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# POPULATION EVALUATION OF ASIAN ELEPHANT (*ELEPHAS MAXIMUS*) IN COMMERCIALLY EXPLOITED HABITATS OF MYANMAR.

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ABSTRACT

A study on the status of the Asian elephant (*Elephas maximus*) was initiated in Myanmar with the objective of preparing a conservation plan for elephants in selected locations of the country. Five forest reserves of the Bago Yoma (central Myanmar), seven forest reserves in Rakhine Yoma (western Myanmar) and Alaungdaw Kathapa National Park (AKNP) of northern Myanmar were the survey sites. The indirect method of estimating elephant density from the elephant defecation rate/day, dung decay rate/day, and dung density estimates was used. The estimated mean daily defecation rate/day was 20.0 for Bago Yoma, 19.0 for Rakhine Yoma and 23.0 for AKNP. The mean daily dung decay rate/day was 0.072, 0.005 and 0.009 for Bago Yoma, Rakhine Yoma and AKNP, respectively. The mean elephant density for Bago was 1.62 (95% CI = 1.49–1.75) and for Rakhine it was 0.05 (95% CI = 0.04–0.005) and for AKNP it was 0.6 (95% CI = 0.528–0.74). Elephant dung density and elephant density varied substantially for Bago Yoma and Rakhine Yoma Reserves. The estimated elephant density for both Bago Yoma and AKNP appear to be very high compared to the earlier surveys. For Bago the result could be due to a very high dung decay rate that may not be representative of the entire wet season or for regions outside the observation area. Sample size for some reserves was very low, hence, laying more transects is recommended for these reserves. Additional dung decay rate experiments, particularly during the wet seasons, and similar systematic surveys covering other regions of the country, are desirable.

Key Words: Habitat and population surveys, indirect census method, forest reserves

## INTRODUCTION

The Asian elephant (*Elephas maximus*) is a globally threatened species and its survival depends on maintaining viable habitats and understanding the population status of the species (SUKUMAR, 1989; SANTIAPILLAI & JACKSON, 1990). The current distribution of the species covers only a small portion of its earlier extensive range (SUKUMAR & SANTIAPILLAI, 1996).

