Elephant Conservation in South India: issues and recommendtions

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Status and distribution of wild elephants

The elephant is distributed over hilly terrain of the Western Ghats and a part of the Eastern Ghats in the southern Indian States of Karnataka, Kerala, Tamilnadu and, relatively recently, Andhra Pradesh. Its range lies between 8°15'N and 15°30'N and 74°15'E and 78°E, and is characterized by a diversity of vegetation types including medium elevation tropical evergreen forest, montane stunted evergreen forest and grassland, semi-evergreen forest, moist deciduous forest interspersed with grasslands, dry decidous forest and dry thorn forest, in addition to planted forests. Over this range of habitat types elephants are seen from an elevation of 100m a.s.l. to over 2000m a.s.l. (Nair *et al.* 1980; Sukumar 1985, 1989; Anon 1993; Easa 2001; AERCC 1998).

The distribution of the elephant can be considered under the following major population categories for the sake of convenience. This is modified from the earlier categories used by Sukumar (1989) based on new information on habitat connectivity:

(a) Northern Karnataka
(b) Crestline of Karnataka Western Ghats
(c) Bhadra–Malnad
(d) Brahmagiri–Nilgiris–Eastern Ghats (Elephant Range 7)
(e) Nilambur–Silent Valley–Coimbatore (Elephant Range 8)
(f) Anamalais–Parambikulam (Elephant Range 9)
(g) Periyar–Srivilliputhur (Elephant Range 10)
(h) Agasthyamalais

Of these, the following four populations (Sections 11.2 to 11.5) have been designated Elephant Reserves by Project Elephant, a conservation endeavour funded by the Indian government.

(a) Northern Karnataka

The elephants of northern Karnataka represent the northern limit of distribution of the species in southern India. They range over the Uttara Kannada and Belgaum Districts of Karnataka state mainly in moist and dry deciduous forests. The estimated population is about 40-60 elephants, completely isolated from populations further south along the Western Ghats. The only Protected Area (PA) for elephants here is the Dandeli Wildlife Sanctuary (WLS), whose area has now 475km^2 from the earlier 5,729km^2. A proper survey of status and distribution of this population is needed.

(b) Crestline of Karnataka Western Ghats

The status of the elephants ranging as small, scattered groups across the evergreen forests and montane grasslands in the Districts of South Kanara, Mangalore, Shimoga and Chickmagalur is poorly understood. It is however clear that the population numbers across this range is very low, not more than about 60 elephants.

(c) Bhadra Sanctuary–Malnad

The Malnad Plateau lying east of the Ghats is separated from them by a tract of coffee plantations and cultivation. The Bhadra WLS (827km^2) is the major habitat for elephants that range over moist deciduous forest. The latest estimate for this region is 500 elephants. A major ongoing resettlement scheme for villages within the reserve is completed and is expected to improve the overall viabilty of the habitat for the elephant population here. This region also maintains tenuous links with the Pushpagiri/Brahamagiri Range further south, but the precise nature of these links is yet to be explored.

(d) Brahmagiri-Nilgiri-Eastern Ghats (Elephant Range 7)

The largest single population of elephants in Asia today is found in this range, which extends from the Brahmagiri Hills, south through the Nilgiri Hills and east through the Eastern Ghats within the States of Karnataka, Tamilnadu and Kerala (with a splinter group in Andhra Pradesh). Covering an area of over 12,000km^2 and a minimum population of 6,300 elephants (Table 11.1), this range still maintains tenuous links with Elephant Range No. 8 (Nilambur-Silent Valley-Coimbatore), with a few elephants moving between these two ranges and possibly maintaining some gene flow.There are four important zones with relatively intact habitat and/or large elephant populations within this range. These are:

(i) Brahmagiri Hills covering parts of Karnataka (Brahmagiri Sanctuary) and Kerala (Wynad North Division), with good evergreen forest, montane shola forest and grassland and elephants at a low density.

(ii) Nagarhole, Bandipur, Wynad, Mudumalai PAs and the Nilgiri North Division with moist deciduous and dry deciduous forests and a very high elephant density and population.

(iii) Biligiriranganswamy Temple (BRT) Sanctuary (within the Chamrajnagar

Division) and eastern portions of the Satyamangalam Division with a diversity of vegetation types, including dry thorn forest, deciduous forest, montane shola forests and grassland and a medium to high density of elephants.

(iv) A 100km tract along the Cauvery River in Karnataka (Cauvery Sanctuary, Kollegal Division) and Tamilnadu (Hosur and Dharmapuri Divisions) with dry deciduous and dry thorn forest and a medium density of elephants.

The priority should be to maintain these habitats and the interconnections between them. With a moderately unequal sex ratio, the effective population size of elephants in this reserve is much less than its potential size. Nevertheless, this population is demographically and genetically viable from a long-term perspective, with a largely protected habitat and should thus be maintained as the key population for the long-term conservation of the species.

Geography of the Elephant Range

This elephant range is situated in the States of Karnataka, Tamil Nadu and Kerala. The terrain of the range is mostly undulating with low hills varying from 400-2,207m a.s.l. (the highest altitude being in the Nilgiri North Division). To the northwest of this range, the Brahmagiri Hills in Karnataka rise to 1,607m a.s.l., and are a part of the Western Ghats. South-east and south of the Brahmagiris, the range extends through the Wynad Plateau, the northern Nilgiri Hill slopes, the Mysore Plateau, to the Sigur Plateau and down to 250m a.s.l. in the Moyar River Valley which is the eastern limit of the Western Ghats. To the north-east, the Moyar Valley rises up the steep slopes of the Eastern Ghats to the Talamalai Plateau (750m a.s.l.) and then through a series of hills to

Fig. 1 Elephant distribution in Southern India

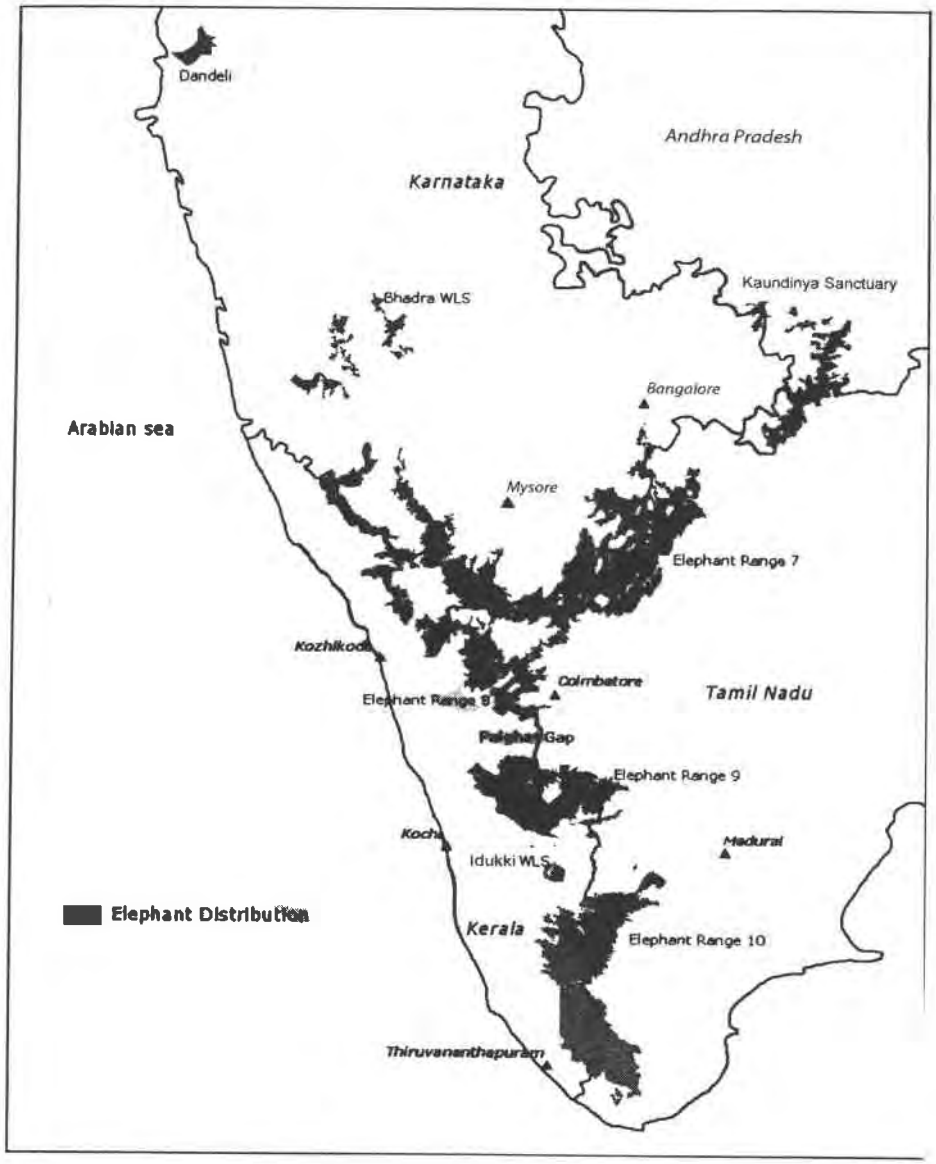


Table 1. The estimated number of elephants in southern India (TN = Tamil Nadu; KA = Karnataka; KE = Kerala).

