the entire troop was viewed. Ajith Kumar (pers. comm.) estimated the average troop size to be between 18-20 animals in the Anamalai Sholas. On three earlier occasions that I saw lion-tailed macaques in Karnataka forests, troops of 18 (Agumbe Ghat, 1967-1968) and 10-15 (Samehakuhole, Hebri Range, 1974) individuals were recorded. During this survey, on both occasions when

lion-tailed macaques were sighted (at Kudlu and Kuringal) only solitary adult males were observed, though the movement of the associated troops could be discerned at a distance. For the purposes of this report an average troop size of 15 animals has been assumed.

**Density and Status.** The intensive line transect censusing necessary to estimate distributional density of troops was outside the scope of this study. During the field survey, I attempted several walks through the forest, counting the number of troops at each locality. The following results are reported:

Location	Distance Walked: (km) and Time	Monkeys Seen-# Troops
Kerti Forest Reserve (Makut Range)	5 km - morning	Hanuman langur - 1 (call) Bonnet macaque - 2
Madibare Forest Reserve (Kundapur Range)	5 km - evening	Hanuman langur - 3 Bonnet macaque - 1
Someshwar Forest Reserve (Karkal Range)	8 km - afternoon	Hanuman langur - 1 Bonnet macaque - 1 Lion-tailed macaque - 1
Tungabhadra State Forest (Sringeri Range)	3 km - afternoon	—
Tungabhadra State Forest (Kalasa Range)	5 km - morning	Hanuman langur - 3 Lion-tailed macaque - 1
Tungabhadra State Forest (Kalasa Range)	4 km - evening	Hanuman langur - 2

During this survey, three reliably good informants who covered 48 km<sup>2</sup> in adjoining sections of the Andar Forest Reserve estimated a total of 23 troops of lion-tailed macaques there. Though nothing conclusive can be stated from these observations, it does appear that in areas of suitable habitat the density of lion-tailed macaques can be expected to be fairly high.

Based on the information collected and my own habitat assessment, I have classified the 28 forest ranges that I surveyed into four distinct categories based upon relative distributional density of lion-tailed macaque troops (Table 4). These categories are:

*Absent* - no troops reported, habitat degraded and unsuitable;

*Low* - described as rare, habitat in fragmented patches;

*Medium* - described as present, not more than one troop seen on the same day by informants, habitat reasonably good; and

*High* - described as *not* uncommon, informants reporting more than one troop encountered on the same day, habitat very good.

From Table 4 it can be seen that only nine ranges are in the high density category. All are in a cluster on either side of the crest of the Ghats between Kollur Ghat road in the north and Yelaneeru in the south. Despite the existence of large projects like Chakra, Varahi and Kudremukh, which have disrupted this tract in the last decade, the remaining habitats are in good condition with reasonable continuity and isolation from human settlements. There is apparently no local tradition of poaching lion-tailed macaques within this tract.

Among the medium density ranges, those in the north, such as Gersoppa and Agumbe, have been disturbed by severe logging in the past. The lion-tails, however, are not subjected to poaching pressure. The medium density ranges in the south, such as Subramanya, Bhagamandala, Mundrote, Makut and Srimangala, have a tradition of poaching, but the forest habitat is remote and fairly undisturbed.

In the remaining 14 ranges low densities are reported. Of these, in the Siddapur, Sagar, Manki and Bhatkal Ranges the habitat has been disturbed and fragmented, mainly by forestry. Though the local people do not kill lion-tailed macaques, some poaching by settlers from Kerala in the Sagar and Baidur Ranges is reported. Within the other low density ranges, poachers have easy access to lion-tailed macaque habitat in Mudugere, Sakleshpur and Yesalur. In the Belthangadi and Uppinangadi Ranges, wholesale habitat degradation as well as poaching have wiped out the lion-tail, except in the most inaccessible regions of the Kadamakal Forest Reserve.

**Population Estimates.** In the absence of any hard ecological data on densities in different habitat types, no serious estimate of the lion-tailed macaque population can be made. The following points are put forth only tentatively.

An estimated 1,000 km<sup>2</sup> of habitat suitable for the lion-tailed macaque remains in Karnataka State. The home range of this species has been estimated at 4 km<sup>2</sup> in *Cullenia exarillata* dominant evergreen forests of the Ashambu Hills, Kerala by Green and Minkowski (1977). In the floristically more diverse Anamalai Sholas the home range is said to be 2 km<sup>2</sup> (Ajith Kumar, pers. comm.), probably indicating smaller home ranges in more diverse habitats relative to single dominant species habitats. The Karnataka forests are mostly low and medium elevation evergreen formations, floristically diverse, and the home range size is probably similar to that found in the Anamalai Sholas. Home ranges of neighboring lion-tailed macaque troops are reported to overlap considerably (Sugiyama, 1968; Green and Minkowski, 1977; Ajith Kumar, pers. comm.). Assuming an overlap of 20% and considering home range sizes of 4 km<sup>2</sup> and 2 km<sup>2</sup> respectively, there are potentially 312 to 625 troops of lion-tailed macaques in the estimated 1,000 km<sup>2</sup> of evergreen forest remaining in Karnataka.