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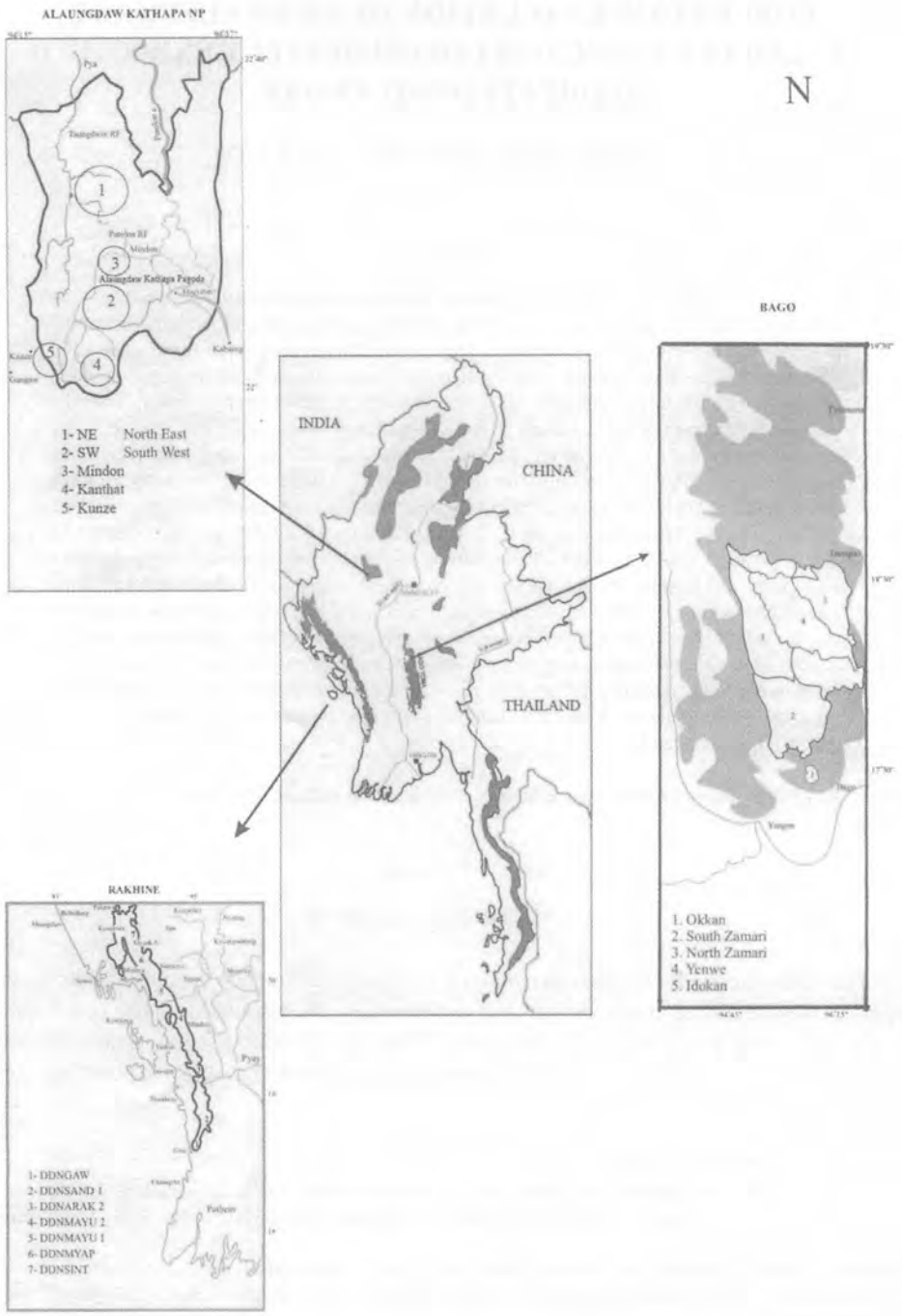


Figure 1. Location of the survey sites in Myanmar. The location of the survey sites are marked among the areas of the elephant distribution in the country.

In this context, after India, Myanmar has the largest remaining habitat and population of both wild and captive elephants. The captive elephant has always been considered the backbone of the country's economy as nearly 50 percent of all timber in Myanmar is still extracted by these elephants and about 3000 working elephants are needed for the timber industry (ZAW, 1998). To replenish captive stocks for timber extraction, elephants have been captured from the wild (SALTER, 1983; HTUT, 1993). Timber extraction has two negative effects on the status of wild elephants: viable habitats are disturbed through extensive logging operations, and there is a substantial decline of the wild elephant population. In 1972 the estimated elephant number for Myanmar was 6000, which was reduced to 3000 by late 1970s and it was predicted that the wild elephant population in Myanmar would decline by about 5% per year (CAUGHLEY, 1980).

Estimating elephant numbers and mapping their distribution thus becomes imperative, however, no systematic surveys or studies on wild elephants have been carried out in the regions of logging and elephant capture. There have been several attempts to estimate elephant numbers, but these have no scientific basis (HTUT 1993; SUKUMAR & SANTIAPILLAI 1996). Estimating elephant numbers is difficult as visibility within the forests is very poor and many of the forests are inaccessible. Most of the regions in this country are very remote, with rugged terrain, infested with malaria, and have few and very poor logistic facilities. However, these regions are very important due to the presence of globally threatened species (SALTER, 1983; IUCN, 1989; HTUT, 1993). Although Myanmar provides crucial habitat for Asian elephants, no scientific study or survey on the species has ever been undertaken. These aspects motivated us to conduct a status survey, population evaluation and preparation of a conservation action plan for the Asian elephant in commercially exploited habitats of Myanmar. This paper reflects the first ever scientific approach to study the elephants in this country and the findings should give scope for critical review of methods used and the results obtained.