Name of Division	Area (km^2)	Elephant Population	
		Minimum	Maximum
Brahmagiri Sanctuary (KA)	181	50	184
Virajpet (KA)	*336*	33	68
Madikeri (KA)	*373*	64	105
Rajiv Gandhi NP (KA)	*644*	842	1439
Bandipur PTR (KA)	*874*	1469	2484
Nugu Sanctuary * (KA)	*32*	12	41
Chamrajnagar Sanctuary (KA)	*560*	411	774
Kollegal (KA)	*1145*	190	518
Cauvery Sanctuary (KA)	*511*	509	1109
Mandya * (KA)	*194*	14	14
Bangalore Rural * (KA)	317	?	?
Bannerghata NP (KA)	*104*	21	121
Wynad North (KE)	214	138	?
Wynad South (KE)	323	58	?
Wynad Sanctuary (KE)	344	700	?
Kozhikode * (KE)	324	65	?
Mudumalai Sanctuary (TN)	*321*	647	761
Gudalur (part) (TN)	93	?	?
Nilgiri North (TN)	*854*	525	558
Nilgiri South (TN)	150	23	?
Satyamangalam (TN)	*1360*	556	1193
Erode (TN)	*782*	154	181
Dharmapuri (TN)	*529*	81	100
Hosur (TN)	*907*	251	296
Total	**11,472**	**6,813**	**9,946**

The estimates are based on total counts (made during 1979 and 1983) and sample block counts (1993) by the forest departments, direct line transect counts and indirect dung counts (Karanth and Sunquist 1992) at Nagarhole, IISc and AERCC at Mudumalai, Bandipur and Wyanad (Sukumar *et al.* 1991; Varman and Sukumar 1995) and KFRI (Anon 1993) at Wynad. Repeated estimates by rigorous statistical methods consistently return density figures of 2-4 elephants/km^2 in this tract. For other areas, the estimates are more tentative at present. On the whole, the population estimates for this range are probably among the most reliable, in statistical terms. The figures in italics are the results of the 2002 South India Synchronised Elephant Census.

Conservation problems and issues

Habitat fragmentation

As this range extends over a large area of the Western and the Eastern Ghats, and covers four States (including the sub-population in Andhra Pradesh), the problems are also specific to different regions. Broadly, the threat of further fragmentation of habitat still exists for this range. There are numerous enclaves of human settlement and cultivation in the various divisions of the Eastern Ghats (primarily in Bannerghatta NP, Kollegal, Chamarajnagar, Hosur, Dharmapuri, Erode, Satyamangalam), the Nilgiris (Nilgiri North, western part of Mudumalai and Wynad Sanctuaries and Wynad North Division) and in Kodagu District, particularly in the Madikeri Division. Some of these settlements, such as those in the *vyals* or swamps of the Wynad and Mudumalai keep elephants away from their traditional dry season feeding grounds. Coffee plantations in the Kodagu Region have already cut off direct access between Nagarhole and Brahmagiris in Karnataka. North of the Cauvery River in the Madikeri Division, the elephant habitat is highly fragmented and separated by a long belt of settlements (along the

the Biligirirangan Range (highest peak 1,816m). East of the Biligirirangans, the lower hills of Satyamangalam, Bargur and Madeshwaramalai extend to the Cauvery River. The terrain along the Cauvery is rugged, and to its north the Melagiri Hills represent the northern limit of elephant distribution, although some herds are now found further north in the Chittoor Hills of Andhra Pradesh.

The mean annual rainfall varies from 625-5,500mm. The Nugu and the Kabini Rivers flow in the Bandipur Project Tiger Reserve and are the main sources of water during the dry season. The Cauvery River is a major water source within the Cauvery Sanctuary and the Hosur and Dharmapuri Divisions. Some important reservoirs in the range are the Nugu and the Kabini.

The range includes the entire spectrum of vegetation types of Peninsular India and is dominated by deciduous forest. The other forest types found within the range are dry thorn, evergreen and semi-evergreen forests, montane-shola grassland and man made forests. Apart from these forest types, micro-habitats such as swampy grasslands, are also found in the range.

Status, density and distribution of elephants

The population estimates for the various divisions in this range are given in Table 1. With a minimum estimate of 6,813 elephants (and an upper limit of over 9,946) this range has the largest known population of elephants in the country. Indeed, even taking the lower limit, this range has more elephants than any other Asian country, with the possible exception of Myanmar.

Table 2. Estimates of elephant numbers from Tamil Nadu, Karnataka and Kerala States, India. (TN = Tamil Nadu; KA = Karnataka; KE = Kerala)

Name of Division	Area (km²)	Elephant Population	
		Minimum	Maximum
Nilambur North (KE)	325	315	n/a
Nilambur South (KE)	100	210	n/a
Mannarghat (KE)	665	193	n/a
Silent Valley NP (KE)	90	100	227
*Palghat (KE)	239	68	83
Mukurthi NP (TN)	78	n/a	38
Nilgiri South (TN)	150	23	n/a
Coimbatore (TN)	*738*	*125*	*231*
Total	**2,385**	**1,034**	**?**

The estimates are based on total counts made during 1979 and 1983 and sample block counts done in 1993 by the forest departments,) and KFRI (Anon 1993). The figures in italics are the results of the 2002 South India Synchronised Elephant Census.

northern banks) from the forests to areas south of the Cauvery.

Pressures from developmental projects (Pykara Ultimate Stage Hydro-Electric Project and the proposed hydroelectric projects such as Mekkadatu along the Cauvery in Karnataka), also threaten to contribute to habitat fragmentation. A proposed railway link between Chamarajnagar (Karnataka) and Mettupalayam (Tamil Nadu) through the Moyar Valley and the steep slopes of the Eastern Ghats near Talamalai, if implemented, would effectively separate the elephant populations of the Western and Eastern Ghats.

In the Wynad North Division, small areas under contiguous elephant habitat are under tremendous pressure from tea and coffee cultivation. Complete loss of contiguity between the Brahmagiris and the rest of the Division within the Periya Range occurs because of tea cultivation. The dry deciduous tracts are comparatively less disturbed, but have been characterized by an almost complete transformation of natural vegetation into teak plantations.

Isolated elephant herds

During 1983-1984 several elephant herds dispersed from the Hosur and Anekal area northwards into the Chittoor District of Andhra Pradesh. A sanctuary (Kaundinya Sanctuary) was set up for these elephants and about 20-30 elephants are isolated within this reserve. Splinter herds or individuals have wandered further north into the Tirupati Hills and into the Cuddapah and Ananthpur districts of Andhra Pradesh. One splinter herd of 6-7 elephants is also isolated in the Tirupattur Division of Tamilnadu.

