

Survey of Elephants in the Mannar District, Sri Lanka

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Introduction

The Mannar region is bounded by 8° 30' N latitude and 80°30' E longitude (Eriyagama 1961). The Mannar District with a total land area of 1,985 km², extends from the Moderagam aru in the south to beyond Pali aru in the north. It was and still is a part of Vanni (Lewis 1894). The Mannar District is bounded on the west by Indian Ocean, to the north by Kilinochchi District, to the south by Puttalam District, and to the southeast by Anuradhapura District, and to the northeast by Mullaitivu District and to the east by Vavuniya District. The Mannar District consists of the following four Administrative Divisions: (i) Mannar, (ii) Mantai, (iii) Musali and (iv) Nanadan (Fig. 1). Of these four Divisions, Mantai is administered by the Liberation Tigers of Tamil Eelam (LTTE). The human population is estimated at 140,000, distributed in 528 villages. With a population density of 71 people per km², Mannar District is also one of the sparsely populated areas in Sri Lanka.

Historically Mannar District has been the gateway to Sri Lanka. Mannar itself was known in King Solomon's times. The Arab trade between the East and West of India was transacted through the channel in Mannar. Vijaya and his band of followers who constituted the first Sinhalese, are said to have sailed down the west coast of India from Supparaka (north of present day Bombay) and landed in Sri Lanka at Tambapanni, which according

to Dipavamsa (the oldest of the Ceylon chronicles) was 'on the most lovely south bank of the river'. The river in question is the Kadamba nathi (Aruvi aru or Malwattu oya) along which Vijaya and his followers traveled to Upatissagama and finally reached Anuradhapura (Nicholas, 1959).

As Brohier (1960) points out, centuries before Vijaya and his Aryan followers reached Sri Lanka, the coastal region of Mannar was 'a great commercial emporium', which was visited by Phoenicians from the Red Sea. The city of Mantai (or Matottam) on the mainland had an extensive trade link with Rome and Greece in the 2nd century A.D, but the archaeological evidence, according to Weerakkody (2000) goes to show that Mantai served as the regular port for foreign trade and travel from as early as the 5th century B.C to the 12th century A.D. and beyond. Ptolemy's account of Ceylon in the 2nd century A.D. names it as 'Margana'. The main exports from Mantai were the famed pearls, precious stones, cinnamon, spices, shanks and elephants (Nicholas, 1959). Pearl fishery in Sri Lanka was the most ancient industry in the world, carried on for 2,000 to 3,000 years (Vane, 1887). According to Abayakoon (1950), Cleopatra's pearls may have come from Mannar, for the Mannar coast was known in Tamil as Muttukarai (pearl coast) in reference to the rich pearl banks or paars found in the shallow sea from Negombo to Mannar in general, and between Marichchikaddu and Silavaturai in particular. Coins of Claudius and Annus Plocamus were used in the purchase of pearls by Romans (Abayakoon, 1950). Robert Knox, the celebrated English prisoner of the last king of Kandy escaped from captivity and arrived at Arippu on the west coast.

Climate

With more than six arid months, the Mannar District is situated in one of the driest areas in Sri Lanka. During the dry season, which extends from mid-March to mid-October, daytime temperatures of well over 30°C (or 85°F) have been recorded. The hottest month is May, when the southwest monsoon is at its height in the south and central hills. The coldest months are December and January coinciding with the northeast monsoon during which the region receives between 760 and 1000 mm (or

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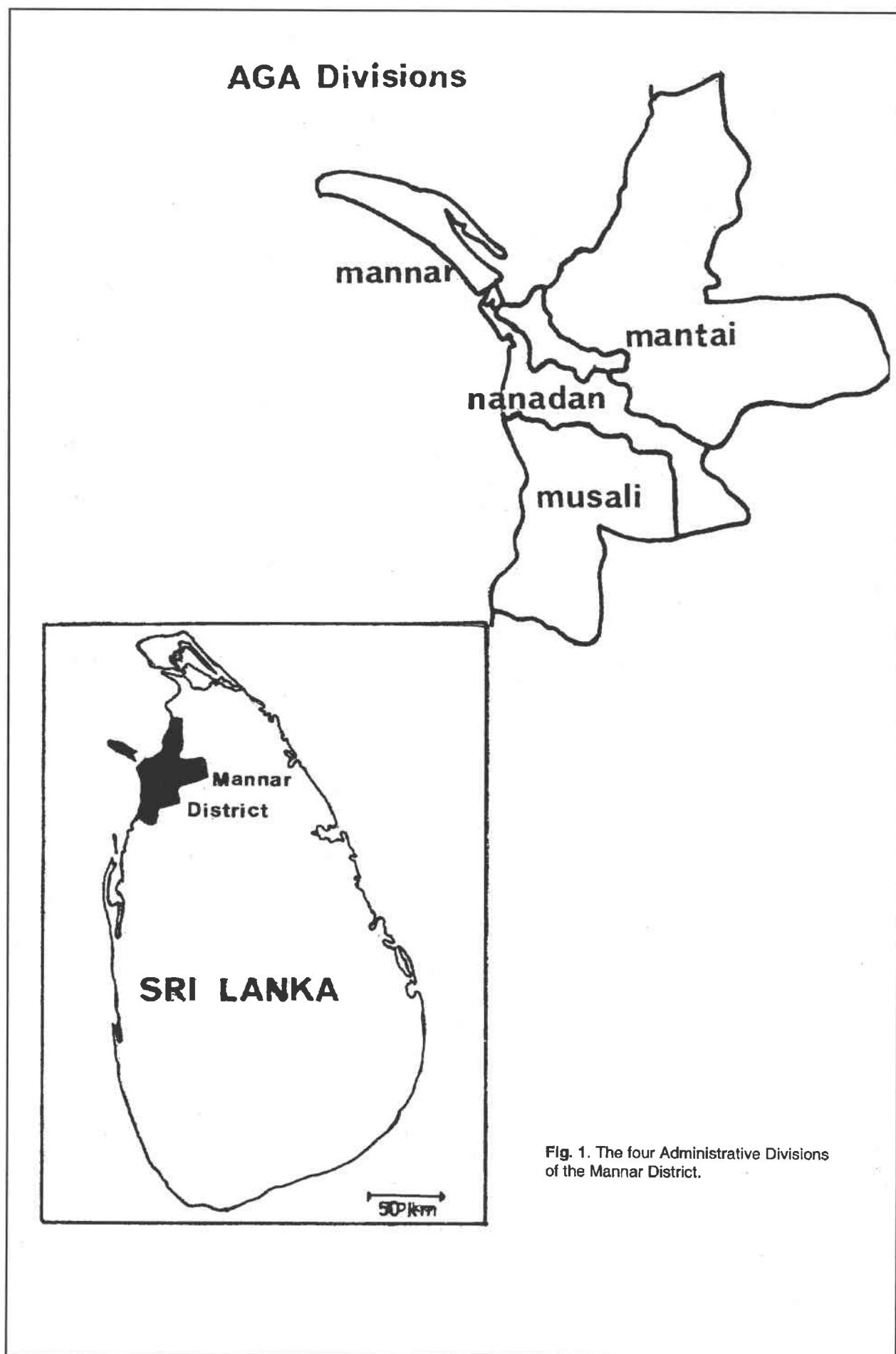


Fig. 1. The four Administrative Divisions of the Mannar District.

30-40 inches) of rain from mid-October to mid-February. The wettest month is November. Erratic showers are not uncommon during the southwest monsoon, but such rainfall has hardly any appreciable effect on the vegetation as the prevalent heat and comparatively lower humidity result in rapid evaporation (Eriyagama 1961).