Such theoretical considerations aside, I am quite certain that the 133 distinct troops reported here (Table 3) do not represent all the existing troops for the following reasons:

- 1) The separation of distinct troops based on only sighting records more than 5 km apart is probably overcautious, resulting in neighboring troops being considered as one.
- 2) Of the more than 300 informants questioned, approximately 150 reported sightings. It seems likely that these individuals could not have seen all the troops existing in the areas that they routinely traveled.
- 3) I was unable to contact many good informants with experience in areas of suitable lion-tail habitat such as Kalasa, Venur, Mundrote, Makut and Srimangala Ranges, where more troops are likely to be present.

Considering all these factors, it seems reasonable to propose that at least another 50% more troops than those reported are likely to be present. Therefore, the minimum population of wild lion-tailed macaques in Karnataka is likely to be about 200 troops, or approximately 3,000 monkeys.

### Conservation

From the results of this survey it is clear that the earlier assessments of lion-tailed macaque distribution and populations in Karnataka by Green and Minkowski (1977) and Kurup (1978) are gross underestimates. The fears expressed on the basis of these estimates that viable conservation efforts are not feasible are also without any factual basis. Within the 1,000 km<sup>2</sup> or so of habitat available, the lion-tailed macaque appears to be reasonably well distributed and many localities offer good opportunities for conservation efforts. Presuming that the earlier assessments of lion-tailed macaque status in Kerala and Tamil Nadu are reasonably accurate (Ali, 1982), the Karnataka populations appear to be larger than those in Kerala and Tamil Nadu combined.

All previous surveys of the lion-tailed macaque in Karnataka, except that by Bhat, appear to have relied on informants such as forest officials and castes/occupational groups among the local people, these individuals usually being unaware of the lion-tail. This has led to underestimates in all regions. In addition, lion-tailed macaques are probably more numerous than earlier estimates would indicate due to the fact that they are now known to occur in selectively logged forest, forestry practices in Karnataka have become more conservative over the past decade and in most localities in Karnataka the lion-tail is not poached as it is in Kerala and Tamil Nadu.

Despite all of the above, it is inadvisable to be complacent concerning the status of the lion-tailed macaque in Karnataka as it is definitely becoming scarcer throughout the state. Developmental projects such as hydroelectric dams, mines and new roads are opening up previously in-

accessible areas. Low elevation habitats are steadily decreasing under pressure from local inhabitants and the steep upper level Ghat forests are being exploited by the plywood and matchwood industries. In addition, a steep increase in the market value of forest produce during the last two years has resulted in serious smuggling problems.

Based on this study, a comprehensive management plan identifying seven key conservation areas (see Fig. 3) is being prepared for the lion-tailed macaque and its evergreen forest habitat in Karnataka. Support from the international primatological community will be important in ensuring that this plan will be implemented by the State and Indian Government.

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**Fig. 3 (a,b,c): Probable distribution of lion-tailed macaques in forests of Karnataka state, based largely on information supplied by local informants. Maps show both existing and proposed nature reserves, and forest ranges outside protected areas (maps by Stephen Nash from author's originals).**