Table 3. Estimates of elephant numbers from southern India. (TN=Tamil nadu; KA=Karnataka; KE = Kerala)

Name of Division	Area (km2)	Elephant population Minimum	Maximum
Thrissur (KE)	210	36	98
Nemmara (KE)	352	42	152
Chalakudy (KE)	477	32	93
kothamangalam (KE)	317	32	90
Malayattur (KE)	617	124	194
Vazhachal (KE)	414	312	619
Munnar Division and Sanctuary (KE)	1,185	161	365
Parambikulam Sanctuary (KE)	274	146	217
Anamalai (Indira Gandhi) Sanctuary (TN)	959	470	623
Kodaikanal (TN)	407	10	?
Dindigul (TN)*	400	70	91
Theni (part) (TN)	450	103	140
Total	**6,062**	**1,538**	**2,692**

* indicates estimates from block counts (all other estimates are based on the indirect dung count method). the estimates are based on census carried out during 2002 using sample block counts and indirect (dung) count by the forest departments in collaboration with the Asian Elephant Reserch and Conservation Centre (AERCC 2002a, b) for Tamil Nadu and karnataka, and by Kerala Forest Reserch insitute for Kerala reassessed by AERCC and Project Elephant directorate. Repeated estimates by rigorous statistical methods such as line transect direct counts consistently return density figures of 1- 4 elephants/km2 in this tract for the Nagrahole-Mudumalai-Bandipur Wynad tract (Karanth and Sunquist 1992; Sukumar et al. 1991; Varman and Sukumar 1995; Centre for Ecological Sciences unpubl). For other areas, the estimates are more tentative at present. On the whole, the populaiton estimates for this range are probably among the most reliable, in statistical terms.

Table 4. Estimates of elephant numbers in Kerala and Tamil Nadu, southern India (TN = Tamil Nadu; KE = Kerala)

Name of Division	Area (km^2)	Elephant population Minimum	Maximum
Theni (part) (TN)	272	62	84
Srivilliputur Sanctuary (TN)	380	133	179
Periyar PTR (KE)	777	1,065	1,717
Konni (KE)	332	31	74
Achenkoil (KE)	264	47	98
Ranni (KE)	1,059	175	297
Punalur (KE)	280	12	30
Total	**3,364**	**1,526**	**2,479**

The estimates are based on census carried out out during 2002 using sample block counts and indirect (dung) count by the forest department in collaboration with the Asian Elephant Research and Conservation Centre (AERCC 2002a. b) for Tamil Nadu and karnataka, and by Kerala Forest Research Institute for Kerala reassessed by AERCC and Project Elephant directorate. Repeated estimates by rigorous statistical methods such as line transect direct counts consistently return density figures of 1-4 elephants/km^2 in this tract for the Nagarahole-Mudumalai-Bandipur-Wynad tract (Karanth and Sunquist 1992; Sukumar *et al.* 1991; Varman and Sukumar 1995; Centre for Ecological Sciences unpubl.). For other areas, the estimates are more tentativeat present.On the whole, the population estimates for this range are probably among the most reliable, in statistical terms.

Anthropogenic pressures on habitat

The large human population both within and along the periphery of the range has made substantial impact on the vegetation in some regions, especially outside the PAs. The causes include extraction of fuel wood, collection of NTFPs (non-timber forest products), grazing by domestic livestock and collection and export of dung as manure. FDs and areas most affected by this include Hosur, Dharmapuri, Erode, Satyamangalam, Nilgiris North, Masinagudi Range of Mudumalai (Tamilnadu), Kanakapura Range, Kollegal, a part of Chamarajnagar (Karnataka) and Wynad (in Kerala).

Human-elephant conflict

Given the extent of cultivation and the abundance of elephants, this range has serious problems of elephant-human conflict. Crop depredation by elephants is common in practically all forest divisions, both in cultivated enclaves and along the outer boundary of forest and settlement. Cases of manslaughter by elephants, often associated with crop depredation, are also widespread in the range. Most sanctuaries, national parks and divisions in this range are surrounded by human settlements. Although no particular division can be singled out, the high degree of fragmentation in places such as Kodagu, Wynad and Bannerghatta does seem to result in greater conflict. During the dry season when major areas of Mudumalai and Bandipur are burnt, elephants migrate westwards towards Nulpuzha, the only water source in the whole area. The high concentration of elephants bring them into conflict with the settlements. Crop-

raiding reaches high levels in areas of Madikeri Division where the habitat is highly fragmented and cultivation pressure is very high.

In Bannerghatta National Park, around five kilometres away from the north-west corner of the park, there is a distillery which maintains around 250ha of eucalyptus plantation and scrub-jungle along with a large tank of water. Elephants are reported to use this as a base from which they conduct nightly raids on surrounding crop fields and then return to it during the day. Effluents discharged from the distillery into the streams and/or illicit distilling within the premises may be attracting the elephants to this area. A dramatic manifestation of this in Bannerghatta has been the dispersal of over 50 elephants from here to Andhra Pradesh during 1983-1984, and what seems to have been a similar effort during 1995 by a herd of about 80 elephants.

Poaching

The large population of elephants with over 90% of the males being tuskers has also led to widespread poaching during the past two decades. No Division has been completely free of this menace, although the levels seem to have been the lowest at Nagarahole NP. During this period, poaching has been noticeable in Hosur, Dharmapuri, Erode, Satyamangalam, Nilgiris North, Mudumalai, Kollegal, Chamarajanagar, Bandipur and Wyanad. Consequently, the sex ratios in this region are becoming increasingly skewed with time. Objective data on population structure and sex ratio are available only for some areas. During 1981-1983, the Chamrajanagar and Satyamangalam Divisions had an adult (>15 years) male: female ratio of 1:5. This widened here and in the adjoining Nilgiri North, Mudumalai and southern Bandipur tract to about 1:8 by 1987. Monitoring of sex ratio in the Mudumalai and Nilgiris North populations indicates that the sex ratio had widened to about 1:30 by 2001.

Recommended actions

Elephant conservation priorities for this range include maintaining habitat contiguity through protection, acquisition and creation of corridors, consolidation of habitat through translocation of some settlements, habitat improvement through promotion of regeneration and afforestation, minimizing elephant-human conflicts through setting up of barriers and population management and control of ivory poaching.

Restoration and preservation of crucial elephant corridors

Brahmagiri-Tirunelli corridor (Karnataka; Brahmagiri Sanctuary, Kerala; Wynad North Division): The elephant populations in the Western Ghats of northern Karnataka along the Brahmagiris are connected to those in the Coorg Plateau only through the northern Wynad Region of Kerala. The southern tip of the Brahmagiris extends into Kerala's Wynad North Division, where the Tirunelli RF and Kudrakote RF provide a narrow connection eastwards to the Tholpatty Range of Wynad Sanctuary. There are eucalyptus and teak plantations in this corridor and also some settlements (Edayurvayal and Panayankolli). This is an extremely important corridor to maintain habitat contiguity for elephant populations in the Western Ghats, and should be accorded a very high priority. Resettlement of villages should be carried out and strict protection against habitat degradation ensured.

Singara-Masinagudi corridor (Tamil Nadu; Mudumalai Sanctuary, Nilgiri North Division): The contiguity between the elephant habitats in the Nilgiris and the Eastern Ghats is today maintained entirely by movement through private lands and forest land leased to the Tamil nadu Electricity Board. Penstock pipes between Glenmorgan and the Singara power station obstruct any elephant crossing along the Nilgiri slopes. Further north between Singara and Masinagudi Villages, elephants move in an east-west direction through a private forest belonging to Singara (coffee) estate. New developments connected with the Pykara Ultimate Stage Hydro-Electric Project are increasingly threatening the existence of this crucial corridor utilized by several elephant clans as revealed by a BNHS study (Desai 1991; Desai and Baskaran 1996). At least a portion of this forest should be acquired and maintained for the elephant movement to continue.

Masinagudi-Moyar corridor (Tamil Nadu; Mudumalai Sanctuary): Further north, between Masinagudi and Moyar Villages, the 7km-long flume channel carrying water from Maravakandy Reservoir to the Moyar Power Station passes through the Mudumalai Sanctuary. A small strip of land on either side of the channel has been leased out to the Tamilnadu Electricity Board. Elephants at present cross the channel at certain points. The Tamilnadu Electricity Board proposes to widen the canal and line the sides with concrete to increase water flow as part of the Pykara Ultimate Stage Hydro-Electric Project. The preservation of this corridor should be strictly ensured, and no development activity be allowed to disrupt the movement of elephants.

Kaniyanpura corridor (Karnataka; Bandipur Project Tiger Reserve): This corridor connects the western parts of the Bandipur National Park with its eastern extremeties. This area maintains a contiguity to habitats within the Sathyamangalam and Chamrajnagar Divisions. The corridor is extremely narrow (20m wide) and is bordered on one side by an elephant-proof trench running through private land and on the other, by the steep slopes of the Moyar Gorge. Private lands need to be purchased to widen this corridor.