Physiography

Much of the land area is flat, being less than 3.65m (12ft) altitude above sea level. Along the coast are sand dunes but towards the Giant's Tank, the landscape takes on a gently undulating aspect, which is more pronounced in the northern direction (Eriyagama, 1961). A few rivers drain the area, and they are from south to north, (i) Uppu aru (Modergam aru), (ii) Kal aru (or Cheddikulam aru, a river formed of two streams which rise in the high ground of the southern corner of Kilakkumulai South), (iii) Aruvi aru, (iv) Nay aru, which enters the sea to the south of Vidattativu, (v) Paranki aru, which reaches the sea at Illupaikadavai and (vi) Pali aru, which flows almost due west, forming the northern border of Mannar District and the southern boundary of Tunukkay division (Fig. 2). It falls into the Gulf of Mannar in the extreme north of Mannar District (Lewis, 1895). Except for Moderagam aru and Aruvi aru, all other rivers become bone dry during the peak of the dry season. A channel from Aruvi aru feeds the Giant's Tank – the largest irrigation reservoir in Mannar District, while another goes to feed the Athimurippu tank. Irrigation in Mannar District takes the form of hundreds of man-made reservoirs or tanks scattered all over the country to catch as much water as possible during the short rainy season (Fig. 3). As Lewis (1895) points out, these tanks for the most part form a connected series, one above the other, those lower down receiving the surplus water of the higher tanks. Water from Giant's Tank feeds 160 other lesser tanks before reaching the seas, and only about 4,000 million cubic metres of water finally reach the sea.

Soil

Except for the narrow sandy coastal strip, much of the Mannar District is composed of soils that are grayish-brown sandy clay to sandy clay loams with concretions of carbonates of calcium, sodium, and manganese oxide (Eriyagama, 1961). This fine clay tends to become stony-hard during the drought, making it extremely impervious to water. Given the combination of high impermeability and the high content of sodium, the soils are characterized by a high salt content and high pH (i.e. highly alkaline). Murunkan clay in particular is well known for its excellent qualities to support agriculture. Further inland, soils are reddish-brown in colour. Such soils are well drained and are ideal for agriculture. According to Boake (1888) the subsoil of loam or clay is very fertile, producing most of the timber trees indigenous to the island. Some fields yield 30-fold of paddy and tobacco.

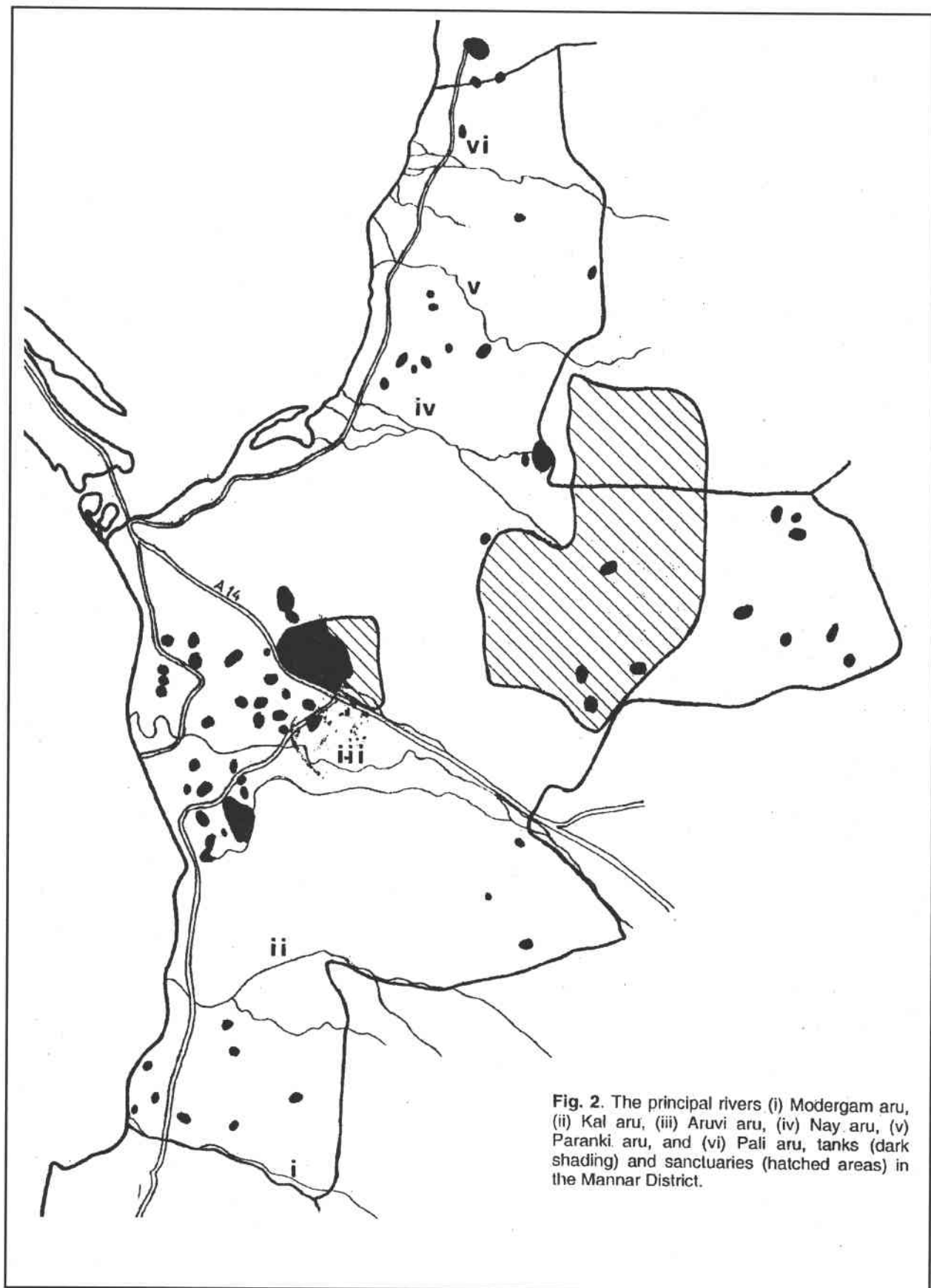
Vegetation

Despite the arid climate and inhospitable landscape, a substantial part of Mannar District is still forested (Fig. 3). The area is rich in biological diversity. Given the arid climate and edaphic conditions, the region has its own peculiar fauna and flora. Along the coastal sand dunes can be seen patches of *Spinifex littoreus* in association with *Ipomoea pescaprae*. Suriya (*Thespesia populnea*) and Malitan (*Salvadora persica*) are two of the commonest trees in the coastal areas of the dry zone. The principal vegetation type is thorn-scrub, which provides some sort of ground cover over much of the region for the soil against excessive loss of water through direct evaporation (Eriyagama, 1961). Many of the plants show marked xerophytic characters such as thorns and spines to protect them against grazers and browsers and also to keep transpiration to a minimum. Much of the island of Mannar is covered with Palmyrah (*Borassus flabellifer*) and Coconut (*Cocos nucifera*) palms. As Eriyagama (1961) points out, given the economic importance of the coconut, it has to a limited extent, replaced palmyrah. The coastal vegetation is characterized by stunted cockspur-thorn (*Acacia eburnea*) and buffalo-thorn. The scrub vegetation consists mainly of species such as *Cassia auriculata*, *Phoenix zeylanica*, *Euphorbia antiquorum*, *E. tirucalli*, *Calotropis gigantea*, and *Glycosmis pentaphylla*. The ground vegetation consists of *Aloe vera* var. *littoralis* (Komarika) and *Opuntia* spp. Much of the former extensive mangroves that bordered the causeway between the mainland and Mannar island has been destroyed as a result of almost 20 years of civil conflict. *Rhizophora* spp. with their characteristic stilt roots and numerous pneumatophores are still common in swampy areas, while the ground flora is mostly of the fleshy *Salicornia brachiata* and *Tamarix gallica* (Eriyagama, 1961).