## MATERIAL AND METHODS

### Survey Sites

The survey sites (Fig. 1) were Bago Yoma (17°–20° N, 96°–97° E), Rakhine Yoma (17°–21° N, 93°–95° E) and Alaungdaw Kathapa National Park – AKNP (22°–23° N, 94°–95° E).

The Bago, Rakhine and AKNP regions have very extensive tracts of hills situated in the central, western and northern regions of Myanmar, respectively. The hill ranges of Rakhine Yoma are a southward extension of the Himalayas. AKNP is in a well-forested mountainous region situated west of the lower Chindwin River and Myittha Valley. The average elevation of the Bago Yoma is about 700 m; the highest point is 900 m above sea level (asl). Rakhine Yoma, which runs for nearly 600 km, ranges from 100 to 1400 m asl and average elevation in AKNP is about 1000 m; steep slopes and narrow ridges characterize all regions. All have good drainage systems: the Pegu and tributaries of Yenwe Chaung, and the Kun Chaung are the major river sources in Bago Yoma. The Sandoway River (Sandoway Chaung) is the major river system in Rakhine. AKNP is drained by a number of tributaries of the Patolon River, Petpa Chaung and Taungdwin Chaung being perennial among them. In all these

regions, the wet season lasts from May to October and rainfall is heaviest in August and September. The annual rainfall for Bago averages 1700 mm, for Rakhine it is 1800 mm and for AKNP, 1500 mm. In all these regions, the vegetation is largely mixed deciduous forest, with semi-evergreen forests occurring in areas of high precipitation. Patches of evergreen trees consisting mostly of secondary growth occur in a few places.

Notable among the mammal species seen here are rhesus macaque (*Macaca mulatta*), hoolock gibbon (*Hylobates hoolock*), Phayre's langur (*Semnopithecus phayrei*), sambar (*Cervus unicolor*), barking deer (*Muntiacus muntjak*), hog deer (*Axis porcinus*), gaur (*Bos gaurus*), Tsaine (saing) or banteng (*Bos javanicus*) serow (*Naemorhedus sumatraensis*), elephant (*Elephas maximus*), Sumatran rhino (*Dicerorhinus sumatrensis*), Asiatic black bear (*Ursus thibetanus*), Malayan sun bear (*Ursus malayanus*), leopard (*Panthera pardus*), tiger (*Panthera tigris*) and Asian wild dog (*Cuon alpinus*) (common and scientific names based on CORBET & HILL (1992), YIN (1993), and MENON (2003).

## Current Habitat and Legal Status

All these regions have been subject to intensive management for logging during the past 130 years (SALTER, 1983; MYINT, 1994; TUN, 1997). Under sustainable management of forests since 1856, timber has been extracted and the system prescribed a felling cycle of 30 years in a felling series. Except in a very small part of a steep slope of Bago Yoma (UGA 1995), timber extraction has been carried out in all the regions. The 130 years of logging has had negative effects and in many places this disturbance, along with other human activities, has resulted in large areas being invaded by bamboo species. (SALTER, 1983; UGA, 1995).

Most of the regions have yet to evolve effective wildlife conservation and management programs. Out of the 16,000 km$^2$ area of Rakhine Yoma, only 1775 km$^2$ has been gazetted as Yakhine Yoma Wildlife Sanctuary, in 1997 (RAO *ET AL,* 2002; UGA, 1995). To preserve the pristine nature of the teak and other forests, a survey for declaring 1500 km$^2$ Bago Yoma Teak Nature Reserve was carried out in 1983, but the area has yet to be brought under legal protection or management. AKNP was legally gazetted as a wildlife sanctuary in 1984.

