DENSITY, GROUP SIZE AND SEX RATIOS OF GAUR (*BOS GAURUS* H. SMITH) IN A SUB-TROPICAL SEMI-EVERGREEN FOREST OF NORTH-EAST INDIA

S. DASGUPTA*, K. SANKAR AND A.K. GUPTA**

Wildlife Institute of India,
Chandrabani, Dehra Dun (Uttarakhand).

Introduction

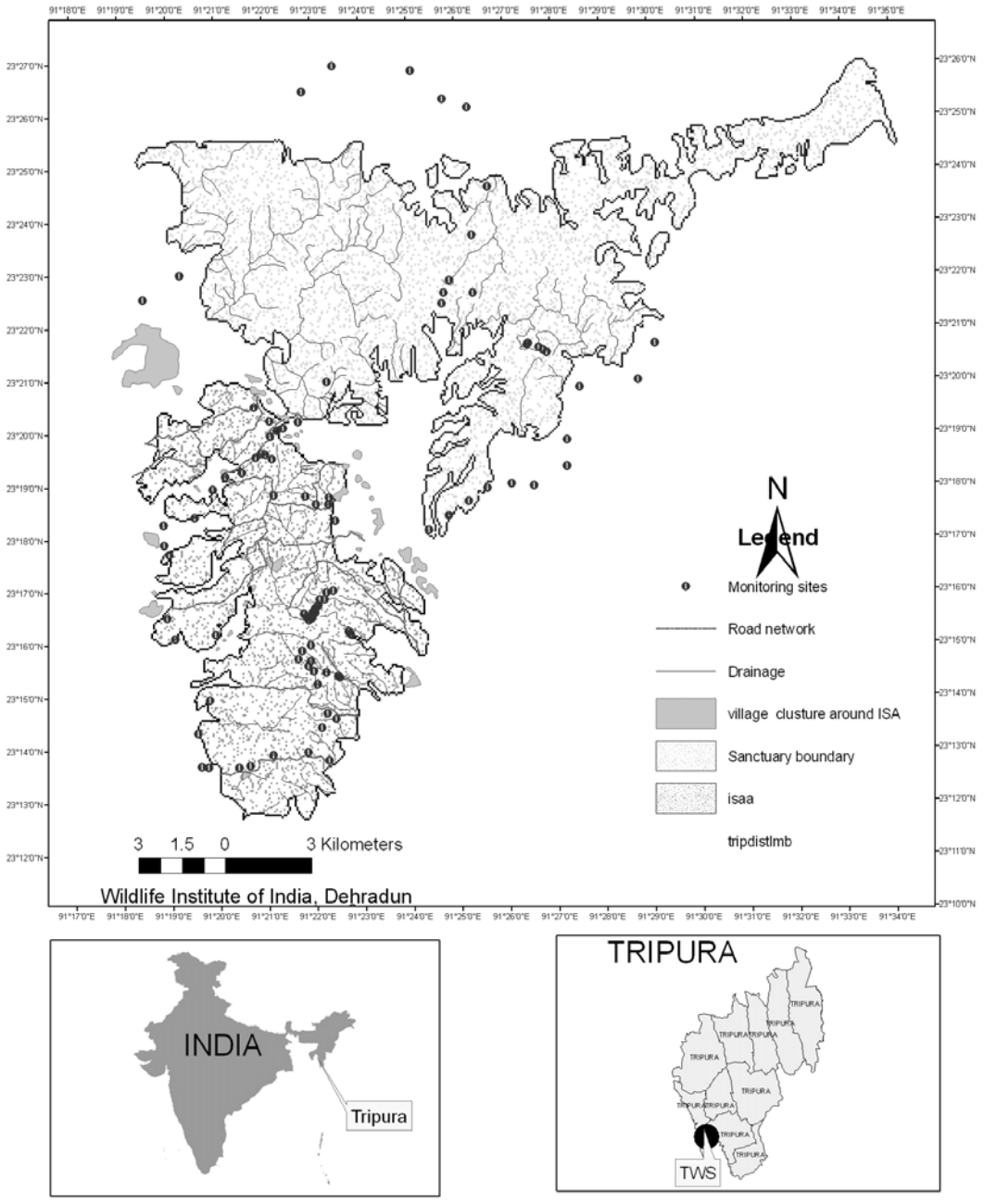
The Gaur (*Bos gaurus gaurus*) commonly referred as the 'Indian bison', belongs to the sub-family Bovinae of the order Artiodactyla. It is the largest living bovine confined to the oriental biogeographic region of the world. The gaur population in India occurs in more or less isolated pockets, largely corresponding to the major mountain systems of the Western Ghats, the Central Indian highlands and North-eastern Himalayas (Schaller, 1967). As diverse as their distribution, their habitats range from bamboo forests in the North-East to dry deciduous in Central India to moist deciduous in the Western Ghats. In Tripura, gaur is found only in the southern part of Trishna Wildlife Sanctuary (TWS). It had however had been previously reported from the Gumti Wildlife Sanctuary situated in the North-East part of the State (A.K. Gupta, pers. com.).