Punjur - Kolipalya corridor (Karnataka; Chamarajnagar Division): A 1.5km-wide strip of RF between the villages of Punjur and Kolipalya in Chamarajnagar Division (BRT Sanctuary) was traditionally used by

over 100-200 elephants moving between the Punjur Range (Chamarajnagar Division) and the Satyamangalam Division (Tamil Nadu). During 1990 tribals from the Biligirirangan Hills were rehabilitated on this corridor by the forest department, and the forest was cleared for cultivation. This has completely obstructed the movement of elephants along this tract. To the east of Punjur village, there is insignificant movement along the steep hill slopes, while to the west of Kolipalya, there are other settlements and cultivation. The restoration of this corridor by resettling the tribals on the forest periphery, and providing elephant-proof barriers around the villages of Punjur and Kolipalya is necessary.

Talavadi-Mudahalli corridor (Karnataka; Chamarajnagar Division, Tamil Nadu; Sathyamangalam Division): Elephants going to the small Suvarnavati Reservoir often use the corridor between the villages of Talavadi and Mudahalli. This corridor connects the Chamrajnagar (Karnataka) and Sathyamangalam (Tamil Nadu) Divisions. Survey of the corridor, its strict protection and provision of appropriate barriers in the villages to prevent crop depredation are priority actions.

Sujalkottai-Bannari corridor (Tamil Nadu; Sathyamangalam Division): Located in the Sathyamangalam Division, connecting the Moyar valley to Guttiyalattur RF, this corridor is extensively used by elephants during the dry season. The habitat is highly degraded due to fuelwood collection, cattle grazing, NTFP collection, human habitations and agricultural lands which border the corridor (Sivaganesan and Sukumar 2000).

Bekkatur - Arabikere corridor (Karnataka; Chamrajnagar and Kollegal Divisions): This corridor located in the Chamrajnagar Division, connects the habitats of Chamrajnagar and Kollegal Divisions. The elephant range to the east of the Biligirirangan Hills has been divided by a long strip of cultivation, extending from the town of Kollegal, south to the Tibetan settlement at Byloor, a distance of 50km, with the Doddasampige RF (in the BRT Sanctuary) being nearly cut off from the Ramapuram Range in Kollegal Division. Only a narrow one kilomete corridor now exists between the villages of Bekkatur and Arabikere along the Kollegal-Satyamangalam highway. Strict protection of this corridor is essential.

Chattiramdoddi-Hunsanhalli corridor (Bangalore Division, Karnataka; Hosur Division, Tamilnadu): The Bannerghatta National Park, parts of Bangalore Division in the Kanakapura Range and the northern part of Hosur Division (Thalli RF) are at present practically cut off from the Cauvery Sanctuary and southern part of Hosur Division through intrusion of cultivation between Chattiramdoddi and Hunsanhalli Villages. Elephants move through cultivated fields and small patches of jungle between these two regions. If the northern portion comprising Bannerghatta National Park and adjacent ranges has to maintain its viability as elephant habitat, it is essential to maintain a forested corridor in this region. Some acquisition of land may be needed to establish this corridor. A proper survey to explore the feasibility of this corridor is needed.

Periya corridor (Kerala; Wynad North Division): In the Wynad North Division, a narrow corridor connects the Kottiyur RF with the Kannoth RF within the Periya Range. This corridor cuts the Mananthavadi-Tellicherry road (north) and is essentially a strip of jungle less than 100m wide. The corridor has semi-evergreen vegetation and is not under great pressure. The terrain in other areas where the forest reaches both sides of the road precludes crossing.

Pakranthalam corridor (Kerala; Wayanad North Division): This is another narrow corridor located in Wyanad North Division, connecting the northern and southern portions of the Periya RF along the Mananthavadi-Kuttayadi-Tellicherry Road (south) at Pakranthalam. Highly degraded scrub-jungle characterize this corridor, which is once again situated on a steep Ghat road. The lower reaches of this corridor actually pass through fallow estate land.

Sampaje corridor (Karnataka; Madikeri Division): The range of the elephant population in the Brahmagiris extends further north to the Pushpagiris and beyond. The exact distribution and habitat connections have to be determined through surveys. There are several places where habitat contiguity has been or could be broken. One of these is along the Madikeri-Mangalore Highway. This highway through the Ghats has steep sides for a major part and is flanked by coffee, cardamom, coconut and arecanut plantations. Only a three kilometre stretch between the Glencoorg Estate and the Sampaje Range Office is used for crossing by elephants. The elephants actually move through the Glencoorg Estate to reach the road. A proper survey and protection of this corridor is essential to maintain north-south movement along the Western Ghats.

Nanjarayapatna corridor (Karnataka; Madikeri Division): The Cauvery River defines the western edge of Dubare RF (45km^2) and separates it from Anekad RF (30km^2) situated about 0.5-3.5km further west. The area between the river and Anekad RF is completely cultivated with paddy, coffee, coconut and other crops, restricting free movement of elephants between the two forests. There is no contiguity between the forests at any point. However, Dubare and Anekad adjoin other forests to their south and north respectively. Movement of elephants between the two forest patches is widespread and regular, increasing in frequency during the paddy growing season. Almost all the crossing occurs after dark as the region is well populated by humans.

Pallivayal-Tattur corridor: (Kerala; Wynad Sanctuary): This corridor connects Kuppadi RF with Kurichiat RF of the Kurichiat Range of Wynad Sanctuary. It is two kilometres wide, with plantation (mainly pepper and banana) along the edge. Most of these plantations are

protected from elephants using electric fences. There is a proposal to construct a road through this crucial corridor, which runs from Sultan's Battery to Pallivayal. Once this road comes into use, the connection between Kuppadi and Kurichiat would be lost.

Control of poaching

Given the large elephant population in this range, it would always be an attractive target for ivory poachers. In the past, poaching was widespread throughout this range. In recent years, however, poachers have been operating mainly in the high density areas of Nagarhole, Bandipur, Wynad, Mudumalai, Nilgiri North and Satyamangalam. Inter-state coordination for patrolling the border areas and intelligence gathering and exchange has to be strengthened. In these Divisions, in remote and sensitive areas, permanent or temporary (depending on the situation) and patrolling camps with wireless communication systems should be established to make species and forest protection more effective.

Minimizing elephant-human conflict

High priority has to be given to controlling crop depredation and manslaughter by elephants. Elephant-proof trenches have been dug along the periphery of Nagarahole NP. There are, however, a large number of gaps at places where streams and gullies emerge. Some of these are being plugged with solid walls which are very expensive. Alternative designs, including use of discarded steel railway lines (rolling stock), may be tried here and at other places on an experimental basis. Electric fencing has been used quite successfully around settlements in the Wyanad Sanctuary and this has to be strengthened here and in other areas.

In addition to measures such as elephant-proof barriers, *ex-gratia* payments, crop insurance, relocation of settlements, etc. there is also a need for population management in Madikeri Division and other places where forests are highly fragmented and conflict is severe. Some capturing of elephants which have been identified as a threat to human life and notorious crop raiders may have to be undertaken in such areas. This should be preceded by a population survey to quantify population structure, sex ratio, population size, etc. in order to ensure that capture does not disrupt the normal demographic processes. Translocation of some elephants into small, fragmented forests may also be tried out in conjunction with barriers to prevent them from going back to their original home. Systematic monitoring of crop-raiding intensities is however never done to determine the efficacy of different methods used. However, any method of preventing elephant visitations to human habitation requires more experimentation and the results should be monitored more scientifically.

Relocation of human settlements

It is important to begin the process of habitat consolidation in this range through gradual relocation of some settlements from highly fragmented areas which adjoin contiguous forested tracts. Apart from relocation of settlements from the corridors mentioned above, the settlements in the western portion of Wynad Sanctuary and Mudumalai Sanctuary should be given priority.

The Wynad Sanctuary is a critical area for conservation of the Asian elephant. It forms a refugium for wildlife from the adjacent sanctuaries during the dry period from January to June. Extensive fires in the adjacent sanctuaries further complement the need for migration to the Nulpuzha in the Wynad Sanctuary. The human settlements are scattered within the sanctuary. To provide a contiguous forest, some settlements should be relocated or moved to a single location.