## Density Estimation

The indirect method of estimating elephant density (BARNES & JENSEN, 1987; DAWSON & DEKKER, 1992; SANTOSH & SUKUMAR, 1993) was followed for the survey. Based on village surveys and discussions with forest and Myanmar Timber Enterprise staff, the survey areas were divided into high, moderate and low elephant use areas. Line transects of indefinite width (BURNHAM *ET AL.*, 1980) were used for estimating dung density in 5 forest reserves of the Bago Yoma, 7 forest reserves of the Rakhine Yoma and 5 regions of AKNP. Line transects of indefinite width are used when animal densities are low, and the numbers recorded from fixed-width transects are assumed to be too low for meaningful statistical analyses (EBERHARDT, 1968)

Each transect was cut afresh using a field compass, a 50-m nylon rope and knife. The compass was used for fixing a straight line; the rope was to estimate the perpendicular distance from the line to the dung piles, and the total distance covered. The rope was also useful in assessing the topography and microhabitats at every 50-m interval. The total number of transects laid was 142 for Bago, 148 for Rakhine, and 22 for AKNP. The total length of

transects in a particular reserve within a region was roughly proportional to the total area of the reserve. For example Zamari reserve in Bago constituted 30% of total area of the reserves sampled for Bago and 25% of transects were laid in this reserve (Table 1). The same sample design was followed for other regions surveyed and lines were well distributed, covering different regions of the reserves sampled. In a given site, not more than 3 groups of workers operated for cutting transects and a minimum distance of 2 km was maintained between the two groups.

For each transect, the date of sampling, its location, vegetation type, topography, start and end times of survey and distance along the transect were recorded. The topography was recorded as small hill with slope, undulating terrain, flat land, and other types. The categories of vegetation types were: semi-evergreen forest, evergreen forest, moist upper mixed deciduous forest, and bamboo. The percentage of transects laid in each category of terrain and forest type roughly matched their overall percentages within a given region (Table 1). On sighting a dung pile during a transect walk, the perpendicular distance of the pile to the transect line was measured, and the condition of the dung pile was noted using the stages of decay prescribed by BARNES & JENSEN (1987).

For both Bago and Rakhine Yoma, a study of elephant defecation was carried out in elephant camps (observing 32 elephants at Bago and 57 at Rakhine), as these elephants feed only on natural vegetation from the surrounding forest areas. In total 1704 man-hours were spent for the defecation study. Fresh dung piles observed during the defecation study were marked for monitoring of decay rate, and a total of 100 dung piles were monitored in each region. For AKNP, data from available literature (MYINT, 1994) on these two parameters were used.

### Data Analysis

The density of dung piles, daily defecation rate and dung decay rate were estimated using an updated version of GAJAHA software (ARCHANA & SUKUMAR, 2006). The same program was also used to compute elephant density. Elephant density was estimated separately for each reserve, and for AKNP, the data of all regions were pooled, as the sample size of the dung piles for each region was very low.

The density ($E$) in elephants/km$^2$ was calculated using the formula:

$$E = Y \cdot r / D$$

where, $Y$ = density of dung piles/km$^2$, $r$ = dung decay rate/day, and $D$ = defecation rate/day.

## RESULTS AND DISCUSSION

Table 1 summarizes the information on the area of the reserves sampled, number and percentage of transects, their topography and microhabitat, distance covered, and the sample size of the dung piles for each reserve in Bago, Rakhine and different regions in AKNP. The results of dung density mean elephant density and mean elephant number for different regions surveyed are summarized in Table 2. The defecation rate for the wet season in Bago was 20.02/day (Standard Error SE = 0.55) and for Rakhine in the dry season it was 19.04/day (SE = 0.55). Overall decay rate for 100 fresh dung piles in Bago during the wet season was

Table 1. Forest reserves sampled, area, number and percentage of transects surveyed, their topography and microhabitats, distance covered and number dung piles recorded for Bago, Rakhine and AKNP regions.

