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# Spatio – Temporal Movement of Asian Elephants (*Elephas maximus*) in Bitherkadu Forest Range of Gudalur Forest Division, Tamil Nadu.

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*Abstract:* The population of elephants has been affected adversely by a growing human population and the resultant destruction of natural habitats for settlement and cultivation. Besides habitat loss, the large-scale capture of elephants in the past also caused its decline. Thus, the Asian elephant has suffered due to enormous loss of its habitat and continued captured for taming over a 4000-year period in human history. The genetically effective population size may also decrease due to another demographic factor of skewing of the sex ratio of reproducing males and females, the more unequal the sex ratio the lower the effective population size. A total of 1227 individuals were sighted in 413 elephant sightings in Bitherkadu Forest Range between January, 2022 and December, 2023. Of which, a greater number of elephants were sighted in the month of August (n=52) followed by May (n=46) and July (n=52). The study revealed minimum number of elephants were sighted in the month of December (n=21). Out of 1227 individuals most of them were female led family individuals (n=1053) and solitary individuals (both tuskers and makhnas) (n=174) during the study period.

**Key words: - Spatial movement, Asian Elephant, *Elephans maximus*, Bitherkad Forest Range, Gudalur Forest Division.**

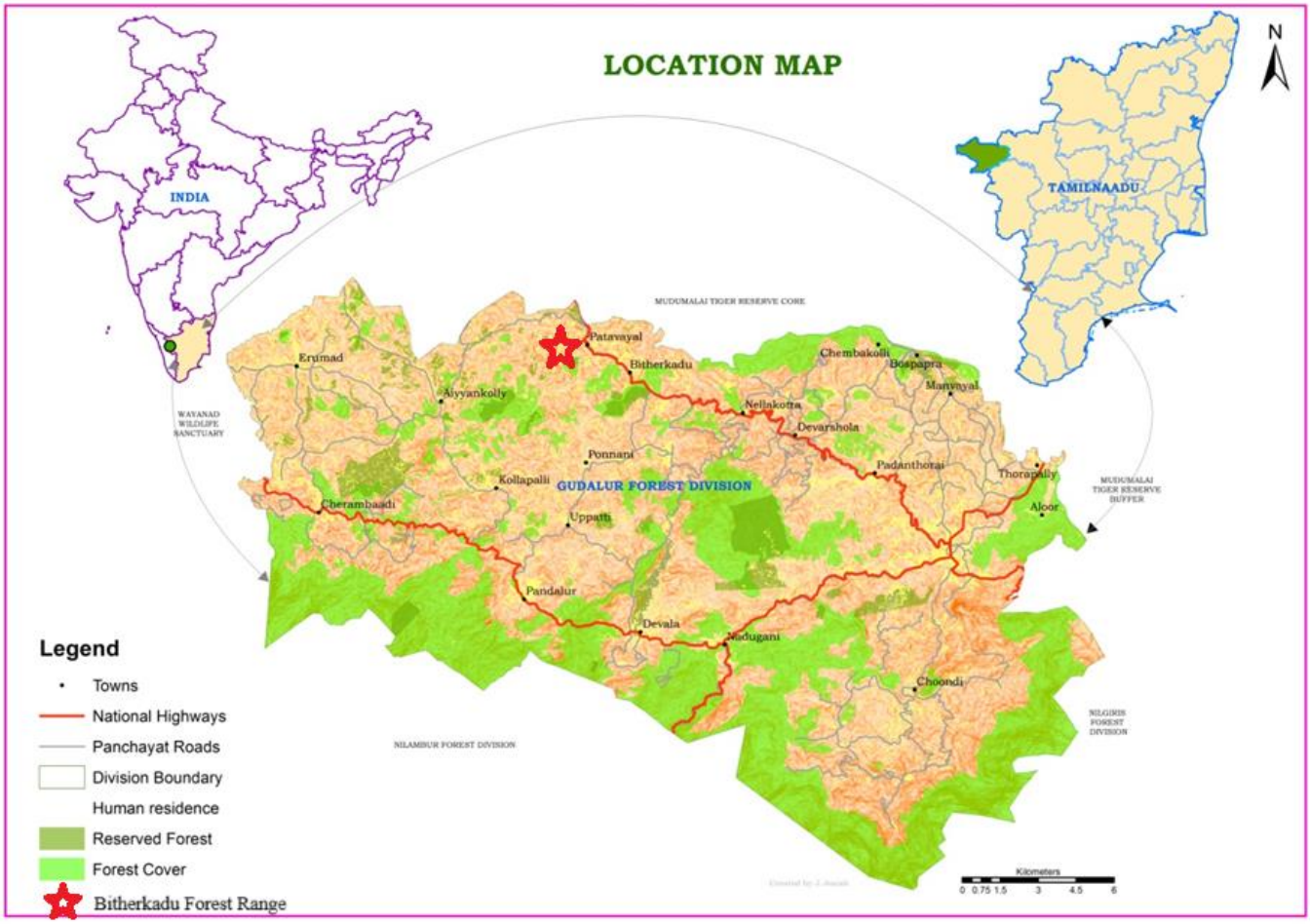
## I. INTRODUCTION

The Asian Elephant (*Elephas maximus*) is an endangered and "Keystone Species" (Ramakrishnan and Saravanamuthu, 2010) categorized under Schedule I and Part I of the Indian Wildlife (Protection) Act, 1972. The Asian Elephant is once found throughout Asia and is now restricted to few localities in the Indian Subcontinent due to various reasons. Over the past few decades many developmental and destructive activities of humans have severely fragmented the forests. The resultant habitat fragmentation is one of the problems faced by many species all over the world. The Asian elephant (*Elephas maximus*), as they require large areas of natural range than other mammalian species in tropical Asia, is one of the main animals to suffer the consequences of developmental activities (Singh and Chalisgaonkar, 2006). Today the Asian Elephant is believed to be around 45,000-50,000 in the wild and is distributed across several populations over South and Southeast Asia (Sukumar, 2003). The population of elephants has been affected adversely by a growing human population and the resultant destruction of natural habitats for settlement and cultivation. Besides habitat loss, the large-scale capture of elephants in the past has also caused its decline. Thus, the Asian elephant has suffered due to enormous loss of its habitat and continued captured for taming over a 4000-year period in human history. In India its range today covers only 3% of