On the mainland, the subsoil of loam or clay being very fertile, most of the economically valuable timber species thrive here. These include Palu (*Manilkara hexandra*), Wira (*Drypetes sepiaria*), Buruta (*Chloroxylon swietenia*), Kohomba (*Azadirachta indica*), and Ebony (*Diospyros ebenum*) typical of the dry evergreen forest. Between Oddaipelankulam and Marikapelankulam on the coastal road to Pooneryn, there are, according to Eriyagama (1961) vast extents of damana land and semi-arid thorn scrub, mainly of cockspur-thorn (*Acacia eburnea*), associated with Murunkan soils. The riparian dominants are the Kumbuk (*Terminalia arjuna*), Kon (*Schleichera oleosa*), and Siyambala (*Tamarindus indica*). The Baobab trees (*Adansonia digitata*) that are found in Mannar and on the mainland are not indigenous to Sri Lanka but were introduced by Arab traders from Africa several centuries ago.

Biological diversity

Mannar District is also rich in mammalian and avian biodiversity. According to IUCN (1990), over 30 species of terrestrial mammals have been recorded but additional



species of Rodents and Bats are present. Threatened animals include the Asian elephant (*Elephas maximus*), sloth bear (*Melursus ursinus*), leopard (*Panthera pardus*), and the water buffalo (*Bubalus bubalis*). A variety of herbivores, such as the spotted deer (*Axis axis*), sambar (*Cervus unicolor*), barking deer (*Muntiacus muntjak*), mouse deer (*Tragulus meminna*), wild boar (*Sus scrofa*), and the black-naped hare (*Lepus negricollis*) occur in the District. In addition, all four species of primates are found here, including the Slender Loris (*Loris tardigradus*). In the coastal waters of Mannar is found one of the most seriously endangered large marine mammals, the dugong (*Dugong dugon*).

The villu ecosystem supports a variety of resident and migratory waterfowl, including large breeding populations of painted stork (*Mycteria leucocephala*) and open-billed stork (*Anastomus oscitans*). Other wetland species include garganey (*Anas querquedula*), pintail (*A. acuta*), whistling teal (*Dendrocygna javanica*), spoonbill (*Platalea leucordia*), white ibis (*Ardea melanocephala*), large white egret (*Egretta alba*), cattle egret (*Bubulens ibis*), and purple heron (*Ardea purpurea*). Indian darter (*Anhinga melanogaster*) is abundant in tanks with high fish density. In addition, Wijeyamohan *et al.*, (2002) have recorded a minimum of 33 resident species from the Giant's Tank alone. This tank alone supports 16% of the national total of birds resident in Sri Lanka, and at least 74% of all the waterfowl in the island.

Protected areas

Despite its vast area and sparse human population, Mannar District has only two areas under protection: (i) The Giant's Tank (3,941ha), and (ii) The Madhu Road (26,677ha) Sanctuaries (Fig. 2), but they represent 15.3% of the land area in the District. The Giant's Tank is situated on the coastal plain of northwestern Sri Lanka, about 5km from the sea near Murunkan, 18km southeast of Mannar. It was declared a sanctuary on 24 September 1954 (IUCN, 1990). The Giant's Tank sanctuary is built around the ancient reservoir which has a maximum depth of 3.2m and a pH of 7.5. It is one of the largest and shallowest reservoirs in Sri Lanka known for its high productivity in freshwater fish and a rich avifauna, especially waterfowl. Fish production is estimated at about 200 metric tones per year (IUCN, 1990). The Giant's Tank and its adjoining Sanctuary provide one of the key habitats for the Asian elephant.

The elephant in Mannar District

Historically, the Mannar District has been famous for its rich and diverse wildlife, and was particularly known for its elephants. In 1888, the then Assistant Government Agent of Mannar, Mr. W.J.S. Boake, wrote as follows about the elephant, "*The elephant still finds a home here, and during the rainy season makes his appearance in considerable numbers, being driven out of the denser jungles by the flies and mosquitoes, which infest such localities, into the low scrub and open plains by the sea. They are not very*

numerous as they used to be, but still may be always found in or near this District. One seldom hears of a tusker now, or of a rogue, but rogues have been present in Vilankulam" (Boake, 1888).

Elephants have been caught and tamed in Mannar District from very early times. They were exported from the ancient port of Mantai which now lies buried under the sea opposite Mannar island. Claudius Ptolemy (c. 121-150 A.D.) refers to this ancient port as the chief outlet for the export of elephants (Nicholas, 1954a). A particular group of Muslims known as Panikkars were adept at catching wild elephants using a noose. Panikkars were originally from Batticaloa and Badulla. Kraaling was not practiced in the north given the heavy mortality such a method entailed. In 1665 only 20 of the 90 elephants that were captured reached Jaffna alive (Nicholas, 1954b).

In 1880 elephants were very numerous in the Nanadan area that they were regularly captured and sold, mainly to India (Boake, 1888). Even then elephants caused great damage to crops and therefore rewards were paid for their destruction. In 1867, elephants to the value of 2,328 sterling pounds were exported (Boake, 1888).

Rationale for the survey

The last "island-wide" survey of elephants that was carried out in June 1993 (Hendavitharana *et al.*, 1994) did not include the north and east of the island because of the civil conflict then raging in the country. Prior to this survey, Norris (1959) arrived at an estimate of 1500 wild elephants in Sri Lanka, but he did not give any details about the distribution of the elephants. Subsequently, the only comprehensive assessment of elephant range and number was that of the team from Smithsonian Institution between 1967 and 1969 during which McKay (1973) estimated between 1600 and 2200 elephants as a minimum figure for the number of wild elephants in Sri Lanka. Even then, much of the northern portion of Sri Lanka, including the Mannar District and the rest of Vanni was not surveyed in any detail. McKay (1973) estimated the total population in this area to be "probably between 200 and 500 elephants". Therefore, as far as elephants are concerned, the Mannar District has never been surveyed in any detail. Hence the need for an update on the range and abundance of elephants here.

Organizing the survey: *the modus operandi*

The survey of elephants in Mannar District is a part of the overall survey of the elephants in the northwestern region of the island organized by the Department of Wildlife Conservation (DWC). We were given the task of organizing the survey in the Mannar District simultaneously with that in the northwest between 25-27 September 2004.