**Table 3: Distinct Troop Sighting Records of Lion-tailed Macaques in Karnataka**

Troop #	# Seen	Date	Location Details
KT 1 *	8-10	1979	Armudighatta/Gumatadevara Honda about 10 km from Hulidevara Kolla on Doddamane-Kumta Road
SD 1 *	20	1979	Chiksuli Forest 5 km south of Doddamane Village
SD 2 *	30-40	1979	Forests near Kudgund Village 5 km north of Malemane Village
SD 3	10-15	3/1984	1 km from Melemanc on the path to Sutlimane
GR 1	4-5	6/1983	On the ridge to the north of Mahime Village on the path to Kodgi Village
GR 2	10-15	1/1984	Mastimane Ghat near Vate Halla Block 28 Plywood Coupe 4 & 9 km above Gersoppa on main road
GR 3	10-20	2/1984	Ambepal Gudda Block 28 Plywood Coupe 1 & 2
GR 4	1	3/1983	On the ridge 4 km above Hessagi & 3 km below Govardhanagiri Fort on the path to fort
BT 1	2-3	5/1983	1 km from Kurandur on the path going up the ridge to Basavanabavi Ghat
BT 2	2	3/1982	On the ridge above Hejila about 8 km below the Yedamale Gudda Peak
SG 1 *	3	1978-81	Between Kanur & Govardhanagiri Fort near to fort in Govardhanagiri SF
SG 2	10-15	2/1983	Near Sukrasetty Halla Stream 5 km from Kogar Cross on Kogar-Bhatkal Ghat Road
SG 3	3-4	7/1983	Within 1 km Kyadgod in Govardhanagiri SF
SG 4	2-3	1982	Within 1 km of Temple on Basavabavi Ghat footpath in Karni SF
SG 5	4-5	1979	5 km from Karni on the Padubeedu Ghat footpath to Baidur in Karni SF
BD 1	4-5	1/1982	8 km to the north of Kosalli water fall in Humlimurdibare RF
BD 2	4-5	1/1981	On the footpath from Onkodlu to the fort ruins 1 km above teak plantations in Hulimurdibare RF
BD 3	8-10	8/1981	On the ridge above Ganganad about 9 km from the village & 6 km below the crest between Chalkinbare and Madlabare peaks
BD 4	8-10	12/1983	On the ridge 5 km above rubber plantations in Hejjalu along the stream in Koratikalbare RF
BD 5	20-25	2/1984	To the north of Halliberu 1 km below Golgodubare Peak in Megani Valley RF
BD 6	1	1982	On the ridge 10 km above Halliberu & 8 km below Toskarbare Peak in Megani Valley RF
KD 1	3	10/1983	At Arukattimuri on the main road from Kollur to Nagodi about 2 km above the turn off point to Dali in Madibare RF
KD 2	2-3	5/1982	On the ridge above Salgeri 5 km away from village in Madibare RF
KD 3	2-3	3/1983	3 km from Luksal on the footpath to Basriberu in Madibare RF
KD 4	1	9/1983	On the ridge above Basriberu 4 km below Kodachadri Peak, in Madibare RF
KD 5	10-15	11/1983	2 km below the top of Umigudda hillock inside Mudur Estate of Mr. Kutty
KD 6	10-15	9/1983	On the ridge top of Nagankalbare RF 5 km from Ashkodu
HN 1	1	4/1983	At Karighatta near Nagodi in Kodachadri SF
HN 2	2	11/1983	At Hullarki about 3 km from Chakranagar on the road to Savehaklu Dam in Killandur SF
HN 3	5-6	10/1983	On Nimbesalgudda about 5 km from Savehaklu Dam in Killandur SF
HN 4	10-15	10/1983	Near district boundary (Kalluguppe) on Haklumane Ghat footpath to Hallihole Valley in Killandur SF
HN 5	4-5	10/1983	In the Sholas within 0.5 km of Savehaklu Dam in Killandur SF
HN 6	10-15	11/1981	On the ridge peak beyond Chakra Dam on footpath to Hallihole Valley in Chakra SF
HN 7	5-10	1982	Near temple on the main Balebare Ghat road in Hulikal SF
HN 8	5-6	7/1983	At Hosur-Bisilare in Varahi SF
HN 9	4-5	11/1983	1 km from Hulibaglu in Varahi SF
SN 1	4-5	5/1983	3 km from Baregundi in Baregundi RF
SN 2	5-6	12/1983	On the ridge 8 km away from Sulluniru in Baregundi RF
SN 3	10-15	3/1984	Below the rocky cliff on the ridge above Hosabalu (Kallahalli) 2 km below District boundary on Baregundi RF
SN 4	4-5	12/1983	2 km downstream of Kunchikalabbi water fall along Varahi River in Metkalgudde RF