the geographical area of the country (Sukumar 2003). Based on a update by Sukumar (2003) the population of elephants in India is between 26,390 and 30,770, distributed in the country's five regions viz. South (13,000-15,000), Central (2,400-2,700), Northwest (750-1,000) and Northeast 10,200-12,000) and Andaman Islands (40-70). The southern Indian elephant populations, among the largest in Asia, are spread over a large area along the Western Ghats, one of the "global hot spots of biodiversity ", and a petit of Eastern Ghats. Even within India, elephants became extinct in recent centuries in the states of Punjab, Rajasthan, Gujarat, Madhya Pradesh, Maharashtra and Andhra Pradesh (Sukumar 1989). The genetically effective population size may also decrease due to another demographic factor of skewing of the sex ratios of reproducing males and females, the more unequal the sex ratio the lower the effective population size (Ramakrishnan *et al.*, 1998). Considering the lacunae, the present study was attempted in Bitherkadu Forest Range, which is one of the forest ranges of the Gudalur forest Division located adjoining to Mudumalai Tiger Reserve where elephant movements need to be studied.

## Study Area

The Gudalur forest division is popularly known as the Nilgiri-Wynaad Plateau (Davidar, 1972) which lies to the west of the Nilgiri hills and forms the south-western extremity of the Mysore plateau. During 1950-1990 there had been rapid changes in the ecology and environment on the Nilgiri-Wynaad Plateau**.** The Nilgiri- Wynaad was an area that had sufficient forested landsand the state could establish control by abolishing the traditional Janmam rights, and the state also wanted to counter and halt the large-scale migrations of human groups from Kerala state. During 1971 The Tamil Nadu state set up a corporation called the TAN TEA (Tamil Nadu Tea Plantation Corporation Limited) under the forest department and opened out tea estates in the contiguous forest areas to provide employment opportunity to the Sri Lankan repatriates. The plantation area was increased to 5,790 ha, and the Sri Lankan repatriates were settled along with their families and relatives in the Nilgiri Wayanad Plateau in the latter half of 1981. The Gudalur division situated at the convergence of Kerala, Karnataka and Tamil Nadu, lies between 11°22'and 11o 34' N and 76o 32' and 76o 15'E covering an area of 484.4 Sq.km. This forest division is surrounded by Sigur Plateau on the east, Nilambur, Wayanad on the west, Mudumalai, Wayanad on the north and Nilambur forest on the south. The tropical wet evergreen and moist deciduous are the major forest types of Gudalur division which form part of the Nilgiri Biosphere Reserve. The other forest types represented are semi-evergreen and South Indian moist mixed deciduous forests on the western side and heavy scrub dry deciduous forests on the east. Bamboo and elephant grass grow luxuriantly and support a large variety of herbivores, arboreal animals and many small and large carnivores.