Surveying elephants in the wild is not an easy exercise. It is even more difficult if the distribution of elephants cuts across areas under different administration, as it is in the

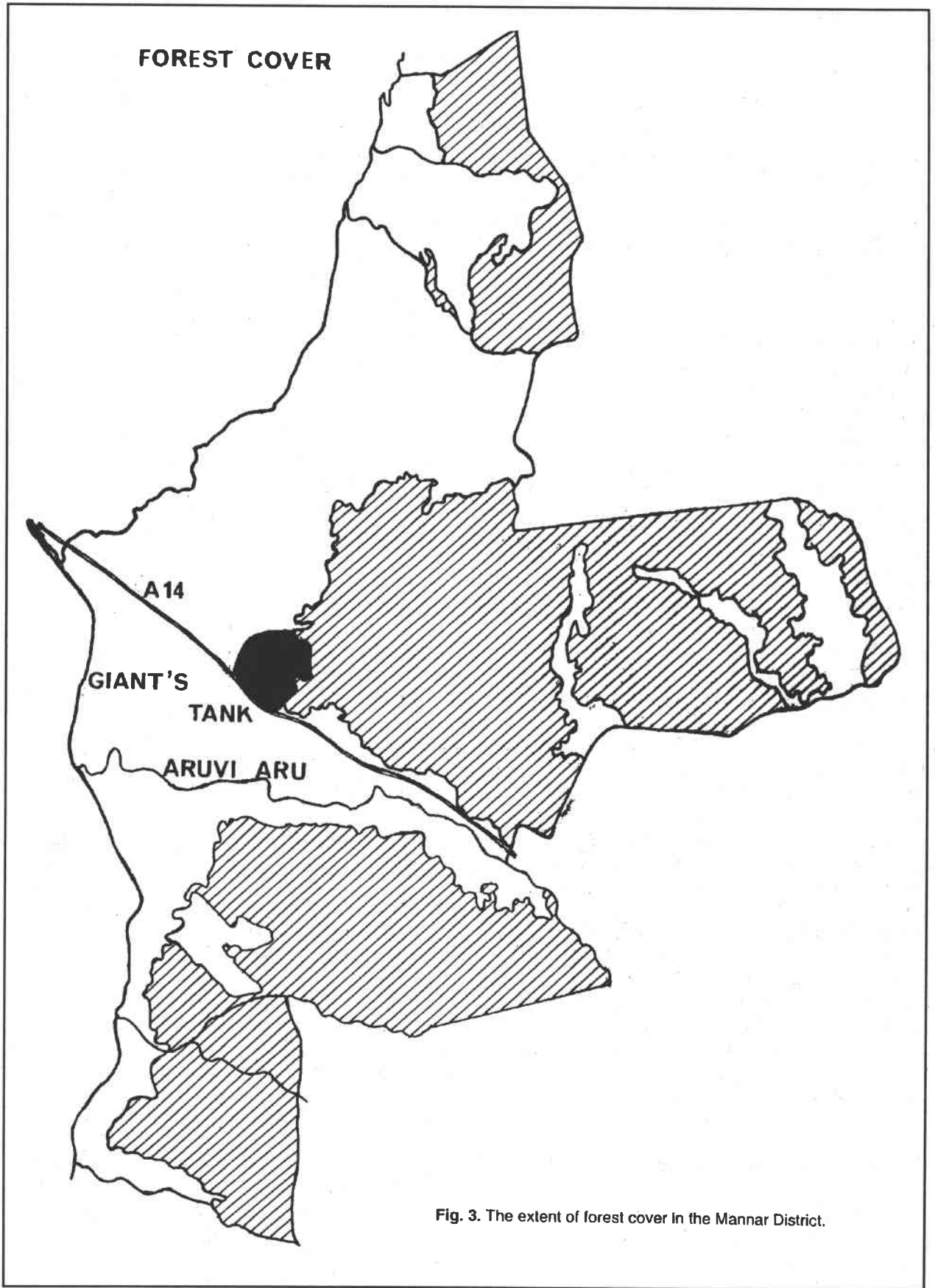


Fig. 3. The extent of forest cover in the Mannar District.

Mannar District. During the preliminary meeting that was held at the Department of Wildlife Conservation in Colombo, we were entrusted with the survey of elephants in the Mannar. The Government Agent, Mr. V. Visuvalingam reacted positively to a request made by Mr. D. Karyawasam, the Director-General, Department of Wildlife Conservation (DWC) for assistance in the survey, and promptly convened a meeting of the Assistant Government Agents and Grama Niladharis from the four AGA Divisions (Fig. 1) and briefed them of the nature of the survey and requested that all assistance be given to us. He furthermore, drafted a letter to the Area Commander of Mannar District, Brigadier Sarath Fernando to inform him of the proposed survey. Mr. Visuvalingam also made an appointment with the Brigadier and took us to discuss the logistics of the survey. In this way, we kept the Army Commander fully informed of the dates and places where the survey would take place. We also informed the Inspector of Police, Mr. Navarathna C. Kumara of Murunkan of the planned survey and enlisted the help of his staff. The Government Agent discussed the survey with several NGOs and made sure that there were sufficient number of vehicles and drivers to transport the students to their observation points. His house functioned as an interim office and hostel for the participants during the survey. Prior to the survey, a training workshop was held at the Vavuniya Campus of the University of Jaffna, at Kurumankadu, Vavuniya in order to introduce the survey techniques to the students.

Mantai is under the control of the LTTE, and hence without the explicit permission and support of the LTTE the survey could not have been carried out by anyone. Thus, our first task was to explain the nature of the work to the LTTE and enlist their support for us and the students from the Universities to enter the areas under their control and carry out observations during the day and night. The LTTE gave us their full support for the survey to be carried out in areas under their control.

Survey and census

While it may be possible to count all the elephants in an area of 10 km² it is a much more difficult task to count them in an area of 2000 km² as for example in the Mannar District. Nicholas (1955) quotes Col. Stevenson-Hamilton, the late Warden of the Kruger National Park in South Africa, who stated categorically that it was impossible to make a census or accurate count of animals including elephants in the bush country of Kruger National Park. What is impracticable in Africa, according to Nicholas (1955) "is altogether impossible here". Their skepticism highlights the difficulty of counting even the largest terrestrial mammal. A large area needs a greater amount of time or a large number of people. This raises the problem of over or under counting due to animal movement during the census, and to different observers recording (or ignoring) the same animal (Rodgers, 1991).

Keeping such constraints in mind, the DWC proposed

the adoption of the water-hole count as a basis for determining the range and possibly some assessment of the number of elephants in the northwestern region of Sri Lanka.

In small areas where a distinct dry season limits the availability of water for elephants, it may be possible to get a crude estimate of elephant numbers by counting those that visit all the water holes on a single day (Ramakrishnan *et al.*, 1991). The critical assumption here is that all elephants would visit a water hole once during the day. In the survey of elephants in Mannar District, we adopted this method in order to assess the structure of the elephant population, the abundance being a secondary concern. For management of elephants, it'd be more useful for us to know the percentage of tuskers among the bulls, the proportion of calves in the population, and the sex ratio of adults. We hoped that these could be determined through visual observation of the animals at water holes.

Abundance, as Caughley (1977) argues, can be measured in three ways: (i) as the number of animals in a population, (ii) as the number of animals per unit of area (absolute density), and (iii) as the density of one population relative to that of another (relative density). One of the central issues in wildlife management concerns the estimation of population size. In the absence of information on the size and spatial distribution of a population, it would be almost impossible to investigate size-dependent or density-dependent relationships (Williams *et al.*, 2002). Reliable estimates of elephant populations are essential to address some of the important conservation issues. However, as Caughley (1977) points out, "the majority of ecological problems can be tackled with the help of indices of density, absolute estimates of density being unnecessary luxuries".

It is therefore necessary that methods that are adopted to estimate elephant numbers (N) and density (D) meet at least the minimal standards for scientific rigor. Elephants can be estimated either in a **census** operation where all the individuals of a population are counted, or in a **survey** of a sample of the population. Elephants can be counted either from air, or from the ground on foot or from a vehicle in open areas (Direct observations). An estimate of population density, as Jachman (1969) points out, is obtained simply by dividing the number counted by the size of the area censused, and the density figure obtained in this way can then be applied to surrounding areas with similar characteristics, such as soil types and vegetation. Elephant numbers can be estimated based on signs such as dung-piles, tracks, feeding signs etc (Indirect method). This method is useful in areas where it is almost impossible to observe elephants.