| Regions | Name of Reserves | Area (km2) | % | No of transects | % | Topography along the transects | % | Forest types along the transects | % | Distance covered (km) | Dung piles recorded |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Bago | South.Zamari | 882 | 29.9 | 36 | 25.4 | Undulating | 35.2 | MUMD | 45.3 | 72 | 309 |
| | North Zamri | 714 | 24.2 | 35 | 24.6 | Hill with slope | 41.5 | SEG | 35.3 | 70 | 62 |
| | Yenwe | 795 | 26.9 | 36 | 25.4 | Flat land | 12.7 | EG | 12.9 | 72 | 122 |
| | Idokan | 521 | 17.6 | 23 | 16.2 | Ridges with valley | 0.0 | LMD + SEG | 3.6 | 46 | 105 |
| | Okkan | 40 | 1.4 | 12 | 8.5 | Small hill | 5.6 | MUMD + SEG | 2.2 | 23.5 | 60 |
| | | | | | | Undulating and steep slope | 4.9 | MUMD + EG | 2.9 | | |
| | **Total** | **2952** | | **142** | | | | | | **283.5** | **658** |
| Rakhine | DDNSAND 1* | 750.5 | 6.3 | 16 | 10.8 | Gentle slope | 13.5 | MUMD | 10.1 | 32 | 42 |
| | DDNARAK 2 * | 2600 | 21.9 | 70 | 47.3 | Flat land | 0.7 | EG | 33.8 | 140 | 108 |
| | DDNGAW * | 2600 | 21.9 | 20 | 13.5 | Hill with slope | 30.4 | SEG | 51.4 | 40 | 66 |
| | DDNMAYU 1* | 2652.8 | 22.4 | 12 | 8.1 | Undulating and steep slope | 47.3 | Others | 4.7 | 24 | 71 |
| | DDNMAYU 2 * | 1200 | 10.1 | 8 | 5.4 | Undulating | 8.1 | | | 16 | 36 |
| | DDNMYAP* | 1750 | 14.8 | 12 | 8.1 | | | | | 24 | 11 |
| | DDNSINT* | 307.2 | 2.6 | 10 | 6.8 | | | | | 20 | 20 |
| | **Total** | **11860.5** | | **148** | | | | | | **296** | **354** |
| AKNP | South-west | | | 6 | 27.3 | Undulating | 45.5 | BAM | 43.5 | 12 | 36 |
| | North-west | | | 4 | 18.2 | Gentle slope | 27.3 | MUMD + BAM | 23.5 | 8 | 0 |
| | Mindon | | | 4 | 18.2 | Undulating and steep slope | 13.6 | RF + BAM | 14.1 | 6 | 0 |
| | Kunze | | | 4 | 18.2 | Steep slope | 4.5 | RF | 1.2 | 8 | 0 |
| | Kanthat | | | 4 | 18.2 | Ridges with valley | 9.1 | EG | 5.9 | 8 | 0 |
| | | | | | | | | MUMD | 11.8 | | |
| | **Total** | **1606** | | **22** | | | | | | **42** | **36** |

*Part of Thandwe Reserved Forest (DDNSAND1), Sabyin & Mindon (DDNARAKAN2), part of Gwa Reserved Forest (DDNGWA), north of May Yu Reserved Forest (DDNMAYU1), south of May Yu Reserved Forest (DDNMAYU2), part of Miva Pya (DDNMYAP) and part of Sin Tanung Reserved Forests (DDNSINT).
BAM (Bamboo), MUMD + BAM (Moist Upper Mixed Deciduous and Bamboo), RF + BAM (Riverian Forest and Bamboo), RF (Riverian Forest) EG (Evergreen forest) MUMD (Moist Upper Mixed Deciduous), SEG (Semi Evergreen forest).