Study Area

The study was carried out between November 2002 and July 2004 in the Trishna Wildlife Sanctuary (194.708 km , 23° 12' - 23° 32' N lat. to 91° 15' - 91° 30' E long.) situated in the South-western end of Tripura State (Fig. 1). This protected area is the last home for the gaur in the state. Trishna Sanctuary falls in 8B Assam Hills Province of North-East India (Anon., 1996). As per revised classification of Champion and Seth (1968), the forests of TWS can be grouped into Northern Tropical Semi-Evergreen forests (2B), Eastern Bhabar Sal forests (3C/C1b) and East Himalayan Moist Mixed Deciduous Forest (3C/C3b). The area is hilly to undulating, marked by low hillocks barely 8 m to 35 m amsl, cut by constricted valleys. The drainage in the northen parts of the sanctuary is towards West and South and in the southern part of the region it is towards East and West both. There are many rivulets in the area which flow through and out into Bangladesh. The soil is deep and usually fertile. The soil in the undulating hillocks and hill ranges are mostly porous well drained sandy loam while the soil of the undulating small hillocks in the western part adjoining Bangladesh are more lateritic, characterized by red soil (Anon., 1996). The area receives heavy rains (2,400 mm annual) but these are well distributed throughout the year. Approximately 63% of the total annual precipitation is received

*Lecturer, Department of Forestry, HNB Garhwal University, Srinagar (Garhwal) (Uttarakhand).
**Chief Conservator of Forests, Tripura Forest Department, Agartala (Tripura)

Fig. 1



Study area map showing monitoring sites and boundary of TWS.

between June and September. The month of June is generally the hottest month (max. 40°C) and January happens to be the coldest (min. 5°C) (Dasgupta, 2006). The ground flora of the area is represented by 96 plant families.Table 1 describes the characteristic features of the vegetation in TWS.

Table 1

Major habitat and vegetation types identified in Trishna Wildlife Sanctuary.

Habitat Type	% area	Dominant/Characteristic species composition
1	2	3
Moist deciduous forest	26.77	*Terminalia bellirica, Aglaia spectabilis, Dillenia pentagyna, Canarium strictum, Syzygium cumini, Ficus* sp., *Eupatorium odoratum* etc
Mixed diptero-carpus forest	16.56	*Shorea robusta* and *Dipterocarpus turbinatus*
Highly degraded sal forest	9.67	*Shorea robusta, Syzygium caarasoides, Litsea* sp., *Stereospermum personatum, Garuga pinnata* etc.
Mixed bamboo forest	8.92	*Ficus* sp., *Stereospermum personatum, Artocarpus lakoocha, A. chana, Terminalia chebula, Schima wallichii, Ficus glomerata, Micromelum integerrimum, Holarrhena antidysentrica, Actino-daphne obvata, Bombax ceiba, Careya arborea, Albizia procera, Lagerstroemia parviflora, Lannea coromandelica, Grewia viminea, Pterospermum acerifolium, Bridelia retusa, Randia* sp., *Trevelia palmata* etc
Bamboo brakes	8.29	*Oxytenanthera nigrociliata*, typical ground flora of the area are *Eupotarium odoratum, Mallotus philippensis, Alstonia scholaris, Grewia viminea, Mimosa pudica, Vitex negundo, Ageratum conyzoides, Macaranga denticulata* etc.
Clearfelled/ Jhumed/open forest	3.26	*Garuga pinnata, Ficus semicordata, Callicarpa arborea, Macaranga denticulata, Saccharum narenga, Eupatorium odoratum, Mallotus* sp., *Albizia procera, Shorea robusta, Duabanga grandiflora, Blechnum orientale, Butea parviflora, Thysanolaena maxima, Millettia pachycarpa, Clerodendrum viscosum, Malocanna bambu-soides, Entada phaseoloides, Cucurbitaceous climber, Musa elongata Arundo donax, Themeda caudata, Apluda mutica, Saccharum fallax*.
Water body associated vegetation	0.68	*Elaeocarpus rogosus, Callicarpa arborea, Lagerstroemia speciosa, L. parviflora, Eurya japonica, Turponia ponifera, Sterculia villosa, Psychotria* sp., *Styrax serrulatum, Mangifera sylvatica*, and several *Ficus* sp.