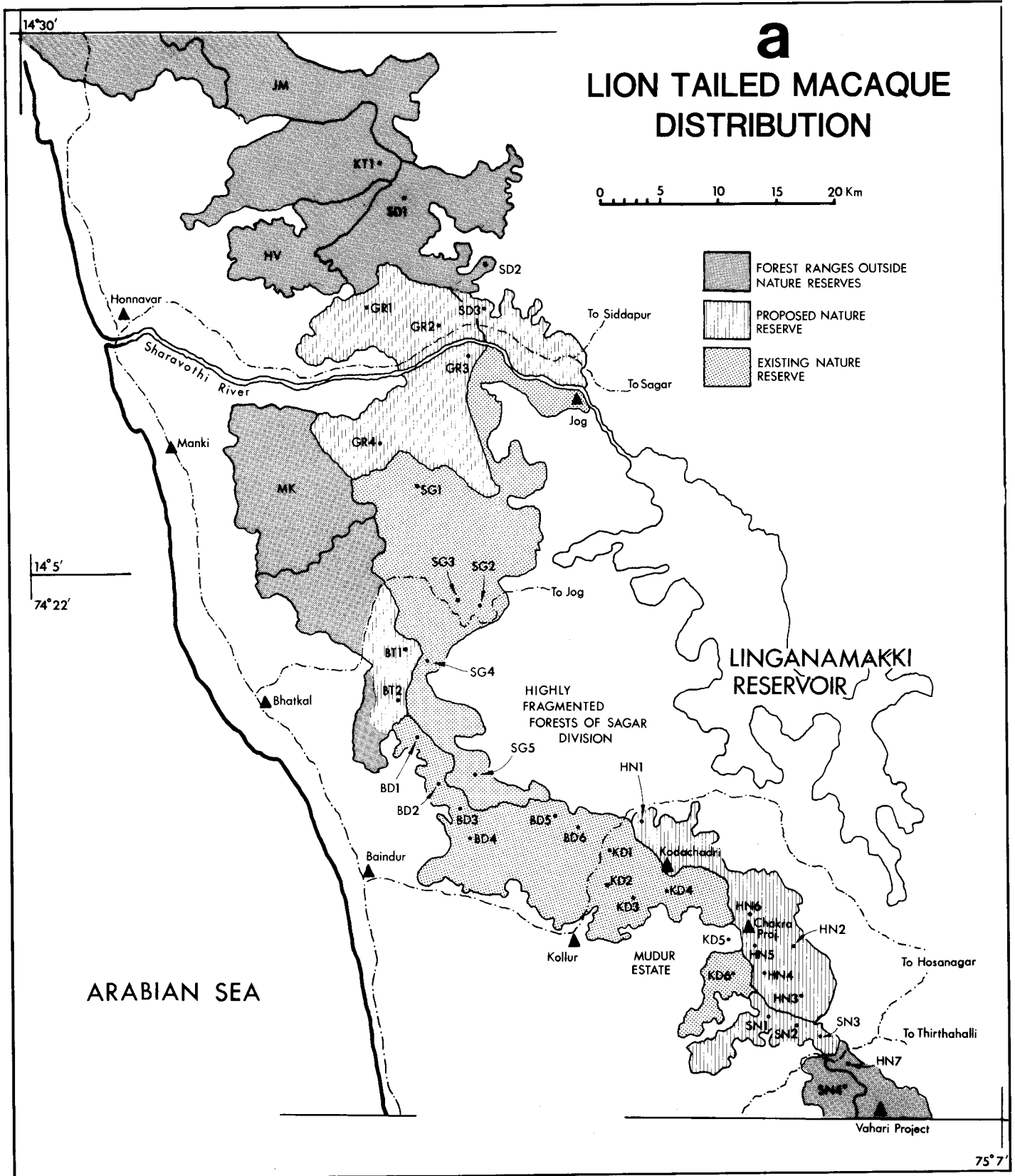


Fig. 3 (a,b,c): Probable distribution of lion-tailed macaques in forests of Karnataka state, based largely on information supplied by local informants. Maps show both existing and proposed nature reserves, and forest ranges outside protected areas (maps by Stephen Nash from author's originals).



Table 3 (Cont'd.)