Table 2. Elephant density estimates for different reserves in Bago, Rakhine and AKNP.

| Region | Reserve | Dung density (SE) | Mean elephant density (95% CI) | Mean number of elephants (95% CI) |
|---|---|---|---|---|
| Bago | South Zamari 1 | 1380 (98.2) | 4.95 (4.65–5.26) | 542 (504–576) |
| | South Zamari 2 | 121 (28.6) | 0.43 (0.37–0.51) | 70 (59–82) |
| | South Zamari 3 | – | – | – |
| | North Zamari | 151 (21.6) | 0.54 (0.49–0.60) | 388 (349–426) |
| | Yenwe | 300 (30.6) | 1.07 (0.98–1.16) | 852 (781–922) |
| | Idokan | 361 (42.2) | 1.29 (1.18–1.42) | 675 (613–737) |
| | Okkan | 392 (59.2) | 1.41 (1.25–1.56) | 56 (50–62) |
| | | | Mean 1.62 (1.49–1.75) | Total 2583 (2433–2805) |
| Rakhine | DDNSAND 1 | 132 (22.4) | 0.03 (0.03–0.04) | – |
| | DDNARAK 2 | 71 (8.9) | 0.02 (0.01–0.02) | – |
| | DDNGAW | 165 (20.3) | 0.04 (0.04–0.05 | – |
| | DDNMAYU 1 | 452 (66.0) | 0.17 (0.12–0.14) | – |
| | DDNMAYU 2 | 225 (37.5) | 0.06 (0.05–0.07) | – |
| | DDNMYAP | 27 (21.5) | 0.01 (0.00–0.01) | – |
| | DDNSINT | 83 (18.6) | 0.02 (0.02–0.03) | – |
| | | | Mean 0.05 (0.04–00.5) | Total 722 (686.4–758.7) |
| AKNP | AKNP | 1633.8 (375.8) | 0.64 (0.52–0.74) | – |

0.072/day (SE = 0.0035) and for Rakhine during the dry season, 0.0057/day (SE = 0.0000). The mean defecation rate was 23.0/day (SE = 1.5) and the mean decay rate of dung piles were 0.0090/day (SE = 0.001) for AKNP (MYINT, 1994).

In Bago, for a 285 km transect survey with a dung encounter rate of 2.4/km, the elephant density varied from 0.4 to 5 elephants/km$^2$ and an average density of 1.6 elephants/km$^2$ (95% Confidence Interval CI = 1.4–1.7 elephants/km$^2$) could be estimated for all the regions surveyed in Bago. The elephant survey in Rakhine is based on a 300-km transect survey with a dung encounter rate of 1.2/km. The density estimates for different regions in Rakhine varied from 0.008 to 0.2 with an average density of elephant for all the regions surveyed being 0.05 elephants/km$^2$ (95% CI = 0.04–0.06). For AKNP, a density of 0.61 elephants/km$^2$ (95% CI = 0.5–0.7) was estimated through a 50-km survey with a dung encounter rate of 0.85/km. The encounter rate of dung piles indicated that the elephants were found to be using only the southwest regions of the park.

For Bago, estimated mean density (2/km$^2$) and number (2600) appear to be very high. Considering the amount of logging and other disturbances (SALTER, 1893; HTUT, 1994), and also the numbers presented for Bago (MYINT, 1994), only 300 elephants could be expected for the regions surveyed. Earlier observation of MYINT (1994) also suggests that the density

estimated during the current study of Rakhine to be acceptable. For a habitat area of 16,000 km$^2$ in Rakhine, MYINT (1994) estimated 750 elephants. Although the habitat is disturbed by logging and other activities, the relatively low human population density, inaccessibility, and large and contiguous forest cover offer some hope for the conservation and management of elephants in Rakhine.