Contd...

1	2	3
Crop fields/ agriculture land	6.59	*Imperata cylindrica, Dentella repens, Centella asiatica, Fimbristylis* sp., *Dysophylla* sp., *Limnophilla heterophylla, Digitaria adscendens, Brachiaria distachya, Marsilea minima, Oxalis corniculata, Eragrostis tenella, Paspalum scrobiculatum, Cynodon dactylon, Evolvulus alsinoides, Monochoria* sp., *Borreria articulata, Torenia edendula* etc.
Habitation/ home garden	1.99	*Areca catechu, Cocos nucifera, Artocarpus chaplasa, Citrus melo, Syzygium cumini, Artocarpus integrifolia, Psidium guajava, Mangifera indica, Musa paradisiaca, Anacardium occidentale, Phoenix sylvestris, Carica papaya, Gmelina arborea, Ziziphus mauritiana, Cinnamomum tamala, Bambusa clump, Aegle marmelos, Acacia auriculiformis, Delonix regia, Ananas comosus, Vitex negundo, Litchi chinesis, Tectona grandis, Ficus hispida* etc.
Barren land	0.01	-----

Though there is no human habitation inside the Sanctuary, there are encroachments of forestlands by local people at places. There are about 41 villages located at the periphery of the TWS. The estimated human population around the park is approximately 1,00,000 (Anon., 1996). The main occupation of local people is agriculture and animal husbandry. Large number of brahmani cattle (*Bos indicus*) (about 550000 cows) and goats are being kept by local people (Anon., 1996).

After the preliminary survey of TWS, the southern part of TWS having majority of the gaur and primate population was selected as Intensive Study Area (ISA). The total area of ISA in the GIS domain is 76.6 km . There are 28 villages around 5 km outside buffer of the ISA. The ISA is traversed by two major roads, one connecting Rajnagar and Radhanagar, and second connecting Kasari and Teendepha. Apart from these two major motorable roads, vast road network exists in the northern part of the ISA. At present ISA has five major artificially created lakes spread over the area. Three of these lakes fall on the ecotourism zones and are accessible to tourists (Dasgupta, 2006).

Material and Methods

Transect method (Buckland *et al.,* 1993; Burnham *et al.,* 1980; Eberhardt, 1968) was used to determine the abundance of gaur in the ISA. Six (6) permanent line transects (2 to 3.2 km) covering all major vegetation types were monitored between November 2002 and July 2004. Each transect was walked at least six times in a season (summer and winter). The following parameters were recorded along the transect :

(a) time of sighting,
(b) initial indication to detection,
(c) segment of the transect,
(d) sighting angle (by compass), sighting distance (by range finder or ocular estimation if line of sight is obstructed by plant canopy),
(e) group size and
(f) sex and age class of the individuals.

The entire ISA was surveyed once at the end of each season for the presence-absence information and was plotted in species-specific grid to estimate the area used by gaur in that particular season. Areas inside ISA with different groups were surveyed in a block of 5 to 6 consecutive days. The group structures of gaur were tabulated for each season. The mean group size in each season was estimated and subjected to ANOVA and Tukey's – HSD test (Zar, 1984). The typical group size of gaur was calculated following Jarman's (1974) guidelines. Line transect data could not fulfill the minimum number of sightings required to use DISTANCE programme, hence data from the line transect surveys were analysed by using transect width after getting average visibility of each transect to calculate ecological density and then the results were compared with the seasonal total count.

Mean group size of gaur was obtained from the seasonal total counts. Mean group size and its standard error were estimated, seasonally, in different habitat types. For comparing group densities, percentage of observed groups in different category based on group size was determined. One-way analysis of variance (ANOVA) (Sokal and Rohlf, 1981) using Tukey's – HSD test was done to test whether the mean group as well as individual density differed among the different seasons and habitats.