(e) Nilambur-Silent Valley-Coimbatire (Elephant Range No. 8)

With an estimated minimum of a few hundred elephants (Table 2), the elephant population in this range is certainly viable in the short term from the standpoint of demography and genetics. The herds comprising the population are, however relatively dispersed due to the considerable degree of habitat fragmentation. If action is not taken to prevent further fragmentation, this relatively low density elephant population is in danger of splitting into several, completely isolated populations. The only large contiguous tract within this range is the New Amarambalam - Silent Valley RFs along with a small part of Attapadi RF. Protection of corridors and habitat consolidation should thus be a high priority in this range. Existing links with Elephant Range No. 7 should also be maintained and strengthened where possible.

Geography of the elephant range

The geography of the range is influenced by the Nilgiri Mountains. From the Nilambur Plains at 100 m a.s.l., the elephant range rises steeply to Kollari Betta situated at 2,594 m a.s.l. Most of the range therefore, consists of steep hills, cliffs and valleys, with very little flat land. Separated from the Nilgiris, and situated in the north of the range is another knot of mountains comprising the Nilambur and Manjeri Kovilagams. The terrain within this range extends in a south-eastern direction encompassing the western (New Amarambalam RF), south-western (Silent Valley RF) and southern (Attapadi RF) escarpments of the Nilgiris. To the south of the Nilgiris, the Attapadi valley separates the former from the Palghat Hills which extend to the Palghat Gap.

Given the great variation in elevation, rainfall too varies across the entire range. In the northern portion of the range comprising the Nilambur North and South Divisions, in the Kovilagams, Silent Valley and the New Amarambalam RF, the rainfall varies between 2,000–5,000mm. Moving eastward along the Attapadi Valley towards Agali, the rainfall steadily decreases and reaches a low of 900mm. In the Coimbatore Division the average

rainfall varies from 750mm in the plains and along the foothills to about 2,000mm on the hills.

The major rivers in the range are the Chaliyar flowing south-west and draining the Nilambur and Manjeri Kovilagams, the Karimpuzha flowing west through the New Amarambalam RF, the Kuntipuzha flowing south through the Silent Valley RF and the Bhawani with its source in the Upper Nilgiris and draining eastwards into the Cauvery.

Vegetation types within the range

This elephant range contains a diversity of vegetation types as a consequence of its varying climatic and geographical regimes. The vegetation types and the areas where they are found are given below.

Wet evergreen forest:

This vegetation type occurs in the high rainfall areas along the western slopes of the Nilgiris in the New Amarambalam RF (Nilambur South Division) and the Silent Valley National Park. Parts of the Silent Valley National Park were once thought to have had the best examples of this vegetation type, but have been highly disturbed due to excessive conversion to plantations. This vegetation type is also found in the Attapadi RF Block 6 and to a lesser extent in Blocks 1-5 (Mannarghat Division). Patches of forest still exist in the northern parts of the Nilambur Kovilagam (Nilambur North Division) and along the Nilambur-Gudalur road in the north-east of the Nilambur North Division. Small forest patches occur on the upper slopes of the Boolavampatti RF in the Coimbatore Division.

Semi-evergreen forest:

This type is found in portions of the Nilambur Kovilagam, along the Karimpuzha River in the New Amarambalam RF and in the Attapadi RF Block 1. Transitional stages are found along the Bhawani River in the eastern forests of the Attapadi RF. It is also found at elevations of 1,200m a.s.l. on the Nilgiri slopes of the Coimbatore Division and at 1,500m a.s.l. in the Boolavampatti.

RF.Moist deciduous forest:

This type is found in many areas within the Nilambur Kovilagam. Most of the plains of the Nilambur South Division, west of the New Amarambalam RF, contain this forest type. This vegetation is also found along the Bhawani River in the Attapadi Valley and in the Walayar RF in the south-east tip of the Mannarghat Division.

Dry deciduous forests:

In all the divisions, this vegetation type is primarily represented in dry teak plantations found at foothills.The drier eastern portions of the Attapadi Valley and the Walayar RF at the south-western tip of the Mannarghat Division have some examples of this vegetation. Eastwards into the Coimbatore Division, along the lower slopes of the Nilgiris, this is the dominant vegetation type. It is also found in the Boolavampatti RF within the valleys.

Shola forest and grasslands:

This is found in the upper reaches of the Nilgiris, from 1,250-2,000m a.s.l. above the New Amarambalam RF and the Silent Valley National Park where the average rainfall is above 2,500mm. It also occurs in the upper reaches of the Attapadi RF. The best tract of this vegetation type is found in the Mukurthi National Park and portions of the Nilgiri South Division.

Dry thorn and scrub forest:

This type is found up to an elevation of 1,000m a.s.l. along the slopes of the Nilgiris. It also occurs in the Anaikatti areas and in the eastern reaches of the Boolavampatti RF in the Coimbatore Division.

Status, density and distribution of elephants

The elephant density and population sizes for divisions in the range are given in Table 2. The density estimates are based on the dung count method used by the Kerala Forest Research Institute for Kerala and forest department censuses using direct counts in Tamil Nadu.

The population within the range could be considered distributed in three distinct areas. The first area comprises the Nilambur and Manjeri Kovilagams situated within the Nilambur North Division. The second major distribution occurs in the New Amarambalam RF in the Nilambur South Division, the Silent Valley National Park and the Attapadi RF Blocks 1-5 in the Mannarghat Division. Migratory paths also lead from here to the Mukurthi National Park and the Nilgiri South Division. A small number of elephants regularly migrate up the steep slopes to the Nilgiri Plateau. The third distribution occurs to the south of Attapadi, in the Siruvani Hills, comprising the Coimbatore Division in Tamilnadu and Attapadi RF Block 6 in the Mannarghat Division of Kerala. Contiguity does exist between the three areas, through narrow corridors.

Corridors

Kallar corridor (Tamil Nadu; Coimbatore Division): The Kallar corridor is a narrow strip starting at Gandhapallayam (near the Jackkanare Mountains) and bisects the Mettupalayam-Kotagiri highway. This corridor is constricted between the steep escarpment of Nilgiri Mountains and the agricultural lands at the base of these mountains. The habitat here is contiguous to the Pillur RF and Attapadi Valley (Kerala State). The corridor is narrow with the steep terrain of the Nilgiris eastern slopes on the east and an expansion of the cultivation on the west. The approximate length of the corridor is seven kilometres and the average width ranges

from 0.5-3km. The link between the Sathyamangalam and Coimbatore Divisions is maintained through this corridor. Movement of elephants from Nilgiri North Division to Coimbatore and Mannarghat Divisions is also reported through this corridor.

The Anaikatti corridor (Tamil Nadu; Coimbatore Division): Elephants along the slopes of the Nilgiris occasionally move south into the Boolavampatti RF in the Coimbatore Division and from there further west into the Attapadi RF Block 6. This corridor situated along the Anaikatti-Coimbatore Road is only five kilometres wide and consists of dry thorn forests. It is an extremely critical corridor as its loss would isolate elephants within the Boolavampatti RF and the Attapadi RF Block 6 from the rest of the range. Cattle grazing and fuel extraction are serious threats to the vegetation of this corridor.

The Vazhikadavu corridor (Kerala; Nilambur North Division): Current status of the movement of elephants through this corridor is unknown. The corridor is situated on the Gudalur-Nilambur Ghat road. A stretch of forest exists on both sides of the road. However, the slopes are too steep for easy crossing. Most of the crossing is supposed to occur about five kilometres ahead of the village of Vazhikadavu which is on fairly level ground. A major tract of this forest has been converted to areca-nut, coconut and banana plantations. This corridor effectively connects habitats within the Nilambur and Manjeri Kovilagams with those in New Amarambalam RF in Nilambur North Division.

The Mannarghat–Mukali road corridor (Kerala; Mannarghat Division): The road between Mannarghat and Mukali has a strip of forest which is approximately four kilometres long. In the lower reaches the vegetation comprises dry thorn forest but gets increasingly wetter, attaining a mixture of moist-deciduous and semi-evergreen, on reaching higher elevations. Elephants seem to use this corridor quite regularly to move between the eastern and western portions of the division. However, the significance of this corridor in maintaining genetic contiguity across the population in this range is largely unknown.

Conservation problems within the range

The Tamil Nadu Electricity Board (TNEB) has occupied a large area of RF in the Nilgiri South Division and the Mukurthi National Park regions, in connection with the execution of various hydroelectric projects. These projects have fragmented the forest and caused much disturbance. There are many wood based industries located here and their demands are met by Nilgiri South Division. Most of the areas in this division fall under tea and potato cultivation. Conversion of grassland into varying types of plantations in the Mukurthi National Park and Nilgiri South Division, in the past, has made the quality of the habitat unsuitable for elephants.