SN 5	2-3	2/1984	On the footpath going up ghat in Ganapathigudda Hillock Compartment 5 block 15 of Tombattu RF
SN 6	10-12	1/1984	Near the top of Umigudda Peak 5 km from Kalmakki in Tombattu RF
SN 7	7-8	2/1984	On the ridge above Jaddinagadde 1 km below Masebare Peak in Tombattu RF
SN 8	4-5	1981	On the ridge above Kelsunka on the Ulthiga Ghat footpath in Tombattu RF
SN 9	7-10	3/1983	On the ridge above Jaddinagadde 2 km below Hullugudda Peak & 8 km from the village in Tombattu RF
AG 1	7-8	11/1982	10 km from Agumbe along Meenahalla Stream in Agumbe SF
AG 2	10-15	10/1983	Along the path to Vanakeabbi water fall 1 km from main road in Agumbe SF
AG 3	3-4	9/1983	Near Muthuganahole on the ridge 8 km from Barkana View Point in Balehalli SF
AG 4	3-4	10/1983	Within 0.5 km of Barkana View Point in Balehalli SF
HB 1	15-25	1/1984	On the ridge 5 km above Hanja below Senkolubare Peak alongside Nadubettuhole Stream in Ballimane RF
HB 2	5-6	1/1984	On the ridge 4 km southwest of Hanja 3 km below Haddinabare Peak in Ballimane RF
HB 3	15-20	10/1983	Below the District boundary on the main Agumbe Ghat road above Someshwar in New Someshwar RF
HB 4	10-20	12/1983	On the ridge 8 km above Megadde near water fall below Narasimha Parvata Peak in Someshwar RF (North)
KR 1	10-20	1/1984	On the ridge 3 km above Kudlu along Kudluthirta Stream in Someshwar RF (South)
KR 2 *	25-30	2/1984	2 km from Kudlu along Nemmarhole Stream in Someshwar RF (South) (5 km from KR 1)
KR 3	10-20	2/1984	5 km from Kudlu on Baradanegudda hillock in Someshwar RF (South)
KR 4	8-10	1/1984	8 km from Kudlu on footpath to Thingalmakki in Someshwar RF (South)
KR 5	2-3	12/1983	2 km from Sangaramale Tota in Andar RF
KR 6	5-6	1/1984	On the ridge 4 km above Mairoli below Valkunje (Ajjikunje) Peak in Andar RF
KR 7	7-8	3/1983	On the ridge 10 km above Yermala (Kunjadabakyar) between Shanthije halla Stream & Payanade halla Stream in Andar RF
KR 8	20	1/1983	On the ridge above Shanthije 5 km to the north of KR 7 in Andar RF
KR 9	10-20	2/1983	On the ridge 1 km above Berkala along the stream in Andar RF
SR 1	8-10	11/1982	In the Shola at Maik betta 12 km from Karki in Narashima parvata SF
SR 2	1	4/1983	In the Shola between Valkigudda & Balekal gudda 5 km from Karki in Narasimha parvata SF
SR 3	8-19	10/1982	2 km from Nemmar-Kerekatte Road on the road to Mathuli in the Sholas of Tungabhadra SF
SR 4	8-10	11/1983	In the Shola near Edgaru on the Nemmarkere katte Road in Tungabhadra SF
SR 5	25	10/1983	In the Shola 1 km from Kerekatte near Gulgunjimane on Nemmar-Kerekatte Road in Tungabhadra SF
SR 6	25	12/1983	In the Shola 3 km beyond Kerekatte on the road to S.K. border before Ganapathi Katte in Tungabhadra SF
SR 7	10-15	10/1983	In the Shola of Gurgalthota 2 km from Keregrama on the path to Mudua in Narasimhaparvata SF
SR 8	4-5	5/1982	At Gulmanehadya near district boundary 10 km from Kerekatte in Narasimhaparvata SF
SR 9	30	4/1984	On the main Kudremukh road 3 km from S.K. border gate towards Malleshwara near Shiva temple in Tungabhadra SF
MD 1	10-15	1983	5 km below S.K. border gate towards Mullur Ghat main road to Karkal in Naravi RF
MD 2	10-20	10/1983	On Hullugudda ridge 4 km above Heranje Jois Garden along a stream in Naravi RF