With an assumption that the proportion of age-sex classes in the population does not differ within a habitat, information collected during line transect, *ad libitum* sightings and opportunistic sampling were used for classifying gaur. Two-way analysis of variance (ANOVA) in a randomized block design, using seasons and habitat as a block, was used to test whether the arc-sine transformed proportions (Sokal and Rolf, 1981) of age-sex classes for each species differed in different habitat types. The point estimates were derived from the seasonal total counts of gaur. Mean biomass density of gaur was estimated for ISA in kg km^{-2}. Mean biomass density was derived by multiplying mean ecological density (D) by its average unit weight which was estimated from published data on body weights (Sankar *et al.,* 2001) and population structure data from the present study.

Results and discussion

Overall mean (±SE) group density of gaur in the study area was found to be 1.5 ± 0.3 per km , whereas the individual density was found to be 5.9 ±1.4 per km . This findings of group density of gaur in Mudumalai Wildlife Sanctuary was 0.84 ± 0.13 per km , whereas individual density was reported as 4.94 ± 1.3 per km (Sankar *et al.,* 2001).

During winter 2002-03, group and individual density (mean ± SE) of gaur was estimated to be 2.2 ± 0.7 groups/km and 6.8 ± 3.0 individuals/km respectively. Second season onwards the group density remained almost constant but there was a fluctuation in the individual density (Table 2). Tukey's test showed that group density as well as individual density of gaur did not vary significantly when compared between winter ($df=1$, $F=1.14$, $p=0.288$) and summer ($df=1$, $F=0.60$, $p=0.439$). There was no significant difference observed either for group density ($df=3$, $F=0.58$, $p=0.627$) or individual density ($df=3$, $F=0.21$, $p=0.890$) for different sampling season. However, across six different habitats (as described in methods) significant difference was observed in both

Table 2

Seasonal variation of gaur density in Trishna Wildlife Sanctuary, Tripura (Intensive Study Area) (2002 to 2004).

Season	No. of sightings	Group density (group/km) (Mean±SE)	Individual density (Individuals/km) (Mean±SE)
Winter 2002-03	N=35	2.2 ± 0.7	6.8 ± 3.0
Summer 2003	N=39	1.1 ± 0.5	4.5 ± 2.5
Winter 2003-04	N=39	1.5 ± 0.6	7.3 ± 3.3
Summer 2004	N=37	1.1 ± 0.5	5.1 ± 2.9
Overall	N=150	1.5 ± 0.3	5.9 ± 1.4

group (df=5, F=5.25, p=0.001) as well as individual densities (df=5, F=4.50, p=0.001).

Group size of gaur ranged between 2 and 14 in the study area. There was a clear seasonal variation in the group size and was estimated to be 4.6 animals (SE =0.26) during winter and 3.1 (SE =0.51) animals during summer. No bachelor herds were observed in any seasons, though solitary black bulls were seen (n=19) in the ISA. A total of 113 groups sighted during the study period pooled together gave an estimate of 4.0 (mean) individuals in a group with standard error of 0.21. Group size of gaur in Pench Tiger Reserve, Madhya Pradesh ranged between 2 and 9, in Kanha between 2 and 40 (Schaller, 1967) and in Palamau between 5 and 7 (Sahai, 1972). Russell (1900) reported a herd size to contain 10 to 20 animals, Brander (1923) 8 to 12 and Sanderson (1912) about 12 but occasionally as many as 30 to 40 and, rarely 100. Group size of gaur in Mudumalai Wildlife Sanctuary was reported as 5.8 ± 1.18 (Sankar *et al.,* 2001).

A total of 613 individuals from 107 groups were classified into different age and sex categories. The ratio of bulls and cow in winter was 56 : 100 and in summer it was 61 : 100. Observed overall sex ratio (bulls : cow) was 58 : 100. There was seasonal variation observed in the cow : calf ratio between winter and summer. The cow : calf ratio dropped from 100 : 27 in summer to 100 : 9 in winter. Study in PTR reported overall sex ratio of gaur as 60 bulls : 100 cows and the cow : calf ratio were 100 : 24 (Sankar *et al.,* 2001). In calculation of the proportion of age and sex classes of gaur population in TWS, the adult female represented 42.8% of the population followed by sub-adults (29.4%), adult males (24%) and calves (3.8%).

Conclusion

The density of gaur in TWS did not show significant changes during the study. However, there is an urgent need to ensure the protection of present habitat in TWS to avoid the chance of direct removal of the individual as well as the chance of

epidemics from cattle. Group size and sex ratio of gaur observed in TWS is comparable with any of the population so far reported from India and thus can be seen as a potential population for the long term conservation.

Acknowledgements

The authors thank the Tripura Forest Department and the officers of the TWS for extending logistic support during the field work. Gratitude is due to the Director and Dean, Wildlife Institute of India, for their support and guidance provided to complete this study under the project on 'Endangered Mammals of TWS'.