Methodology

The survey of wild elephants was carried on two days (25 and 26 September 2004), and it involved the services of 24 participants. On 25 September, the northern part of the

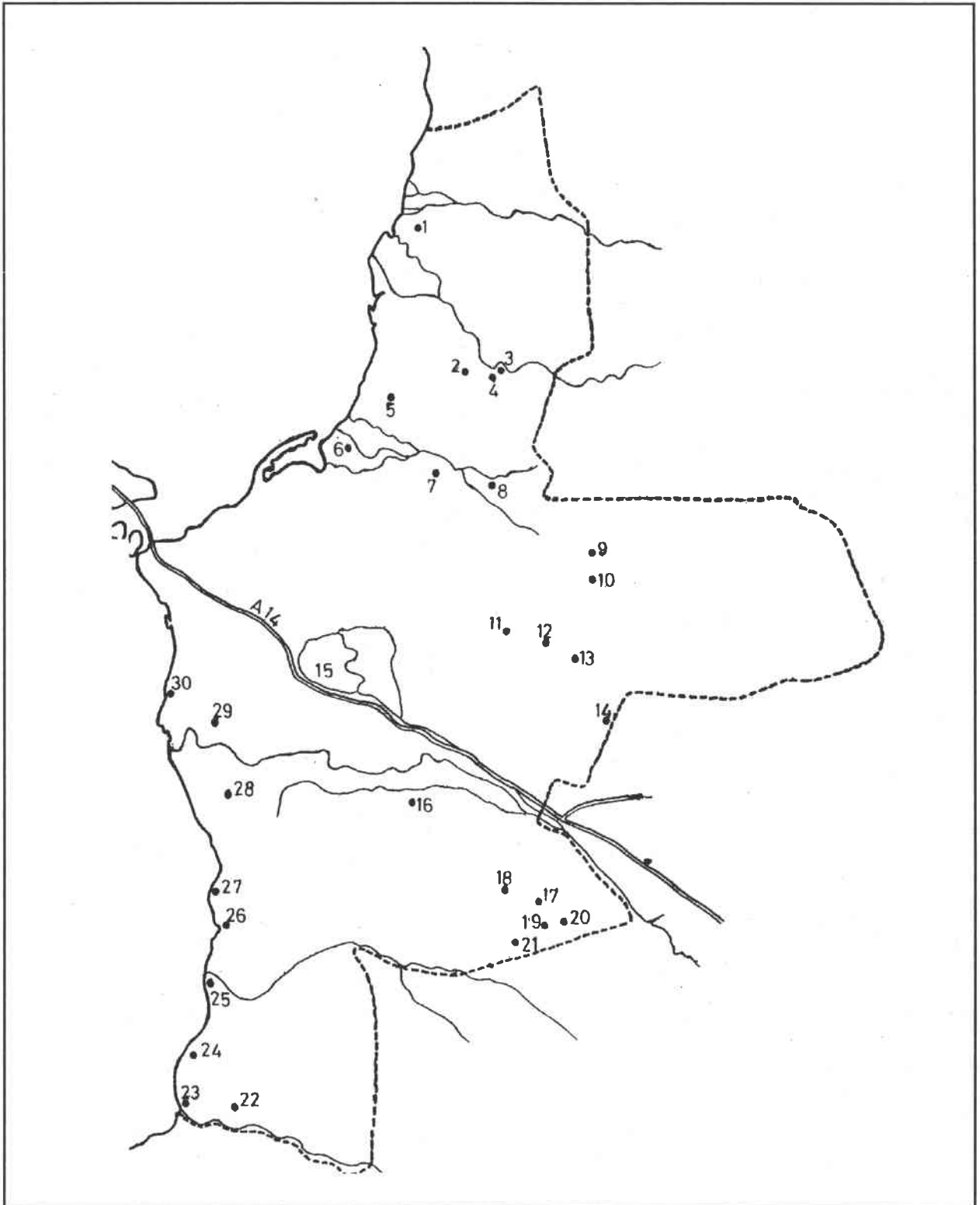


Fig. 4 Elephant observation points: 1. Moodampitty, 2. Kurai, 3. Parankikulam, 4. Sethuvinayagar, 5. Kovitkulam, 6. Palamadu, 7. Sannar, 8. Periyamadu, 9. Palampitty, 10. Thandikulam, 11. Periyavillu, 12. Sinnavillu, 13. Madu, 14. Pandivirichan, 15. Giant's Tank, 16. Pannaivattuwan, 17. Kunjikulam, 18. Uvayadikulam, 19. Puthukulam, 20. Kalliadikulam, 21. Periyamurippu, 22. Periyakattu, 23. Mullikulam, 24. Karadikulam, 25. Kal aru, 26. Anaivillu, 27. Kakkupadayan, 28. Pandarikulam, 29. Eruvettan, 30. Achchankulam.

Mannar District was covered. This area is largely under the control of the LTTE, while on the second day, the southern part of the District was surveyed. Observations were carried out from 1600 to 2300 hrs and beyond in some areas. A number of water holes or (Fig. 4) were identified from where observations on elephants could be carried out. At every water hole, a group comprising 2-3 students was stationed with either a Grama Niladhari or a local villager. A mobile patrol visited all the observation points and covered other areas which were not manned by observers. Direct observations of elephants were the preferred method of investigation. At every sighting of elephants, their number and composition was noted.

The most direct way to estimate the abundance of an elephant population is to count all individuals in a defined area. As Shoshani *et al.*, (2004) point out, counting elephants was done so that only the minimum number of individuals is reported. Duplication was reduced to a minimum or avoided by keeping a tab on the time and distance between successive observations. Wherever possible, animals were classified into calves, juveniles, subadults, adult females and adult males and tuskers. Therefore interviewing local residents is an extremely important aspect of this survey. However, elephants visit water holes frequented by people, more during the night than in the daytime. If no elephants were sighted, then the number of elephants that visited the area most recently was recorded from the villagers. In areas where there were clear, fresh footprints, their diameter or circumference was measured in order to estimate the approximate shoulder heights of the elephants that visited the area, using the formula that twice the circumference of the front foot gives the approximate shoulder height of an elephant (Boyle, 1929; Sukumar *et al.*, 1988). In Africa, elephant's should height has been estimated indirectly using the hind footprint length since the latter is known to relate to shoulder height, and so it could be used to estimate age distributions in a population (Western *et al.*, 1983). Dung and footprints or other spoor, such as chewed vegetation and scratching posts, provide indirect data (Shoshani *et al.*, 2004).

Results and discussion

There were three problems that faced the observers. The **first** relates to the unexpected rainfall which was very high on the second day of the survey. In Mannar District, the northeast monsoon rains usually commence by mid-October. Hence the survey was planned in advance of the rains so that elephants could be observed, sexed, classified and counted at the few remaining waterholes that are not bone dry. In Mannar District, almost all the waterholes had become dry and the drought was one of the worst in living memory of the people. In the LTTE controlled areas, only one tank (besides the Giant's Tank) had water and that is at Sannar which, according to local people, never dries up. South of the A14 highway, Mullikulam had little water but Periyakattukulam had become dry by the time the survey had started. However, the sudden and unexpected rain (which fell first on 23 September)

shifted the movement of the elephants away from the water holes and dispersed them into the forest and along the rivers. Hence the low counts at the observation points on the second day of the survey.