MD 3	7-8	1/1984	On the old path to Gangamoola 5 km above Mallar (Mala) on the ridge in Naravi RF
MD 4	20-30	1/1984	1 km from Bejal enclosure on the footpath to Kuringal (Korankal) on the ridge above Mallar in Naravi RF
MD 5	10-12	7/1983	On the ridge near Kadandalaje 4 km below Bejal enclosure in Naravi RF
MD 6	10-12	2/1983	On the ridge 2 km above Mapala & about 7 km from MD 5, in Naravi RF
MD 7	10-15	1/1984	3 km below Kuringal Peak to the south in Naravi RF
MD 8	10-15	1/1984	Within 2 km of Kaniyala enclosure in Naravi North Beat of Naravi RF
MD 9	5	2/1984	Near Gundi enclosure in Naravi North Beat of Naravi RF
MD 10	6-7	12/1983	At Edishere 6 km from Gundi enclosure in Naravi RF
MD 11	10-15	12/1983	On the ridge above Oddadaka 8 km south of Gundi enclosure in Naravi RF
MD 12	10-15	12/1983	4 km below Panjala enclosure in Naravi South Beat of Naravi RF
VN 1	10-15	10/1983	On the ridge 8 km above Malige in Aladangadi Beat of Naravi RF
VN 2	10-15	11/1983	Plywood Coupe 12 km to northeast on the ridge above Malige (6 km from VN 1) in Aladangadi Beat of Naravi RF
VN 3	10-15	10/1983	8 km further above VN 2 along stream side near District border in Aladangadi Beat of Naravi RF
VN 4	8-10	10/1983	On the ridge above Siralu 8 km from it along Handeluhalla Stream in Sirlalu Beat of Naravi RF
VN 5	20-30	1981	1 km above the Pela enclosure near stream bank Sholas in Savanalu Beat of Naravi RF
VN 6	20	2/1983	At Ballekana below Hirmarguppe Peak 10 km up ghat from Navur in Navur Beat of Naravi RF
VN 7	10-20	1/1984	In the valley adjoining Gundalpade Rock on the bridle path from Navur in Navur Beat of Naravi RF
KL 1	4-5	1982	Near Gangamoola on the footpath leading to it in Tungabhadra
KL 2 **	15-20	3/1984	On the jeep track to P&T Microwave Tower near Kuringal 0.5 km below it in South Bhadra SF
KL 3	5-6	4/1983	On the deadwood extraction Coupe Road 1 km from Bhagavati in South Bhadra SF
KL 4	10-15	4/1982	Near the bridge at the entrance of the jeep track to Kuringal into the forest Shola in South Bhadra SF
BL 1	5-6	2/1984	1 km from Bolle enclosure above Ragikumri in Mithabagil Beat of Naravi RF
BL 2	10-20	2/1984	On the ridge at Kunchila 6 km above Kolli Temple in Mithabagil Beat of Naravi RF
BL 3	5	11/1983	8 km from Didipe on the footpath through Yelanir Ghat in Mithabagil Beat of Naravi RF
BL 4	2-3	12/1983	In the Sholas 2 km from top of Bandaljearbi waterfall in Charmadi-Kanapadi RF
BL 5	1	2/1983	0.5 km from 3rd hairpin bend on the main Charmadi Ghat road on the tract to IPM Coupe in Charmadi-Kanapadi RF
BL 6	4-5	1/1984	On the ghat slopes near Chickmagalur border to the left of Charmadi Ghat Road 15 km from Hosmata and 11 km from Maduguni Estate in Charmadi-Kanapadi RF
BL 7	1	5/1983	4 km further up on the footpath to Ammedhikal Peak above Neriya Rest House in Neriya-Hebbur Rubber Estate
MG 1	8	8/1982	In the valley below Biligalgudda Peak near Jai Bharath Plywood Coupe in Balur SF
MG 2	4	12/1982	Near Uliyamakadu close to d-line beyond Bairapur Estate in Balur SF
SK 1	1	12/1982	2 km below Jenkalbetta Peak in Mafatlal Plywoods Coupe in Kabbinale SF
SK 2	10-20	9/1983	At Anegundi 1 km from hotel at Kempahole on Shiradi Ghat main road in Kagenari SF