The Nilambur and Manjeri Kovilagams, within the Nilambur North Division, once excellent elephant habitat and containing patches of excellent wet evergreen and semi-evergreen forests, have suffered from the lack of effective surveillance. Considerable fragmentation has already occurred due to the establishment of plantation estates such as those of the Gwalior Rayon Corporation and a number of other cardamom, coffee and rubber estates. Recent encroachments have fragmented the available habitats. The actual area under estates and encroachments is still unknown.

The Attapadi RF is a striking example of how human encroachment can transform pristine wet evergreen forests to near desert in a strikingly short time. The road from Mukali to Anaikatti in Tamil Nadu (via Agali), along the Attapadi Valley and parallel to the Bhawani River, has dense settlements which have completely curtailed elephant movement between the two portions of the Attapadi RF. It is only in the western and southern portions of the RF some forest remains. Compensation claims for crop-damage by elephants is minimal, though there is some conflict in the Agali area.

Repeated fire and human encroachment, on the western and southern peripheries of the Silent Valley National Park, seem to be major problems. Even though these convert natural vegetation to grasslands, which may actually be preferred by elephants, their negative impact on the biodiversity of the area is to be seriously considered. A notable feature of the elephants in the park is that they virtually never raid crops even though they have ample opportunity to do so in the periphery. This may be due to the abundance of grasses and reeds the park has to offer.

The dry thorn and deciduous forests of the Coimbatore Division have been degraded in the past due to fire, cattle grazing and fuel extraction. Being relatively arid compared to the rest of the range, agriculture is of the subsistence variety putting a great deal of stress on the forest.

Recommended actions

Protection of corridors

1. The Kallar corridor has to be preserved as it connects the elephant populations of Elephant Ranges 7 and 8. The activity of the residential school and other developmental activities within the corridor area should be monitored.

2. Increased protection of Vazhikadavu corridor, in the forests around Vazhikadavu, through legislation would prevent further encroachment into this narrow corridor. This would also maintain valuable evergreen tracts.

3. Increased protection of the Anaikatti corridor through legislation and surveillance is necessary. Elephants regularly use the fields that lie between Anaikatti and the start of the corridor. Farmers have complained of great

economic losses through crop-raiding by elephants and may be easily convinced to sell their lands. This would effectively increase the width of the corridor by three kilometres bringing it to a total of eight kilometres.

Relocation of settlements or acquisition of land

The proposal made by the Kerala Forest Department to acquire 120ha of the Mandanmutti Estate bordering the Silent Valley National Park should be given serious consideration. Most of the forests around the National Park are in private hands, blocking the movement of elephants from the park into habitats within the Attapadi RF. Acquisition of this tract of land will facilitate this movement.

Illegal encroachment into the Attapadi RF and Nilambur FDs should be immediately stopped as a priority. Demarcation of boundaries by the construction of cairns to protect RF and boundaries is essential.

The evergreen forests of Silent Valley NP are being degraded, often into grasslands, because of high incidence of fire. Protection against fire and promoting natural regeneration and forest succession should be taken up through a scientifically designed programme. To protect the buffer land, a proposal exists to include another 200km^2 from the Attapadi RF in the park. This would not only increase the available protected elephant habitat but would also preserve the rich, though highly threatened forest type.

The proposal to bring some of the area of Nilgiri South Division under the Mukurthi National Park has to be given priority.

(f) Anamalai-Parambikulam (Elephant Range No. 9)

This range extends over a relatively large area and has a sizeable population of elephants. The elephant population seems demographically and genetically viable from a long term perspective, although this has to be verified from field data. The habitat is, however, under threat of multiple fragmentation due to a variety of causes — numerous hydro-electric projects (dams, canals, penstock pipes and a power house), tea estates and cultivation and development along major roads. This population is completely cut off from the one further south in Range No. 10. Management priorities would include the maintenance of corridors, habitat restoration, control of ivory poaching and minimizing elephant-human conflict.

Geography of the range

This range is situated south of the Palghat Gap, in the states of Kerala and Tamilnadu. Topographically, the range comprises portions of three major hill ranges of the Western Ghats. The central range comprises the Anamalai Hills (*anai* = elephant), rising from the Palghat Gap to a peak of 2,690m a.s.l. at Anaimudi (the highest peak in southern India), while to the west the Nelliampathis extend as a spur into the Malabar Plains, and to the east, the Palani Hills descend to the Coimbatore Plains. The rainfall varies between 900mm on the eastern side, within the Chinnar Wildlife Sanctuary to 5,000mm on the western side. The range has several perennial and semi-perennial river systems and man-made reservoirs. Notable among them are, the Periyar River forming the southern boundary of the range, the Chalakudy river north of the Periyar, the Kallar River, the Pambar River, Kudaraiyar River within the Chinnar Wildlife Sanctuary and Porandalar River, forming the approximate eastern boundary of the range. The important reservoirs in this range are Parambikulam and Thunakadavu, in the Parambikulam Sanctuary, Sholiyar in the Vazhachal Division, Aliyar, Amaravathi, Thirumurthy in the Indira Gandhi Sanctuary and Mattupatti and Anairangal Reservoirs in the Munnar Division.

Vegetation types The complex topography and rainfall gradient contribute to a striking diversity in vegetation. The forest types in this range include:

Wet evergreen forest

Fairly intact patches of wet evergreen forests exist in the western or windward side of the Western Ghats, especially in areas where the precipitation exceeds 2,500mm. Vazhachal Division, Parambikulam Sanctuary and Nemmara Divisions probably contain the most intact of these patches.

Semi-evergreen forest

This vegetation type is found where some degradation of wet evergreen forests occur. It also occurs in portions of Malayattur Division, Vazhachal Division, Nemmara Division and Parambikulam Sanctuary.

Moist deciduous forest

Areas within the Chalakudy Division were once covered with wet evergreen and semi-evergreen forests. As a result of human induced deterioration of these forests most of this forest type has been converted to moist deciduous type. Some parts of the Nemmara Division, Indira Gandhi Sanctuary and high altitude areas of Theni Division display this vegetation type.

Dry deciduous forest

The drier eastern reaches of the Indira Gandhi Sanctuary and the Theni Division are largely covered with this vegetation type.

Teak and other plantation species

A large percentage of natural vegetation in all divisions especially in the Indira Gandhi Sanctuary and the Parambikulam Sanctuary have been converted to extensive teak plantations. Kodaikanal Division has

an extensive area under eucalyptus, wattle and pine plantations.

Moist bamboo brakes

These brakes along with patches of cane, are found in all divisions on the windward side of the Western Ghats.

Shola forest and grasslands

The Eravikulam National Park, situated north of the Munnar Division has some excellent examples of this vegetation type. It is also found at high elevations in the Indira Gandhi and Parambikulam Sanctuaries and the Kodaikanal Division.

In some of the divisions, this natural vegetation has disappeared because of extensive tea cultivation. Between these vast commercial tea estates, patches of shola-grassland type of forest can be observed. In some reserves the natural vegetation has now been converted to extensive teak, wattle, bluegum, and pine plantations.

Status, density and distribution of elephants

Population estimates for the range vary from a minimum of about 1,600 to a maximum of 3,475 elephants (Table 11.3). Population estimates are based on direct count censuses by the forest department of Tamil Nadu and the indirect dung count made by KFRI (Anon 1993).

The figures in itlics are the results of the 2002 South India synchronised elephant census.

There are considerable differences in elephant distribution and densities across this range. A relatively high density (>1 elephant/sq.km) of elephants occurs in parts of Parambikulam, Indira Gandhi Sanctuary and possibly Vazhachal, while medium(0.2 to 1.0 per sq.km) to low <0.2 per sq.km) densities are seen in most other divisions. The populations are basically divided between the western and eastern portions ofthe range, with severaal other small populations or herds being practically isolated, especially in Kodaikanal and Theni Divisions. The former herds are believed to be moving in from Munnar Division while those in Theni Division are confined to a narrow strip of jungle along the eastern slopes of the hills overlooking the Cumbum Valley.

Conservation problems within the range

Threat of habitat fragmentation

Even though there is relatively large habitat area available for this population, the numerous hydroelectric projects, combined with large-scale plantations of tea and cardamom, roads and towns, have fractured the habitat considerably. The elephant population in the range is thus, partially isolated, probably as several sub-populations.