The **second** problem relates to the ban imposed by military on taking binoculars into LTTE controlled areas. As a result of this constraint, it was not possible to sex and classify animals seen at a distance. It is unfortunate that even *bona fide* researchers are denied an opportunity to use the binoculars at a time when the guerrillas all over the world have access to high-powered night vision equipment, telescopes and Global Positioning System (GPS) for surveillance!

The **third** problem concerns the danger posed by unexploded landmines in some areas which poses a serious threat to the life and limbs of people. Such areas could not be surveyed. In the estimation of elephant numbers, every effort was made to discard numbers that may belong to the same population (e.g. in Giant's Tank, a group of 53 animals was not included as it may belong to the much larger group of 77 animals recorded from here).

Distribution of elephants

Elephants in Mannar District enjoy wide distribution that stretches from the Modergam aru in the south to north beyond Mundrampitty near Pali aru (Fig. 5). They are absent along the coast from north of Achchan kulam to just north of Kalliyadi. Despite this large extent of elephant range, the density of elephants varies from place to place, being more in the areas under the LTTE control, just north of the A14 highway. This is largely due to the fact that there are numerous water holes scattered in this area and also substantial forest cover to the east. Elephants are known to move from the south to the north across the A14 highway. However, the appropriation of land along the A14 highway by the Army and the establishment of camps and bunkers, in some places, disrupts elephant movement. Besides, at least 5 elephants have been electrocuted along the A14 highway between Parayanalankulam in the east and Murunkan in the west, during the past three years, through contact with the low-slung naked electricity wires that the army and police use to tap electricity from the national grid.

Abundance of elephants

The results from the survey are given in Table 1. A total of 220 elephants were recorded from the survey, of which 169 were from the LTTE controlled areas, while 51 animals were recorded south of Aruvi aru. In addition, information provided by villagers (and hunters) indicates that up to 350 animals could be using the Mannar District as their habitat during the drought. We should not ignore the knowledge and experience of the local rural people, who in most instances know much more about elephants than urban pundits who just visit an area for a day or two.

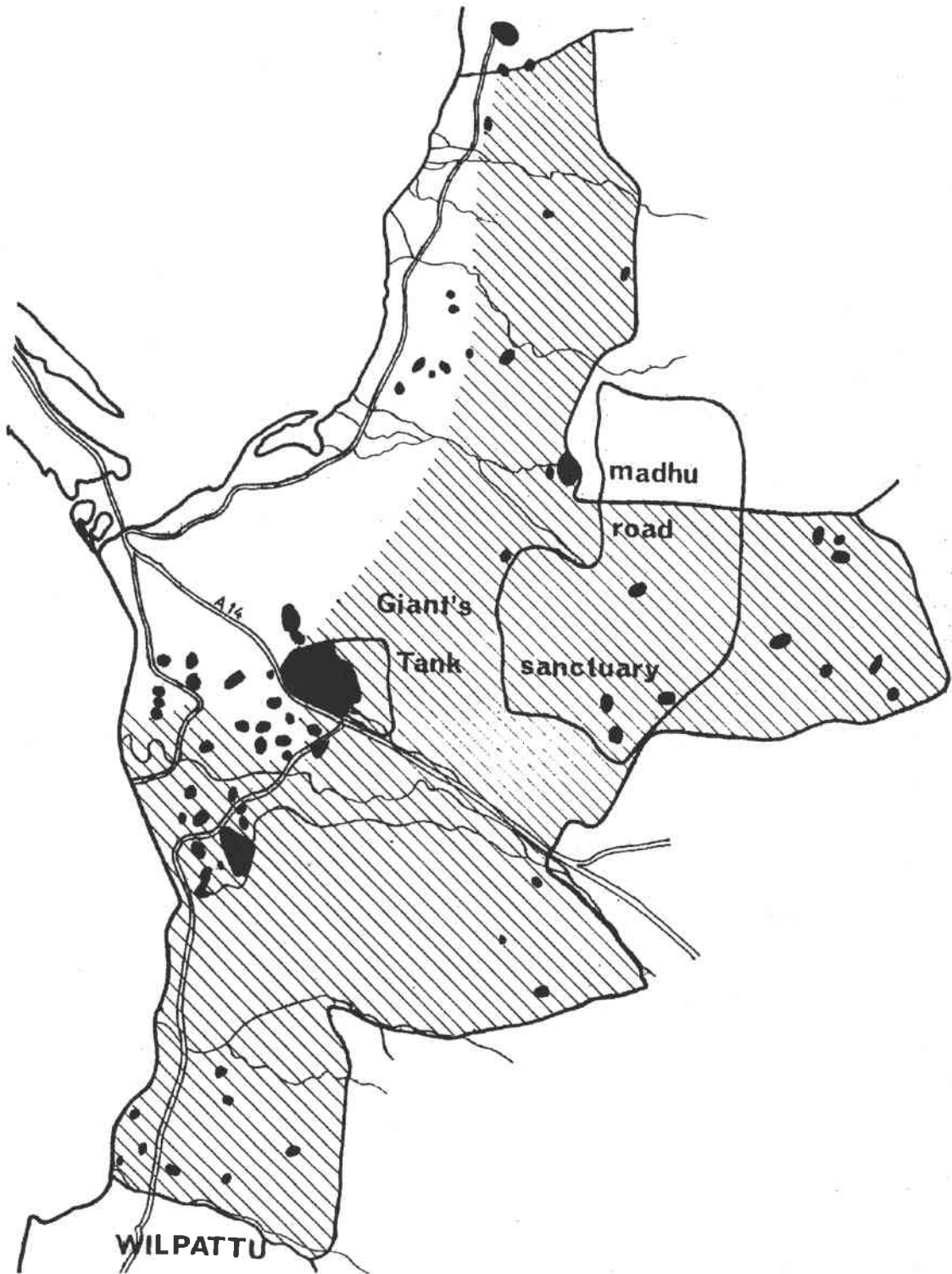


Fig. 5 The dry season range of Elephant in the Mannar District.

As Blanc *et al.*, (2003) point out, even the guesses made by people who know the area in question have to be relied upon. Given the closeness of the two estimates of 169 and 189 from the observers and villagers in the LTTE controlled areas for the number of elephants (Table 1), the estimate given by the villagers should be considered an informed guess. Even this figure must be considered a minimum estimate, given the difficulty of counting elephants in forests. A population of 350 elephants in the Mannar District represents approximately 10% of the national total. This translates into a crude density of 0.18 animal per km². However, ecological density for the elephant can be much higher in areas of optimal habitat, or during periods of concentration at the height of the drought (Eisenberg & Lockhart, 1972).

The elephant biomass calculations at the crude density of 0.18 per km² in Mannar District, work out to be 326 kg per km². At ecological densities of 1.0 to 1.2 animals per km², the elephant biomass may reach 1,800 to 2,170 kg per km². Density, expressed either as individuals per unit area, or as an index to numbers (e.g. number of faecal droppings per 100 stations), is often a valuable and necessary piece of information for management of elephants (Riney, 1982). If measured during the same season in consecutive years, changes in density-related figures will indicate increases or decreases in the population. Biomass refers to the total weight of animals supported by a unit area. The biomass level that a species population sustains represents a relation between the production of food in the environment, and the ability of animals of the species to transform the food into animal biomass (Owen-Smith, 1988).

For such a large mammal as the elephant that can tolerate a lower quality of diet than smaller herbivores, a high proportion of available herbage becomes acceptable food. Density and biomass supply helpful information on what exists at a particular time (present status, standing crop, occurrence).