**Map 1. Location Map of Gudalur Forest Division**




## II. METHODS

- **GIS Mapping**: Geographic Information System (GIS) tools were used to dipict the elephant movements across the forest range.
- **Home Range Estimation**: The approximate home range was calculated for just three individuals as they were frequently sighted during the study period. Using their geo-coordinates home range map was prepared doe three individuals.
- **Mapping Spatial distribution of elephants:** Using ArcGIS (version 10.4.1) software of all elephant sighting locations and their identifications, a database is now developed to track their spatial movements across the study area.

## III. RESULT

### Spatial distribution of elephants in Bitherkadu Range

In the Bitherkadu Forest Range, a total of 1227 elephant individuals were sighting in 413 elephant sightings with the following group compositions have been observed (Table 1):

1. **Solitary Male Elephants**: The highest number of sightings were of solitary male elephants, with a total of 174 individuals.
2. **Nine Individuals in Groups**: The second highest group composition was nine individuals in the herd (n=19 sightings), with a total of 171 individuals.
3. **Twelve individuals in Groups**: Twelve individuals in a group was recorded by just single sighting

**Table 1. Spatial distribution of elephants in Bitherkadu Forest Range**

| S. No | Group size of elephants sighted | Total number of sightings | Total number of individuals sighted |
|---|---|---|---|
| 1 | A herd comprising 15 individuals | 2 | 30 |
| 2 | A herd comprising 12 individuals | 1 | 12 |
| 3 | A herd comprising 11 individuals | 10 | 110 |
| 4 | A herd comprising 10 individuals | 2 | 20 |
| 5 | A herd comprising 9 individuals | 19 | 171 |
| 6 | A herd comprising 7 individuals | 11 | 77 |
| 7 | A herd comprising 6 individuals | 26 | 156 |
| 8 | A herd comprising 5 individuals | 11 | 55 |
| 9 | A herd comprising 4 individuals | 26 | 104 |
| 10 | A herd comprising 3 individuals | 56 | 168 |
| 11 | A herd comprising 2 individuals | 75 | 150 |
| 12 | Solitary individuals Tusker & Makhnas | 174 | 174 |
| | Total | 413 | 1227 |

A total of 1227 elephant individuals were recorded across 74 locations in the Bitherkadu Forest Range. The highest number of sightings occurred in Soosanpaadi (n=184), followed by Gods Brook RF (n=159), and Sussex Estate (n=102) (Table 2).

**Table 2. Elephants sighted in different locations in Bitherkadu Forest Range**

| S.No | Name of the Location | Total number of sightings | Total number of individuals sighted |
|---|---|---|---|
| 1 | 2 Acre | 4 | 11 |
| 2 | 7 Kovil | 1 | 3 |
| 3 | 78 Lines | 2 | 4 |
| 4 | Anaipallam | 1 | 1 |
| 5 | Amco Factory | 2 | 4 |
| 6 | Ammankovil Watch Tower | 7 | 9 |
| 7 | Ammankovil | 1 | 1 |
| 8 | Ammankovil Bit VI | 1 | 3 |
| 9 | Ammankovil RL | 1 | 3 |
| 10 | Aanappanshola | 14 | 29 |
| 11 | Ayanipera | 1 | 2 |
| 12 | Ayyankolly | 3 | 5 |
| 13 | Ayyankolly Health Center | 14 | 32 |
| 14 | Chandacharakunnu | 1 | 1 |