(a) Hydro-electric and irrigation projects: A series of dams, canals, penstock pipes and power stations in recent decades within the range have disrupted the traditional movement of elephants, and in some cases have directly led to their deaths. The reservoirs within the elephant habitat include the Peechi, Poringalkuttu, Sholayar, Parambikulam, Thunakadavu, Peruvaripallam, Aliyar and Amaravathi. The Parambikulam-Aliyar Project has been the main deterrent. Obstacles to elephant movement occur at many places. Penstock pipes along steep slopes from the Sholayar reservoir to a power house completely obstruct elephant movement. The canal leading from the Thunakadavu Reservoir to the Sirkarapathy Power Station is open along four stretches. Elephants and other animals have been washed away by the swift current and sometimes drowned. The last stretch of the penstock canal, down the hill slopes, cannot be traversed by elephants.

(b) Tea and cardamom estates: The central portion of the range (primarily the Valparai and Munnar areas) has been taken up by a number of tea, coffee and cardamom estates. More than 20,000ha is under these plantations. Only in a few places are narrow paths available for elephants to move in an east-west direction. To the south of the range, the extensive cardamom and other plantations in the Devikulam-Periyar Region have completely eliminated the elephant, thus isolating the population of the Anamalais with that of Periyar.

(c) Other cultivations and settlements: There has been an increase in the number and size of settlements on the road, running from Chalakudy to Adirapally Falls 30km away. These settlements have virtually stopped elephants from moving between the northern and southern portions of the division.

Threat of isolated elephant herds

There are several parts in this range where the constriction of habitat has led to virtual isolation of small elephant herds. The viability of these herds and the habitat is in serious doubt. These include the following:

a) Elephants have been visiting the Kodaikanal Region in Palani Hills in recent years. This area mostly contains monoculture plantations of pine and wattle, and small patches of shola forest and grasslands. The narrow belt through which the elephants move on the eastern fringe of the range does not have any long-term prospects of sheltering elephants.

b) In the Theni Division, in the area adjoining Kottamalai (which is the southern limit for elephant movement in the range), the distribution is confined to a very narrow belt of forest along the steep eastern slopes which is also degraded by dense human settlements and cultivation on both flanks. Suranganar Reserve Forest located in the Gudalur

Range in Theni Division, forms the eastern slopes of the Western Ghats along the border of Kerala State. The records reveal that, starting from the foothills of Suranganar RF as well as along the border, there had been planned encroachment both by the people of Gudalur and adjacent Kerala with encroachment slowly increasing during 1985 and 1989. The total area under encroachment in 1976 was reported to be 650ha. in the linear stretches along the border. Due to this encroachment, the entire habitat in the northern portion of the division is confined to a narrow belt of forest on the hill slopes and the elephant movement has stopped in the Kottamalai area itself. The western side of this narrow belt is connected to the Devikulam Range of the Munnar Division, which has extensive plantations of cardamom and tea.

c) Elephants which visit Mathikettan shola forests from the Munnar Division are also trapped between the Bodinayakkanur and Kottamalai areas. This is due to private establishments on the northern side of Mathikettan, as well as degraded forests and human settlements on the southern side (areas of Chinnamanur Forest beat in Gudalur Range).

Habitat degradation

In Malayattur Division, large tracts of forests seem to have been cleared for the illegal cultivation of ganja (*Cannabis indica*). The dimensions of this problem is unclear because of inadequate surveillance.
Extensive transformation of natural vegetation to softwood plantations (chiefly eucalyptus) on the southern banks of the Chalakudy River has destroyed what was once good elephant habitat. At least two time-share resorts have been established on the banks of the river. This may cause an increase in the vehicular traffic, which is already high, as the Adirapalli Waterfalls forms a major tourist attraction. Large tracts of land, cleared in the past, currently with good grass growth, have been earmarked for the establishment of soft-wood plantations.

Large areas of forest in Parambikulam and Indira Gandhi Sanctuaries have been converted to teak plantations. These are often infested with weeds such as *Lantana* and *Eupatorium*. In Vazhachal and Pooyamkutty, there is large-scale extraction of reeds.

Poaching for Ivory

The extent of poaching for ivory is not clear in the range. The limited surveys by KFRI (Easa 2001) reveal an overall male to female ratio of 1:9, which indicates that adult sex ratios may be even more unequal. Ivory poaching thus seems to be a serious problem in the range.

Human-elephant conflict

Conflict is largely confined to the central portion of the range, around the Valparai area, where elephants regularly move across tea plantations. Cases of manslaughter are known every year. Crop depredation in other parts of the range is marginal.

Recommended actions

Preservation of elephant corridors
There are three corridors within this range used by elephants to move between the western and eastern parts, all of which are located in the Indira Gandhi Sanctuary in Tamilnadu. However, the usage pattern of elephants is not well known.

Attakati-Upper Aliyar corridor: This is located in the western part of the Indira Gandhi WLS. Using this corridor along the steep hill slopes, elephants move between Attakati and Kadamparai. This corridor is well used and has undisturbed forest cover. However, constant vehicular movement on the Valparai-Pollachi Road hinder movement.

Ayerpadi-Waterfalls Estate Corridor: This is the second corridor along the Pollachi-alparai Road, located between Ayerpadi and Waterfalls Estates within the Anamalais. There is a very narrow stretch of forest available in this gap. Elephants are reported to cross here during the dry season.

Siluvaimedu-Kadamparai Corridor: This corridor has very steep slopes and a narrow patch of forest between Siluvaimedu and Kadamparai estates. There is very little information on the usage of this corridor.
In addition, the elephants often move through tea plantations as well. The Madupatty Tea Division of the Tata Tea Company is one such example. There is a need for proper survey and documentation of such corridors through the estates.

There is also a need for the survey of elephant movement along the road from Chalakudy to Sholayar. The numerous settlements and cultivation along the road have disrupted elephant movement and existing crossing points have to be identified, protected and strengthened.

Translocation of settlements

People in the Churulipatti enclosure (32ha) of Chinnar Wildlife Sanctuary (Kerala) have expressed a willingness to be relocated outside the reserve. This would establish a contiguous stretch of forest along the border with the Indira Gandhi Sanctuary in Tamilnadu.

Habitat restoration

In areas such as Vazhachal and Chalakudy Divisions the habitat has to be improved for elephants through phasing out of softwood plantations and promoting natural regeneration.

The encroachment, starting from the foothills of Suranganar RF in Theni Division and along the State

border, had resulted in denudation of forest and stopped elephant movement to the Periyar Region. In 1976, eviction of encroachments was initiated. However, the encroachers subsequently entered forest areas and re-encroachment has increased. In August 1994, a fresh eviction operation was started and a total of 275ha was reclaimed. If the entire area occupied by encroachers is reclaimed and habitat improvement operations are initiated, the area would provide additional habitat for elephants with the possibility of restoring the contiguity of the Periyar and Anamalai populations.

Creation of Protected Areas

The status of the Vazhachal Division needs to be upgraded to that of a Wildlife Sanctuary given its excellent diversity of vegetation, high elephant density and abundance of forage species. This may also lead to a better control of extraction of reeds within the Division and possible acquisition of tea estates which have sprung up recently. There is a proposal to declare Kodaikanal Division as a Sanctuary. If that happens, the Sanctuary would promote free movement of elephants and other mammals within the division and from adjoining divisions.

Control of poaching

In most of the divisions within this range, increased surveillance of the interior reaches and interstate coordination in controlling poaching is essential. Communication may be improved by the use of modern high-range wireless systems. The areas currently under *ganja* cultivation need to be mapped and an assessment as to whether they pose an impediment to movement of elephants across the divisions should be made.

(g) Periyar-Srivilliputhur (Elephant Range 10)

This range probably represents the most compact block of elephant habitat in the south, with least fragmentation. Although it harbours a relatively large population of more than 1,500 elephants, the long-term genetic and demographic viability is compromised because of a very distorted adult male to female sex-ratio and age structure. High priority must, therefore, be accorded to the protection from further poaching of male elephants, and to the examination of the demographic and genetic viability of the population. Habitat links with the smaller population further south in the Agasthyamalai-Mahendragiri range (comprising Kalakkad-Mundanthurai and Neyyar Protected Areas) has to be studied and consolidated.