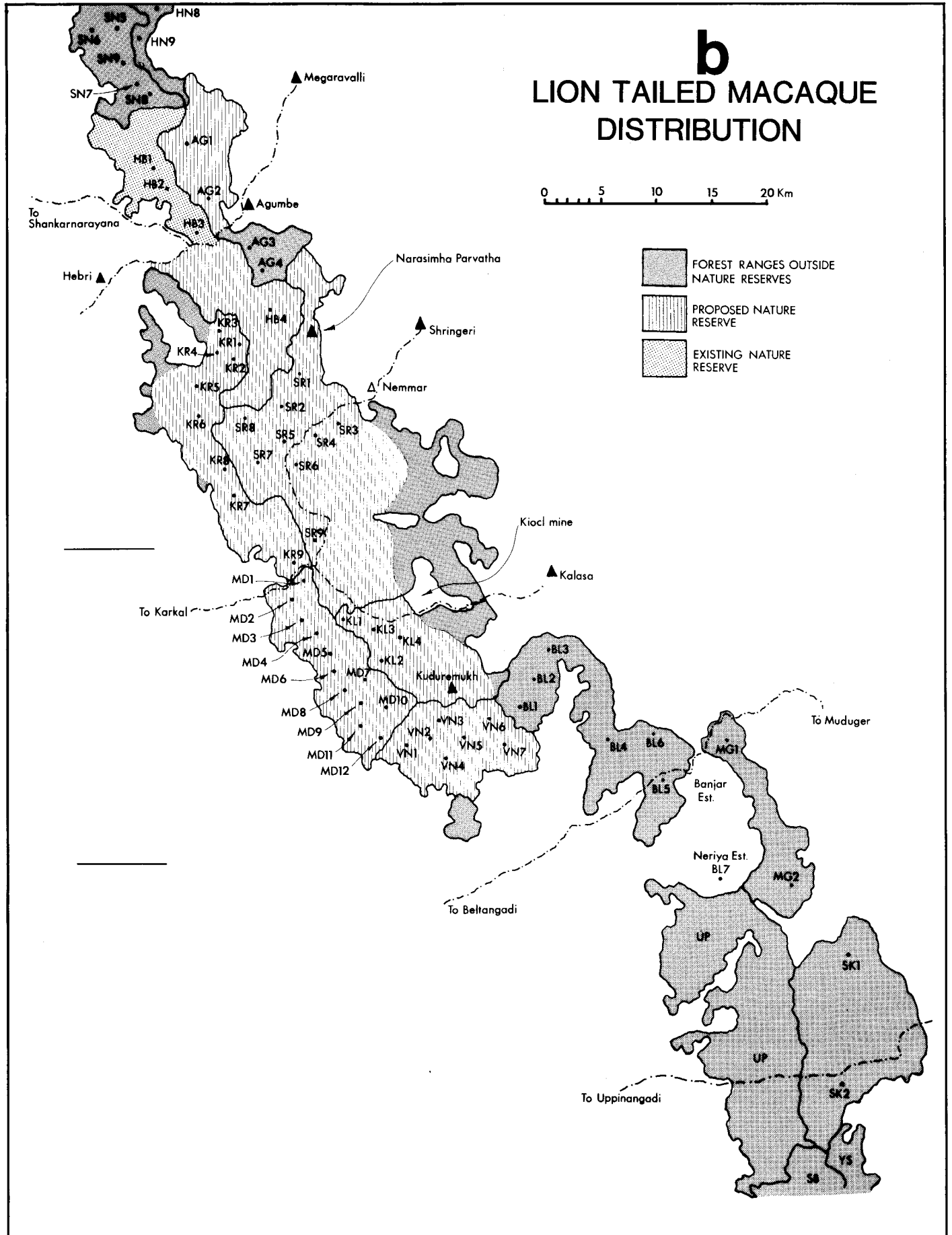


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**Table 3 (Cont'd)**

YS 1	2	6/1983	At the bridge across Addahole River on Bisale Ghat main road in Bisale SF
SB 1	10-15	1/1983	Above Koonadka in MPL 1980 Plywood Coupe 5 km from Kaikamba in Bagimale RF
SB 2	2	8/1983	2 km from Kaikamba at Bainkodi in Kidu RF
SB 3	4-5	2/1984	On the ridge 3 km above Balagodu along Padakahole stream near district boundary in Kiribag RF
SB 4	4-5	4/1983	On the ridge 3 km above Uppangala within 2 km of River Uppangalahole in Kiribag RF
SB 5	3-4	2/1984	On Umigudde hillock 5 km from Kollamogaru in Kilarmale RF
SB 6	5-6	2/1984	On Thingalagudde hillock 3 km above Kotegudde Thota in Kilarmale RF
SJ 1	7-8	3/1983	5 km above district boundary along Garadimottethodu (tributary of Meenugundi Hole) in Kadamakal RF
BG 1	10-15	1/1984	Along Kumekolli Stream at the edge of Kodangimale cardamom estate in Padinalknad RF
BG 2	10-15	1/1984	At Kudukollikodange near Betemale cardamom estate in Padinalknad RF
BG 3	10-12	12/1983	On the edge of forest touching Belathmale cardamom estate in Padinalknad RF
BG 4	10-15	11/1983	At Paisarimale 8 km from Karike Forest nurse in Pattighat RF
BG 5	8-10	8/1983	At 8th mile stone on Karike-Bhagamandala main road in Pattighat RF
BG 6	4-6	10/1983	2 km above Thodikana on the Pattighat Road in Pattighat RF
BG 7	4	1/1983	In Yelolimale cardamom estate 6 km from Belthmale cardamom estate in Pattighat RF
BG 8	10-12	1/1984	In Paduvalthmale cardamom estate opposite side of the valley from Bachimale & 6 km from Talakaveri in Pattighat RF
MN 1	6-7	12/1983	In Parivarthmale 9 km from Nadumale in Padinalknad RF
MN 2	3-4	9/1983	In Pathalamale area 5 km from Nadumale in Padinalknad RF
MT 1	10-15	1/1983	In OC Jose Plywood Coupe near Palemanekolli 10 km from Matre in Matre Section of Kerti RF
MT 2	1	10/1982	P. K. Plywood Coupe 16 km from Koolimakki in Koolimakki Section of Kerti RF
MT 3	5-6	12/1983	7 km from MT 2 in the same section of Kerti RF also in P. K. Plywood Coupe
MT 4	5-6	10/1983	3 km from Chelavara in Chelavara Coupe of Udumbe Section in Padinalknad RF
MT 5	1	1981	At Bannadapare 10 km from Heggala in Kerti RF
MT 6	5-6	1/1983	8 km above Makut on the Main Ghat Road in Kerti RF
MT 7	5-7	12/1983	12 km above Makut at Memanakolli off the Main Ghat Road and about 5 km from MT 6 in Urti RF
MT 8	5-6	1982	Along Kariyapole River (tributary of Barapole) 5 km from Sollekolli & 12 km from Parkatgeri in Urti RF
SL 1	3-4	11/1983	At Kamberimalegundi on Nadkanibetta hillock 6 km above Parkatgeri in Pookala Section of Brahmagiri RF
SL 2	10-12	8/1983	At Ubbakallu-Balyabugari area on the ridge 10 km above Ponnambare, Theralu in Pookala Section of Brahmagiri RF

\*: Troop sightings recorded by informants of H. R. Bhat (1982).

\*\* : Troops actually seen by author.

Note: The first two letters in the column titled Troop # indicate the Forest Range in which the troop is located and the subsequent number indicates the serial number given to the troop within that range. The abbreviations used for the various ranges are:

KT - Kumta	MD - Moodabidre
SD - Siddapur	VN - Venur
GR - Gersoppa	KL - Kalasa
BT - Bhatkal	BL - Belthangadi
SG - Sagar	MG - Mudugere
BD - Baindur	SK - Sakaleshpur
KD - Kundapur	YS - Yesalur
HN - Hosenagar	SB - Subramanya
SN - Shankaranarayana	SJ - Sampaje
AG - Agumbe	BG - Bhagamandala
HB - Hebri	MN - Mundrote
KR - Karkal	MT - Makut
SR - Sringeri	SL - Srimangala