| | | | |
|---|---|---|---|
| 15 | Channakolli | 2 | 2 |
| 16 | Cheepundi | 13 | 15 |
| 17 | Chennimalai Estate | 6 | 16 |
| 18 | Cholady | 1 | 1 |
| 19 | Coco- Plantation | 11 | 14 |
| 20 | CTRD Elamanna | 1 | 1 |
| 21 | CTRD Trust | 2 | 11 |
| 22 | Donarhills | 7 | 41 |
| 23 | Edathal | 4 | 6 |
| 24 | Elamanna | 1 | 3 |
| 25 | Elamanna Murugan Kovil | 1 | 3 |
| 26 | Eliyaskadai | 2 | 10 |
| 27 | Eliyaskadai Tower Medu | 3 | 17 |
| 28 | Gandhikunnu | 1 | 6 |
| 29 | Godsbrook RF | 58 | 159 |
| 30 | Health centre care | 1 | 1 |
| 31 | Kalpara | 1 | 2 |
| 32 | Karagamoola | 1 | 1 |
| 33 | Karagampadi | 3 | 4 |
| 34 | Karamoola | 1 | 2 |
| 35 | Karuthadu | 7 | 19 |
| 36 | Kottapadi | 26 | 67 |
| 37 | Kottapadi 2 Acre | 3 | 4 |
| 38 | Kottapadi Tribal Colony | 1 | 1 |
| 39 | Kundhalady | 1 | 1 |
| 40 | Mangamoola | 9 | 24 |
| 41 | Mariamman Kovil | 1 | 2 |
| 42 | Mazhavan Cherambadi | 4 | 5 |
| 43 | Moolakadai | 3 | 6 |
| 44 | Mukkatti | 2 | 2 |
| 45 | Munanad | 1 | 1 |
| 46 | Murugan Kovil Medu | 7 | 34 |
| 47 | Murukkampadi RL | 3 | 3 |
| 48 | Muthirakolly | 1 | 9 |
| 49 | Needle Rock RF | 1 | 3 |

| | | | |
|---|---|---|---|
| 50 | Nelakottai | 4 | 4 |
| 51 | Nelliyalam | 1 | 1 |
| 52 | Nelliyampadhi | 3 | 35 |
| 53 | No 10 Laborlines | 2 | 6 |
| 54 | Orkadavu | 5 | 23 |
| 55 | Pakkana | 1 | 9 |
| 56 | Palapally | 3 | 3 |
| 57 | Pattavayal | 12 | 13 |
| 58 | Perungarai | 6 | 27 |
| 59 | Podiyotta RF | 9 | 15 |
| 60 | Punjakolly Kavayal Swamp | 1 | 1 |
| 61 | Ramarkovil | 1 | 1 |
| 62 | Rock wood Estate | 8 | 46 |
| 63 | Ruby Estate | 7 | 38 |
| 64 | Ruby FB | 1 | 7 |
| 65 | Samiyarmalai | 10 | 32 |
| 66 | Saraswathy School | 2 | 5 |
| 67 | Selakunnu RF | 2 | 2 |
| 68 | Sivakami Estate | 2 | 8 |
| 69 | Soosanpadi | 29 | 184 |
| 70 | Sussex Estate | 18 | 102 |
| 71 | Thattamparai | 6 | 8 |
| 72 | Urundukovil | 1 | 2 |
| 73 | Vattakolly | 3 | 3 |
| 74 | Vilangur | 33 | 48 |
| **Total** | | **413** | **1227** |

**Table 3. Month wise elephant sightings in Bitherkadu Forest Range**

**Month wise elephant sightings in Bitherkadu Forest Range**

| Year | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2022 | 23 | 19 | 37 | 36 | 46 | 40 | 45 | 52 | 34 | 31 | 29 | 21 |
| **Total** | **23** | **19** | **37** | **36** | **46** | **40** | **45** | **52** | **34** | **31** | **29** | **21** |

Out of 1227 elephant individuals sighted in Bitherkadu Forest Range, the highest number of elephants were sighted in the Month of August (n=52), followed by May (n=46) and July (n=45). The study revealed that the fewer number of elephants were sighted in the Month December (n=21) (Table 3).