It appears that there are far more elephants today in Mannar District than was expected. This is not surprising given the resources available to the elephants in Mannar District. In the first place, there is extensive forest still intact in the north. Sri Lanka's forest cover has declined to less than 22% and much of what is left can be found in the north and east. Thus elephants have sufficient habitat, low human population density, and hundreds of man-made reservoirs, a number of which hold permanent water even during the peak of the dry season. The Giant's Tank provides the best area for elephants and other wildlife, especially birds. The LTTE has imposed a strict ban on illegal timber harvesting within the forests in the north. No tree can be cut without their permission. Thus elephants have sufficient habitat to move about and adjust their densities to changing patterns in vegetation.

Population structure

The unexpected rain was in a way, a blessing in disguise in
Gajah 24: (2006)

that in some areas, it was possible to see clear footprints which were measured to estimate the approximate shoulder heights of the elephants. A total of 21 elephant footprints in two separate areas were measured. On the basis of the footprint measurements (see Table 2), it appears that the population structure consists of adults (47.6%), subadults (23.8%), juveniles (14.3%) and calves (14.3%). The size classes were estimated based on the criteria given by Eisenberg & Lockhart (1972) and McKay (1973). It is interesting if the observed percentages of the size classes in Mannar District are compared to what was found by Eisenberg & Lockhart (1972) in Wilpattu National Park, where adults comprised 49%, subadults 25%, juveniles 20% and calves 7%. Thus the observations in Mannar District appear to be in keeping with the more extensive censuses performed by Eisenberg & Lockhart (1972). More than 10% of the animals are calves, which is a healthy indicator of recruitment in the population. As Moss (1988) points out, age structures of elephants usually contain peaks and troughs - i.e. there will be numerous individuals in one age class, very few in the next and so on. There is no even distribution of ages through the population. In respect to sex-classes, the male-female ratio is equal until the adult class is reached, whereupon there are only 8% males compared to 31% females (Kurt, 1969). On a separate day, following rains in the LTTE controlled area of Moondrampitty south of Pali aru, we found one very large footprint 39cm in diameter, which is likely to belong to a bull that is about 2.45m in height at the shoulder.

Tuskers

The survey reveals the presence of at least 4 tuskers in the District (Table 1). The proportion of bulls bearing tusks varies enormously among different Asian elephant populations (Sukumar 1989). In Sri Lanka, Deraniyagala (1955) found that 324 bulls out of a sample of 364 were without tusks. i.e. 89% were tusk less or makhnas. McKay (1973) in a much smaller sample of 25 captured bull elephants found 23 (or 92%) were tusk less. In comparison, almost 90% of the bulls are tuskers in South India. It is difficult to determine the % of tusker in the Mannar District based on the results of this survey as it was not possible to determine the adult sex ratio of the animals recorded. However, if we assume an adult male: female sex ratio of 1:3, then the proportion of tuskers in Mannar District would be about 7.3% - exactly the same as that arrived in 1993 census (Hendavitharana *et al.*, 1994).

Human-elephant conflict

The survey also revealed skulls and bones of two elephants but the cause of death could not be ascertained. While there had been much discussion in the media about the impact of wild elephants in agricultural areas in the south, no one highlighted the plight of the people *vis-à-vis* elephants in the LTTE controlled areas.

A key element of elephant conservation is monitoring

Table 1. The number of elephants recorded during the survey. Numbers within [brackets] refer to the approximate number of elephants recorded by villagers just prior to the survey to survey.

location	time	tuskers	adults	subadults	juveniles	calves	total
Day 1 (25 September 2004)							
Parankikulam	1840						2
Parankikulam	1910						13
Palampiddy	1950						[120]
Palampiddy (feeding sign)	1930					1	
Palampiddy (f-prints)	2110						2
Palampiddy (f-prints)	2110						8
Koorai		1	13	7	3	2	26
Giant's Tank	2335	1	43	8	25 (plus calves)		77
Giant's Tank	2350	1	1	1	1	4	
Periyavillu							[30]
Periyavillu (heard)	2025						1
Pandivirichchan (heard)	2340		1				1
Aryvi aru							5
Potkerni							1
Maruthmadhu jct							3
Veppankulam							1
Pitchaivaniparkulam							3
Vilatikulam							[35]
Periyamadukulam							2
Periyamadu							[4]
Periyakattu	2320						15
Total							169 and [189]
Day 2 (26 September 2004)							
Adaipankulam	1900	1					
Aruvi aru bridge	1715	1					1
Pannivattuwan	2400						1
Pannaivattuwan	0615 +			4			4
Pannaivattuwan							[100]
Periyamuripukulam	0600 +						1
Thekka pannai		1					[12]
Aathikulam							3
Kallikulam							[19]
Arippu							[30]
Periyakattu	1900						7
Karadikuli	2300						2
Mullikulam							5
Aruvi aru	2220						12
Kal aru (f-prints)	0930						11
Madhu Rd-Mannar A14	2140						3
Total							51 and [161]
Grand Total		4 tuskers					220 and [350]

how different forms of human activity influence elephant distribution and abundance (Walsh *et al.* 2001). One of the serious issues that need to be mitigated in the Mannar District is the growing threat of elephants to people and cultivation. The problem has been compounded by the fact that for much of the past two decades, the area was plunged into an internecine civil war and people fled the area to the safety of India as refugees, abandoning their homes, goods and chattel. Today, with the fragile peace still holding between the LTTE and the Government of Sri Lanka, refugees are slowly returning to their original homes to face an unexpected threat – this time from wild elephants. These animals moved into the abandoned home gardens, attracted by the abundance of palatable and highly nutritious food plants. With plenty of food and water, the animals have become ‘permanent residents’. Therefore returning refugees have to compete with elephants in cultivating their own land. Elephants killed at least two people and a few were injured but to date no one has received any compensation. The DWC sent some thunder flashes to Mannar District for the first time, so that they could be used to ward off elephants. Elephants can be saved if even a small portion of the money now being used in workshops, symposia, meetings and conferences is directed towards alleviating the hardship of the poor people who bear the brunt of elephant depredations. Conservation has to sustain not only the spirit but also the stomach.

Impact of the civil war on environment

The civil war has radically altered economic, political, and social conditions of the people in the Mannar District with profound impacts on the environment, natural resources and biodiversity. The impact of armed conflict on the environment in Mannar District is perceptible and it occurs through habitat destruction and loss of wildlife, over-exploitation and degradation of natural resources (Shambaugh *et al.*, 2001). Many of the refugees rely on bushmeat for protein. The LTTE has banned the hunting of wildlife except the pig and hare in areas under their control. Outside however, illegal hunting for bushmeat is rampant. At least 50 hunters are involved in the Mullikulam area alone in bushmeat harvesting. Yet bushmeat hunting should not be banned since it would deny the poor people living in remote areas an important source of protein (Whitfield, 2003). It should be regulated. If such harvesting is not regulated, there is a risk that resource depletion and environmental degradation can drag the people into a vicious circle: poverty, further political instability, more armed conflict, greater environmental degradation, and even greater poverty (Shambaugh *et al.*, 2001). Depletion of biodiversity and the natural resource base can undermine the sustainable livelihoods for the people (Santiapillai & Wijeyamohan, 2003).

Conclusion

The survey of wild elephants in the Mannar District represents the first attempt to obtain reasonably

reliable minimum estimates of their number. It is a part of a much larger survey carried out simultaneously by the Department of Wildlife Conservation in the northwestern region of Sri Lanka. Until this survey was carried out, there had been no reliable information on the elephant's range and numbers from the north in general and the Mannar District in particular. The status of the elephant varies widely across its range in the island, and moreover its long-term survival is more threatened in some areas than in others. Therefore regional assessment of elephant range and numbers is crucial given that elephants move long distances across political boundaries and protected areas. This is an important consideration in the north since the Vanni is under the control of the LTTE, while all the national parks are under the control of the Government. Decisions made in one area may therefore affect elephant populations in the other.