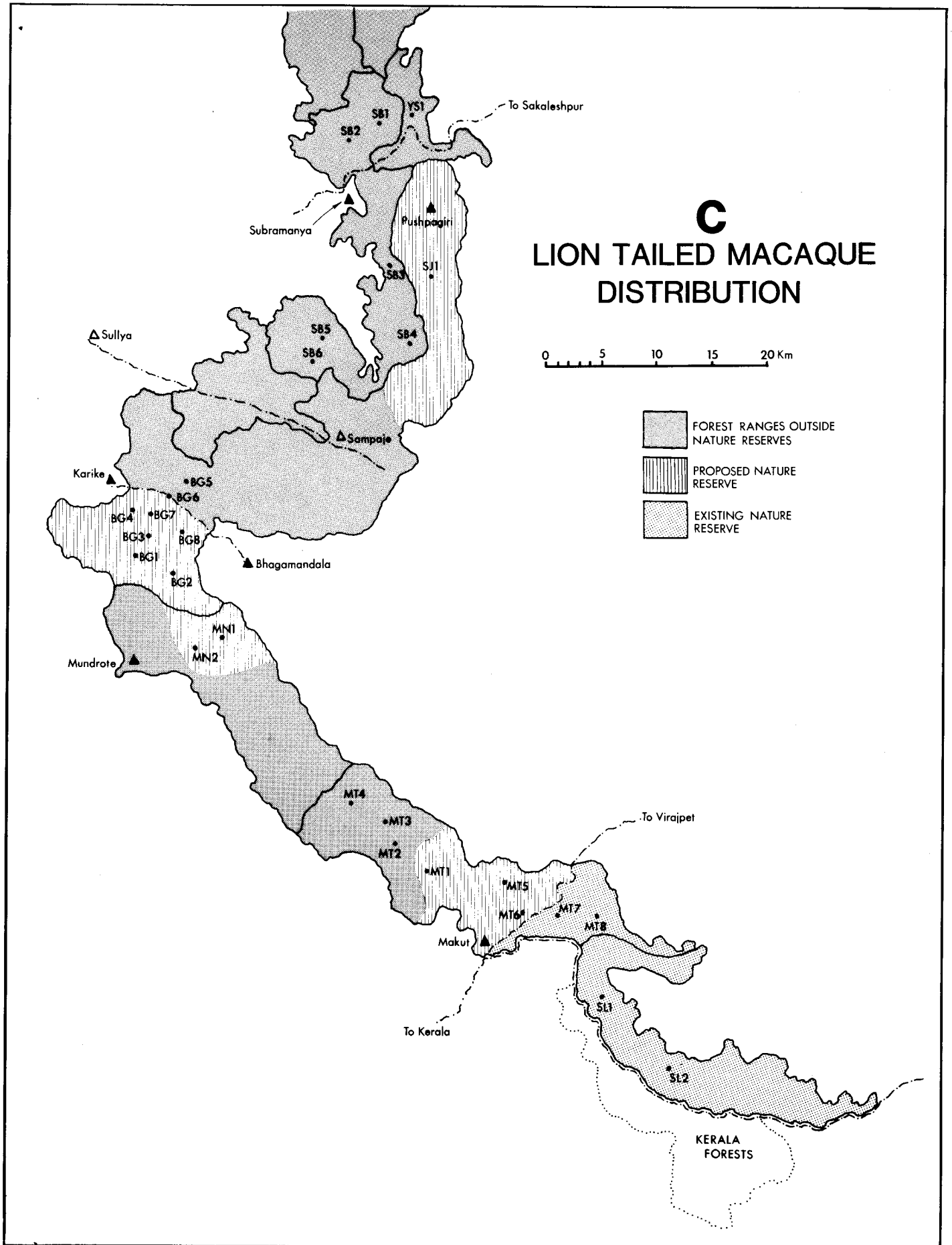


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**Table 4: Status Summary of Lion-tailed Macaque and its Habitat in Karnataka**

Forest Range	Forest Type	Area of Reserved Forest in Ghats (sq km)	Est. Area of Evergreen Forest	Area Under Selective Felling (sq km)	Traditional Poaching	Relative Abundance Compared to Past	Number of Troops Reported	Estimated Distributional Density
Siddapur	26/4	NA	15	—	No	Rarer	3	Low
Gersoppa	25	131	36	4.14	No	Rarer	4	Medium
Manki	26/4	79	24	4.00	No	Rarer	0	Low
Bhatkal	26/4	161	84	Nil	No	Rarer	2	Low
Sagar	26/4	239	167	5.4	No	Rarer	5	Low
Hosanagar*	26/5,3	107	70	1.00	No	Rarer	9	High
Agumbe	26/3	74	55	1.00	No	Rarer	4	Medium
Baindur	26/4	100	82	Nil	No	Rarer	6	Low
Kundapur	26/5	86	47	Nil	No	Same	6	High
Shankaranarayan	26/5	107	51	0.81	No	Same	9	High
Hebri	26/5	118	66	Nil	No	Same	4	High
Karkal	26/2,5,9	123	69	0.56	No	Same	9	High
Mudabidre	26/2,9	87	65	1.42	No	Same	12	High
Venur	22; 26/9,2	108	54	0.81	No	Same	7	High
Sringeri	26/9	203	115	1.50	No	Same	9	High
Kalasa**	22; 26/8	135	47	1.62	No	Same	4	High
Mudugere	26/8,1	74	52	0.65	Yes	Rarer	2	Low
Sakaleshpur	26/1,8	139	89	1.28	Yes	Rarer	2	Low
Yenalur	26/1	36	21	1.21	Yes	Rarer	1	Low
Belthangadi	26/1,8	85	51	0.80	Yes	Rarer	6	Low
Uppinangadi	26/1	147	37	NA	Yes	Extinct	0	Absent
Subramanya	26/1	190	93	1.62	Yes	Rarer	6	Medium
Sullya	26/1	80	8	Nil	Yes	Extinct	0	Absent
Sampaja	26/1,8	271	110	2.00	Yes	Rarer	1	Low
Bhagamandala	26/1,8	152	122	2.70	Yes	Rarer	8	Medium
Mundrote	22; 26/1,8	165	115	2.00	Yes	Rare	2	Medium
Makut	22; 26/1,8	195	136	3.72	Yes	Rarer	8	Medium
Srimangala	22; 26/1,8	129	104	0.65	Yes	Rarer	2	Medium
		3,521	1,985	38.89				

\*: Including submersion area of Chakra; part of Vahari Projects

\*\* : Excluding Kudremukh Mining Lease Area

NA: Not available