**Identified individuals that are frequently sighted in Bitherkadu Forest Range**

The solitary elephants that were frequently sighted than female led family herds in Bitherkadu Forest Range. Of which, Chelakunnu Velukkan (CT-2) was sighted highest numbers (n=41) followed by Bitherkadu Female -1 (BK - 1) (n=8). It is very important to note that the above-mentioned individuals were frequently sighted during the study period (Fig. 1)

**Figure. 1. Identified elephant individuals in Bitherkadu Forest during 2022**

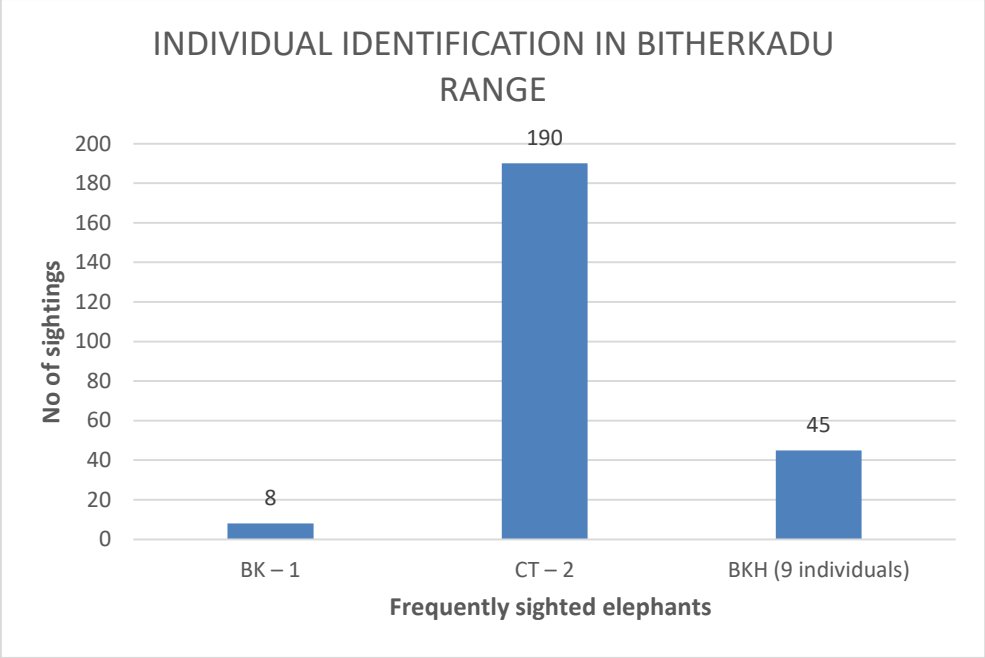
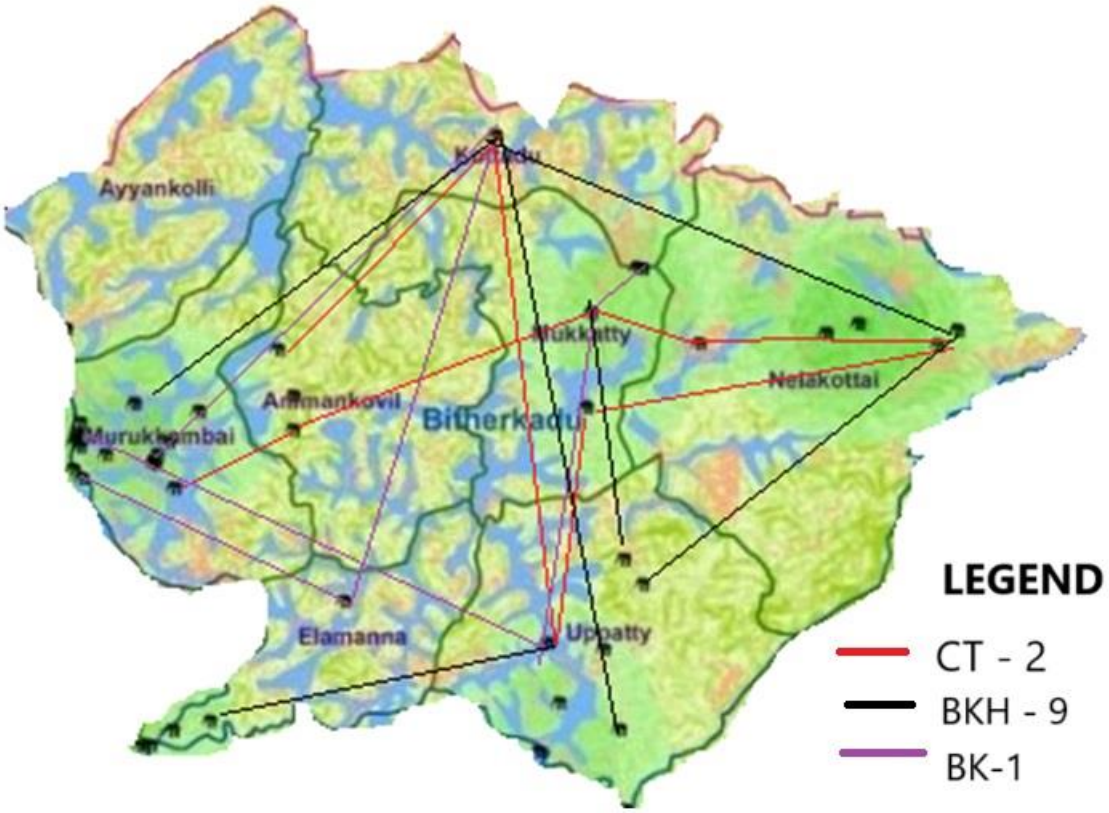