For AKNP, the overall elephant dung encounter rate was 0.8/km (varying between 0 and 3/km) and most other regions surveyed had no dung along the transects. MYINT (1994) estimated a density of 0.09 elephants/km (95% CI = 0.04–0.15) for AKNP and our density estimate of 0.61 is six times higher than the earlier estimate. As observed by MYINT (1994), it is likely that elephants do not use some of the regions of the park and the estimated density thus cannot be extrapolated for the entire park. The lack of sightings or low density of elephants could be due to logging in the past, other disturbances, and distribution of food and other resources. Only 20% of locations surveyed had elephant dung piles, and if the density estimates are extrapolated to only a small portion (say 10 to 20%) of AKNP, only 100 to 190 elephants would be predicted for the park.

Many other reasons also could be identified for the high density of elephants in some of the reserved surveyed. Two extreme dung decay rates were found for the dry and the wet seasons. The dung decay rate was high during the wet season, but low or slow in the dry season. If the decay rate of the old dung piles is very slow but fresh dung disappear faster then the old during the wet season, some of the old dung piles from the dry season would also remain in the wet season and increase the dung density, resulting in over estimation of density.

As this is the first scientific study of its kind in Myanmar, comparative figures on population density are not available from anywhere in the country. However, it is important to mention that the encounter rates of dung piles are relatively lower than reported for some of the elephant habitats in India. The encounter rate of dung piles/km was 0.14–1.1 times that of elephant habitats in India for Bago, 0.07–0.59 that in Rakhine, and 0.05–0.44 that in AKNP. Considering the encounter rate of dung piles/km and density estimates of the elephant habitats in India, and incorporating the elephant dung encounter rate/km of the regions surveyed in Myanmar, a density range of 0.1–0.3 elephants/km$^2$ for Bago, 0.05–0.13 elephants/km$^2$ for Rakhine and 0.03–0.1 elephants/km$^2$ for AKNP would result (Table 3).

Table 3: Comparison of results across elephant habitats in India and Myanmar

| Name of region | Encounter rate of dung/km | Estimated density (km–2) |
|---|---|---|
| **India:** | | |
| Mudumalai Wildlife Sanctuary, southern India | 15.7 | 1.74 |
| Buxa Tiger Reserve, west Bengal | 8.7 | 0.35 |
| Kalakadu Mundanthurai Tiger Reserve, southern India | 2.0 | 0.2 |
| Myanmar: | | |
| Bago Yoma | 2.3 | 1.61 |
| Rakhine Yoma | 1.2 | 0.051 |
| AKNP | 0.9 | 0.6 |

[1] Mean elephant densities

Figure 2. Logging operation.

Figure 3. Logging operation.

Figure 4. Remnants of the logging operation.

Figure 5. Current status of the habitat.

Figure 6. Current status of habitat.

Figure 7. Training program for the saurvey.

Figure 8. Clearing a path for transect survey.

Figure 9. Transect survey.

Figure 10. Camp move for the survey.

Figure 11. Decay rate experiment.

## Recommendations for Population Survey Based on the Management Plan

As mentioned earlier, wild elephants are being captured to replenish captive stocks for timber extraction and it is not known what effect this capturing has on the wild elephant population. Given this, the first and foremost conservation strategy for the country should be to determine the number of elephants in the wild.

Reliable surveys will be possible only when suitable methods of estimating numbers are available or the existing methods are reviewed and their applicability is well investigated. After achieving this goal, population estimation should seek to identify regions of high, moderate and low elephant density or usage within the country.

Through our efforts, only a small proportion of the country has been surveyed and a few personnel have been trained. More regions need to be explored for population estimation and capacity building and the knowledge gained through these approaches should be reviewed periodically for more effective use.

The results for Bago appear to overestimate of the density and the number of elephants, which could have been due to the rapid decay rate of the dung piles. The decay rate results could be biased and not representative of regions outside the reserves which were surveyed. The results could also be influenced by the fact that the surveys were carried out in the wet season. One way to overcome this problem is to carry out a series of decay rate experiments spread over the wet months and get a more realistic mean rate of decay. It may also be better to avoid carrying out censuses during the wet season and confine these entirely to dry months when the variation in dung decay rates can be expected to be substantially lower.

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