RESEARCH NOTES
(I)

DETECTION FUNCTION MODELS FOR INDIRECT EVIDENCE OF ELEPHANT AND GAUR

Evidences left by animals are a sure means to detect their presence. Sometimes such signs are successfully used for estimating the density of animal populations (Barnes and Jensen, 1987; Varman *et al.*, 1995). In any case, accurate estimation of the density of indirect evidences will be the first step involved. Other than plot or strip sampling, quite often line transect methods are used for the purpose. As usual, the problem of identifying an appropriate detection function model arises in utilizing the data obtained through line transect sampling. An attempt is made here to identify a suitable model for detection function for data on dung piles obtained through line transect sampling in the case of Elephant *(Elephas maximus)* and Gaur *(Bos gaurus)*.

Data collected during the course of the wildlife census conducted in the State of Kerala in April 1997 were used for the present study. The total forest area was divided into small blocks of about 6 km^2 on an average, utilizing Survey of India maps. The total number of such blocks in the State was, 1506. The actual size of the blocks varied from 1 to 28 km^2. These blocks formed the basic sampling units. About 36 per cent of the blocks in each Forest Division were selected for the survey through simple random sampling without replacement. In each selected block, a transect of 2 km was laid out and perpendicular distance to dung piles of Elephant and Gaur was measured using a tape. The dung piles were noted as belonging to three stages *viz.*, (i) fresh and moist, (ii) old and dry, and (iii) very old. The data pertaining to the first two stages of dung piles were utilized for the present study.

Before proceeding with the estimation of dung density, the blocks were post-stratified as belonging to different vegetation types as follows. In each of the selected blocks, visual estimation of percentages of area belonging to different forest types were made. Cluster analysis was carried out utilizing these data and the cluster membership of each block was found out. For the cluster analysis, the distance measure used was squared Euclidean distance and the clustering distance and the clustering method used was Average linkage between groups (Norusis, 1988). The different clusters identified were predominantly (I) evegreen (II) moist deciduous (III) dry deciduous and scrub (IV) plantations (V) shola and grassland. The block level data were pooled for each vegetation type and the combined density of dung belonging to fresh and old stages was estimated using programmes SIZETRAN (Drummer, 1991) and DISTANCE (Laake *et al.*, 1994) for each vegetation type. The total transect length sampled for clusters I, II, III, IV and V were 371.30, 144.89, 184.99, 149.35 and 54.72 km respectively.

The dung density estimate and coefficient of variation obtained for Elephant and Gaur are given in Tables 1 and 2. The models used were Fourier Series, negative exponential, half normal and hazard cosine. In the case of Elephant, least coefficient of variation (CV) was obtained with the Fourier series model in the first four clusters viz., evergreen, moist deciduous, dry deciduous and scrub and plantations. In the fifth cluster (shola and grassland), half normal model had the least CV. In the case of Gaur, the least CV was obtained for Fourier Series model in cluster I and cluster IV. In cluster II,III and V least CV was obtained for half normal distribution.

Table 1

Density estimate and coefficient of variation obtained for different detection function models in the case of Elephant dung

Model	CL I	CL II	CL III	CL IV	CL V
Fourier Series	90.58 (4.01)*	362.61 (6.90)*	172.41 (6.94)*	299.25 (9.17)*	177.56 (19.02)
Negative exponential	218.51 (5.53)	486.77 (7.46)	267.46 (8.94)	346.35 (9.00)	215.85 (18.73)
Half normal	61.22 (6.78)	246.62 (9.15)	109.29 (10.96)	183.76 (11.03)	125.36 (16.26)*
Hazard consine	252.01 (5.93)	345.67 (7.76)	241.88 (9.54)	283.98 (10.00)	163.92 (21.67)

Table 2

Density estimate and coefficient of variation obtained for different detection function models in the case of Gaur dung.

Model	CL I	CL II	CL III	CL IV	CL V
Fourier Series	59.83 (8.58)*	107.45 (23.92)	105.78 (16.49)	157.19 (12.89)*	129.51 (22.21)
Negative exponential	87.97 (10.51)	130.86 (17.68)	100.34 (15.81)	195.02 (13.67)	126.16 (23.26)
Half normal	40.27 (12.89)	78.32 (15.40)*	47.42 (13.71)*	106.48 (16.77)	67.73 (20.21)*
Hazard consine	63.30 (10.87)	443.06 (33.78)	316.68 (25.43)	154.24 (15.77)	124.30 (31.00)

Out of the four models tried, Fourier series is the most flexible model which can be made to fit a wide range of shaped for the detection function. It belongs to the class of non-parametric models and possesses several robustness properties (Burnham *et al.*, 1980). Since it has shown good resulsts in the case of both Elephant and Gaur in most of the vegetation types considered here, it is recommendable as a detection function model to be used for estimating dung density in the case of these two species.

References

Barnes, R.F.W. and K.L. Jensen (1987). How to count elephants in forests. IUCN *African Elephant and Rhino Specialist Group, Technical Bulletin,* **1** : 1-6.

Burnham, K.P., D.R. Anderson and J.L. Lakke (1980). Estimation of density from line transect sampling of biological populations. *Wildlife Monograph,* **72**.

Drummer, T. D. (1991). SIZETRAN : Analysis of size-biased line transect data. *Wildlife Soc. Bull.,* **19**, 117-118.

Laake, J.L., S.T. Buckland, D.R. Anderson and K.P. Burnham (1994). *Distance User's Guide Version 2.1.* Colorado Cooperative Fish and Wildlife Research Unit, Colorado State University, Fort Collins.

Norusis, M. J. (1988). *SPSS/PC + Advanced Statistics Version 2.0. for the IBM PC/XT/AT and PS/2.* SPSS Inc., Chicago.

Varman, K. S., Uma Ramakrishnan and R. Sukumar (1995). Direct and indirect methods of counting elephants. A comparison of results from Mudumali Sanctuary. *A Week with Elephants (International Seminar on Asian Elephants).* Bombay Natural History Society, Mumbai. pp. 331-340.

K.A. Mercey*
and
K. Jayaraman**

* Assistant Professor (Statistics), College of Veterinary and Animal Sciences, Mannuthy, Thrissur, (Kerala)
** Scientist-in-Charge, Division of Statistics, Kerala Forest Research Institute, Peechi, Thrissur (Kerala).