**Table4. Home range pattern of identified elephant individuals in Bitherkadu Forest Range during 2022**

| S No | Identified Individuals | Home range area in sq.km | Months stayed | Total number of months stayed in Bitherkad forest Range | Total number of sightings |
|---|---|---|---|---|---|
| 1 | BK – 1 | 11.6 | Jan - Dec | 12 | 8 |
| 2 | CT – 2 | 41.4 | May – Dec | 6 | 190 |
| 3 | BKH (9 individuals) | 20.5 | Jan – Dec | 12 | 45 |

The spatial patterns of the identified elephants' home ranges varied among individuals. The elephant with the largest home range, CT-2 (Cherambadi Tusker-2), was recorded at 41.4 sq. km, followed by BKH-1 (Bitherkadu Herd-1) at 20.5 sq. km. The other identified individuals, BK-1 (Bitherkadu Tusker-1), recorded home ranges of 11.6 sq. km and 10.2 sq. km, respectively, in the Bitherkadu Forest Range. (Map. 2).

**Map 2. Home range of frequently sighted elephants in Bitherkadu Forest Range during 2022**




**Discussion**

The home ranges of Asian elephants have been estimated from radio-telemetric studies carried out in India (Baskaran et al., 1995; Williams et al., 2001; Sukumar et al., 2003) and Sri Lanka (Fernando and Lande, 2000). These indicate home-range sizes of 250–1000 Sq.km for family herds in Indian populations but a more restricted 50–150 Sq.km in Sri Lanka. The area over which elephants move depends on availability of food and water, which is related to local topography and climate. Regional information on home range size and elephant movement. As per the theory of natural selection, activities of an animal should lead towards maximizing fitness in terms of reproductive success. Movement is one of the activities, which every animal performs in its life time. If an animal has to maximize its fitness than it cannot afford to move aimlessly or in a disorganized manner. Therefore, animals mainly move in order to acquire food, water, shelter, cover, and in search of mate etc (Pyke, 1983). Ishwaran (1981) stated that, in

dry conditions, swampy areas in the middle of tea are the only places that provide grass for elephants. Exposure of fresh grass due to receding levels of water under dry conditions and the adaptability of Asian elephants to feed on grasses as compared to African elephants. Seasonally, forage availability in natural vegetation habitats and presence of water and grass in tea seem to influence elephants' use of these habitats more frequently during hotter months of the dry season, which is similar to the patterns found in other studies (Bal et al, 2011; Kumar et al., 2010. However, in the wet season, elephants used agriculture habitat more frequently than in the dry season.