Geography of the range

The range is located in the states of Tamil Nadu and Kerala and covers an area of over 3,300km^2. It lies between 9°-9°45'N and 76°45'-77°45'E with an altitudinal variation from near sea level to 2,000m. The range geographically comprises the southern part of the Periyar Plateau and its eastern spur, the Varshunad Hills. From the west, the Periyar Plateau rises relatively gradually through a series of hills to its highest point (1,830m), while on the east it falls steeply to the Madurai Plains. South of Periyar the Achenkovil valley lies on either side of the Achenkovil River, bounded by high rugged and undulating hills on all the sides, giving the appearance of an oval basin in the hills.

Mean annual rainfall is about 2,000mm in the western part, and lower in the eastern rain shadow. The area is drained by the Periyar River which has been harnessed for irrigation and hydroelectric power by a dam, whose reservoir is the central feature of the Periyar Project Tiger Reserve (PTR). The Vaigai River, draining east flows through the Cumbum Valley bordered by the Varushanad Hills to the southeast. Achenkovil, Pambiyar, Chittar and Kallar are other important rivers which flow in the FDs south of the Periyar Reserve. These divisions have the Kakki and Pamba Reservoirs.

As in other parts of the Western Ghats, there is a strong west to east gradient in rainfall. Tropical wet evergreen and semi-evergreen forests are seen over much of the range including Periyar PTR, Achenkovil, Konni, Ranni and Punalur Divisions, and the ridge of Srivilliputhur Division. Moist deciduous forest and grasslands predominate in the part of the Periyar PTR around the reservoir and portions of Srivilliputhur Division. Theni Division has mixed deciduous on the Varshunad Hills, and dry thorn forest along the foothills. There are also extensive plantations of *Eucalyptus* and to a lesser extent teak in parts of the range.

Status, density and distribution of elephants

There is a distinct difference in elephant density between the Periyar PTR and other divisions of the range. Periyar PTR has a density of 1.1-1.5 elephants/km^2, with a higher concentration around the reservoir and lower abundance away from it. Other divisions in the range have by contrast a low density of between 0.1-0.3 elephant/km^2. The population estimates are summarized in Table 11.4. In total, a minimum of about 1,500 elephants and an upper limit of 1,900 elephants may be taken for this range.

In 1993, the Kerala Forest Research Institute made estimates of elephant density using the indirect method of dung density (Anon 1993) for all the divisions within Kerala. We also have a density estimate for Periyar PTR from the dung count method carried out by Indian Institute of Science in 1994 (Ramakrishnan *et al.* 1998). Outside Periyar PTR, there is need for refining the population estimates through more intensive work.

Conservation problems within the range

Human-elephant conflict

Relatively, there is not much depredation of crops or manslaughter by elephants in this range. Kallar and

Pellavakkalmedu within the Srivilliputur Sanctuary have irrigation dams which promote cultivation at the foothills. Elephants visit these crop lands during the rainy season, resulting in some conflict.

Anthropogenic pressures on habitat

Cattle grazing occurs in the Kotamalai Region and foothills of Srivilliputhur. Illegal cultivation of *ganja* occurs in the interior forests of Srivilliputhur, Theni, Periyar and other Divisions. The *ganja* cultivators cause considerable disturbance to the forests. For the ganja cultivation, prime reed areas, highly favoured as food by elephants, are selected and the area is cleared for the cultivation. There is also illegal exploitation of forest products such as bark of cinnamon (*Cinnamomum zeylanicum*), reeds, etc. within the range.

Sabarimalai Temple, located in the south-western part of Periyar PTR's buffer zone, is an important Hindu pilgrimage site and receives millions of visitors annually, the main season being November to January. The area around Sabarimalai is severely degraded and wild animals move away during the peak tourist season. There are demands for expansion of the Sabarimalai Township to accommodate the increasing rush of pilgrims. During Sabarimala season, millions of people use the roads in Ranni, Konni, Punalur and Achenkovil Divisions for three months and it becomes difficult for the elephants to cross the road, thus affecting their movement. Widening of the road from Ranni-Pamba, with steep slopes on one side and cutting on to the other, has impeded the elephants from crossing the road. During the same season several thousand pilgrims visit the Achenkovil Temple located inside the Division. Forest fires associated with anthropogenic pressures have degraded evergreen forests in many areas.

The ruins of another ancient temple are found at Mangaladevi, 14km to the north-east of Thekkady and bordering Tamil Nadu. Access to Mangaladevi is restricted and requires special permission. However, there is a proposal to construct a road from the Tamil Nadu side, which may cause severe disturbance and damage to the habitat.

In Konni Division the total area under plantations extends up to 8,300ha, the largest in the State for a single Division. A large portion of the deciduous forest has been converted into plantation. In Punalur Division, most of the forest land is cleared for oil palm cultivation and for raising plantations for wood-based industries. Ranni Division was a major supplier of sleepers for the Southern Railways. The Achenkovil Division was earlier under the Kallar Valley Teak Plantation Division and suffered heavily due to uncontrolled extraction. The timber extraction started in the 1960s and continued until the 1980s. Reed extraction and extraction of other forest products for basket and newsprint activities are a major source of disturbance. The habitat is degraded due to fire, extraction of natural resources, weeds and dependence of the people on the forest.

Michaenia weed infestation is another major problem in these divisions. It has spread over an area of 40km^2 in Goodrikkal Range alone.

In Punalur Division, there were 80 enclosures with marginal encroachment. The absence of permanent demarcation of the forest land has led to large-scale encroachment. In Punalur division 29ha of forest land was leased to a mica mine. Now the area is occupied by people who have raised valuable plantations. There are two estates within Achenkovil Division and the Division has three *pandaras* (tribal colonies) along the road in the encroached forest lands. In Ranni Division, seven settlements exist within the reserve. Crop raiding is reported in Angamali and Goodrikkal. Cattle from Tamil Nadu visit the Pasukadatheri Hillocks adjoining the Tamil Nadu border in Achenkovil.
Inaccessibility of the forests in these forest divisions makes it an ideal ground for illegal activities such as poaching, illicit felling, etc.

Poaching for ivory

Historically, this has been the most serious conservation problem within this reserve. Poaching for ivory in Periyar and adjoining areas has been severe during the 1970s and 1980s, but has declined in recent years due to the reduction in the number of tuskers. However, the past rate of poaching has resulted in a highly skewed sex ratio in elephants. Earlier observations by Chandran (Chandran 1990) and by IISc researchers (Ramakrishnan *et al.* 1998) indicated an adult male to female ratio in excess of 1:100, but a more recent survey by KFRI (Easa 2001) over a wider area than the Periyar Reserve has come up with a less skewed adult sex ratio. However, this study still came up with a sub-adult sex ratio of 1:64 that indicates that adult sex ratios in coming years would continue to be very unequal. Most of the historical poaching in Periyar is believed to have been carried out by gangs coming from the adjoining areas of Tamilnadu (Srivilliputhur). It can thus be expected that ivory poaching has also affected the elephant population in the latter region.

Recommended actions

Population management

In the Periyar Tiger Reserve, the elephant population showed a lower birth rate and a negative population growth rate during the 1990s because of the highly skewed sex ratio. This seems to have changed to a certain extent in recent years with a higher birth rate, possibly through the growth of some sub-adult bulls into the adult age class. The possible management of this population through the translocation of bulls should be examined from demographic and genetic viewpoints.

Control of ivory poaching

Because this range has suffered the most from ivory poaching in the past two decades, it is obvious that

curbing poaching should be the high priority here. Coordination between Kerala and Tamilnadu is essential in addition to strengthening anti-poaching infrastructure, intelligence gathering and enforcement.

Habitat management

Planting fodder plants in extracted areas where weeds are coming up is essential. There exists a proposal to purchase the Achenkovil estate through the Vamanapuram Irrigation Project and Compensatory Afforestation Programme. The proposal should be given priority. Demarcating the forest boundary to prevent further encroachment and habitat improvement programmes through soil conservation measures should also be carried out.

(h) Agasthyamalais

A population of between 100 and 150 elephants is thought to range over the evergreen forests of the Agasthyalamalais, cheifly in the Kalakkad-Mundanthurai Tiger Reserve and the Neyyar Wildlife Sanctuary. A few elephants are also found in the Tirunelveli and Kaniyakumari Forest Divisions. The population size, structure and viability here have to more objectively studied before firm recommendations for conservation can be made.

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