The water hole count method adopted during the survey is not perfect but useful in areas where the objective is not simply to estimate the number of elephants but more importantly, to understand their distribution, structure and composition. Total counts do not have the advantage of sample statistics to give measures of precision of the estimate (Rodgers, 1991). Besides, the longer the time period taken to do the count, the greater the chances of double counting. This is the reason the survey was limited to just one day in each area. Despite the drawbacks, the survey provided information on the structure and composition of the groups, the percentage of calves and the proportion of tuskers – information useful to wildlife managers. One clue to the reliability of this method is to repeat the survey immediately. An immediate recount means, as Rodgers (1991) argues, there is no chance of conditions changing. Ideally the survey needs to be carried out twice a year in the dry and rainy seasons to determine the changes in the range and abundance of the elephant.

An index of abundance would be sufficient to tackle many of the wildlife problems. Wildlife management authorities need to know the status of the elephant populations, whether they are increasing, decreasing and whether their numbers should be regulated to reduce conflict and to relax the pressure on habitats (Blanc *et al.*, 2003).

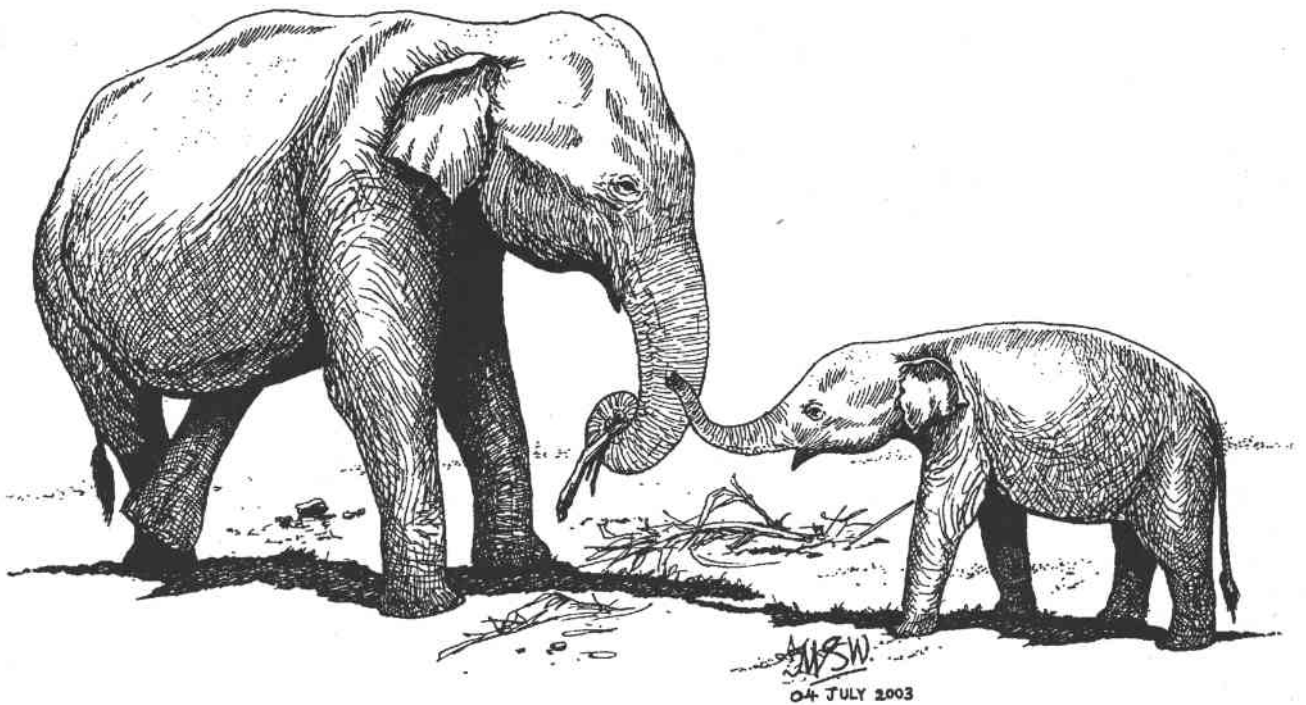
McKay (1973) estimated that there could be between 200-500 elephants in the entire northern Sri Lanka in the late 1960s. The present survey indicates that at least 220 elephants are present in the Mannar District alone, but the numbers could be even as high as 350 or higher. Such information, however imperfect it may be, would be useful for the effective conservation and management of elephants. While the effect of the elephant on its habitat may benefit many other species of wildlife sympatric with it in the area, it can also have a detrimental impact on the vegetation, should elephant density increase.

Mannar District represents an important area for elephants. It provides a connection for the elephants in

Table 2. Estimates of shoulder heights of elephants based on footprint diameter based on the criteria established by Eisenberg and Lockhart (1972) and McKay (1973).

#	fore foot diameter (cm)	circumference (in cm)	shoulder height (m)	size class
1	33	102.3	2.08	adult
2	15	47.1	0.96	calf
3	16	50.3	1.01	calf
4	37	116.2	2.36	adult
5	20	62.8	1.27	juvenile
6	37	116.2	2.36	adult
7	34	106.8	2.17	adult
8	32	100.5	2.04	adult
9	22	69.1	1.40	juvenile
10	28	87.9	1.78	subadult
11	29	92.1	1.85	subadult
12	17	53.4	1.08	calf
13	30	94.2	1.91	subadult
14	35	109.9	2.23	adult
15	18	56.5	1.15	juvenile
16	34	106.8	2.17	adult
17	32	100.5	2.04	adult
18	24	75.4	1.53	subadult
19	32	100.5	2.04	adult
20	35	109.9	2.23	adult
21	30	94.2	1.91	subadult

Number of adults 10 (47.6%), subadults 5 (23.8%), juveniles 3 (14.3%) and calves 3 (14.3%)



Artist: Manjula Wijesundara

Wilpattu National Park and those in the Giant's Tank and Madhu Road Sanctuaries. In addition to enhancing elephant movement and gene flow, the area has great value as habitat for plant and animal communities. The survey has shown that elephant distribution is not confined to such protected areas alone. The majority of elephants appear to be found in unprotected areas. Therefore this situation could lead to increased conflict with people, especially in areas where refugees have been resettled and agriculture is the principal land use. There is an opportunity in Mannar District to link up the Wilpattu North Sanctuary with the Giant's Tank and Madhu Road Sanctuaries (Fig. 2) through a forest corridor to enable the elephants to move to and fro across the A14 highway. This is possible given the low human population density in the area and the presence of many water holes and forest blocks. Such a forest corridor provides a means of ensuring connectivity for elephant movement across landscapes threatened with fragmentation. The proposed corridor being more than 10km wide, it would be more than adequate to ensure the gene flow between elephant populations to the north and south of the A14 highway. As Sukumar (2003) argues, if the objective of a corridor is merely to act as a passage for elephants, it would be better to maintain the vegetation in a state that encourages rapid movement rather than a prolonged stay that could promote conflict.

Information on elephant number, minimum viable population (MVP) size, and movement pattern would be invaluable to define clearly the management objectives for both protected and unprotected areas of elephant range (Lindsay, 1993). Furthermore, should a national park, nature reserve or forest corridor be planned in the Mannar District to ensure the long-term survival of the elephant, such information would be most useful.

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