The movement of elephants to large grassy villous during wet season was influenced by the availability of food and the dry season movement was influenced by the permanent water source (Eisenberg and Lockhart, 1972). Better rainfall in the subsequent years may have had a positive impact on the regeneration of palatable species resulting in increased elephant use of their preferred habitat (natural vegetation) (De Boer et al, 2000).

Buss (1961) and Buechner et al. (1963) showed that elephants in and near Murchinson Falls National Park, Uganda, moved extensively into the woodlands during summer and savannas during the wet season, depending on the availability of shade, browse and water. Dublin (1996) observed a high preference to grassland habitat in the wet season and to browse habitat in dry season and concluded that forage quality is the determining factor in habitat choice. According to Graham et al. (2009) Coffee and Eucalyptus plantations act as important habitats in the plantation landscape of the Valparai plateau. The present also corroborates with this study as elephants use coffee and tea plantations as important habitats in Bitherkadu range.

Out of 1227 elephant individuals siged in Bitherkadu Forest Range, a greater number of elephants were sighted during the month of August (n=52) followed by May (n=46) and July (n=45). The study revealed minimum number of elephants sighted in the month of December (n=21). Elephants could potentially range outside PAs, survive in reasonable numbers in human dominated landscapes, and benefit from forest agriculture matrices, despite pressures associated with anthropogenic landscapes (Calabrese et al., 2017; Leimgruberet al., 2003; Madhusudan et al., 2015). However, space use by elephants is influenced by distribution of resources, vegetation type, changes in land use, and presence of human disturbance within in their distributional range (Hoare & Du Toit, 1999; Roever, van Aarde, & Leggett, 2012). However, in the absence of natural vegetation areas, such as forest fragments and monoculture refuges, elephants may be forced to increase their use of coffee, agriculture, and residential areas, which may intensify direct encounters between people and elephants and crop damages in the study region.

Solitary elephants were recorded more numbers of sightings than female led family herds in Bitherkadu Forest Range. Of which, Chelakunnu Velukkan (CT-2) was sighted highest numbers (n=41) followed by Bitherkadu Female -1 (Bk - 1) (n=8). It is very important to note that the above-mentioned individuals were frequently sighted during the year 2022. Spatial pattern of identified elephants' home range was varied among the each other's. The long home range elephant was recorded more (41.4 sq.km) in CT-2 (Cherambadi Tusker-2) followed by BKH-1 (Bitherkadu Herd-1) (20.5 sq.km). The other identified individuals of BK-1 (Bitherkadu Tusker -1) recorded as 11.6 sq.km respectively in Bitherkadu Forest Range of Gudalur Forest Division.

## III. Acknowledgment

We extend our sincere thanks to the Principal Chief Conservator of Forests and Chief Wildlife Warden for granting the necessary permissions to carry out our work. We also thank the District Forest Officer, Forest Range Officers, Forest Guards, Forest Watchers, Anti-Poaching Watchers, and Anti-Depredation Squads of the Gudalur Forest Division especially Bitherkad Forest Range for providing invaluable logistical support in the field during data collection.

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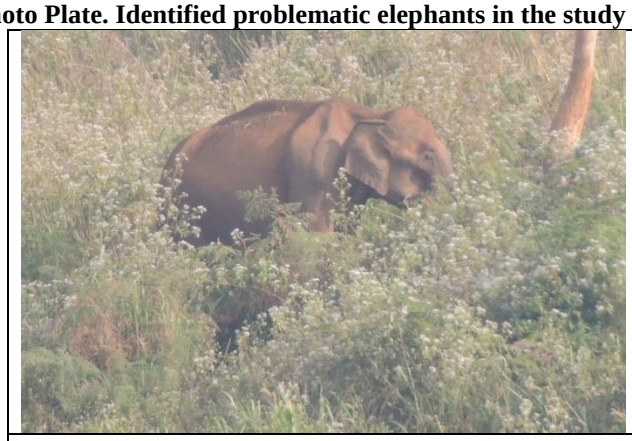
**Photo Plate. Identified problematic elephants in the study area**

|  |  |
|---|---|
| **BK-1** | **CT-2** |

**BKH**