SUMMARY

The study on status and distribution of gaur was carried out in Trishna Wildlife Sanctuary (TWS), Tripura between 2002 and 2004. The density of gaur was found to be 1.5 groups per km² and 5.9 individuals per km². The group size of gaur ranged between 2 and 14 and the observed overall sex ratio (Bulls : Cow) was 58 : 100. Gaur density in TWS remained without any significant change and thus showed that the population is not facing any immediate threat, if not removed directly by poaching, hunting or epidemics. Group size and sex ratio of gaur observed in TWS is comparable with any of the population so far reported from India and thus can be seen as a potential population for the long term conservation.

Key words **: Gaur (*Bos gaurus* H. Smith), Density, Group-size, Sex-ratio, Sub-tropical semi-evergreen forest, Trisha Wildlife Sanctuary, Tripura, India.**

उत्तरपूर्वी भारत के उपोष्ण अर्द्ध–सदाहरित वनों में गौर (*बौस गौरुस* एच० स्मिथ) का घनत्व, समूह–आकार और लिंग अनुपात

एस० दासगुप्त, के० शंकर व ए०के० गुप्त

सारांश

गौर की स्थिति और उसके वितरण का यह अध्ययन 2002 और 2004 के मध्य तृष्णा वन्यप्राणि अभयारण्य में सम्पन्न किया गया। यहां गौर की सघनता 1.5 समूह प्रति किमी² तथा 5.9 प्राणी प्रति किमी² पाई गई। गौर समूह का आकार 2 से 14 प्राणियों तक का तथा लिंग अनुपात (नर : मादा) 58 : 100 रहता पाया गया। तृष्णा अभयारण्य में गौरों की सघनता में कोई खास परिवर्तन होते नहीं देखा गया जिससे स्पष्ट हुआ कि इनकी संख्या को तत्काल कोई संकट नहीं है यदि चोर शिकार, आखेट या महामारी फैलने से ही इन्हें समाप्त न होना पड़ जाए। तृष्णा अभयारण्य में लक्षित इनके समूह का आकार और लिंग अनुपात उतना ही है जितना अन्य संख्याओं में भारत में कहीं से भी सूचित किया गया है और इसलिए दीर्घकालिक संरक्षण के लिए इसे संभवनापूर्ण संख्या की तरह देखा जा सकता है।

References

Anon. (1996). *Management Plan of Trishna Wildlife Sanctuary*. Govt. of Tripura, Agartala.

Brander, A.D. (1923). *Wild animals in Central India*. Edward Arnold Co., London.

Buckland, S.T., D.R. Anderson, K.P. Burnham and J.L. Laake (1993). *Distance sampling: Estimating abundance of biological populations.* London: Chapman & Hall.

Burnham, K.P., D.R. Anderson and J.L. Laake (1980). Estimation of density from the transect sampling of biological populations. *Wildlife Monographs*, **72** : 1-202.

Champion, H.G. and S.K. Seth (1968). *Revised classification of forest types in India.* Manager of Publications, GoI, Delhi.

Dasgupta, S. (2006). Conservation ecology of endangered diurnal primates and gaur in Trishna Wildlife Sanctuary, Tripura. *Ph.D Thesis*. FRI DU, Dehra Dun.

Eberhardt, L.L. (1968). A preliminary appraisal of line transect. *J. Wildlife Management*, **32**: 82-88

Jarman, P.J. (1974). The social organization of antelope in relation to their ecology. *Behaviour*, **48**: 215-220.

Krishnan, M. (1972). An ecological survey of mammals in India. The Gaur. *J.Bombay Nat. Hist. Soc*.. **69**(2): 322-349.

Russel, C. (1900). *Bullet and shot in India forest*. Plain and Hill, London.

Sahai, R.C. (1972). Distribution, Composition and herd size of gaur (*Bos gaurus*) in Palamau, Bihar, *Cheetal*, **15**(1) : 61-67.

Sanderson, G. (1912). *Thirteen years among wild beast of India*. Edingurgh.

Sankar, K., Q. Qureshi, M.K.S. Pasha and G. Areendran (2001). Ecology of gaur (*Bos gaurus*) in Pench Tiger Reserve, Madhya Pradesh. *Draft final report*, Wildlife Institute of India, Dehra Dun. 116 pp.

Schaller, G.B. (1967). *The deer and the tiger. A study of wildlife in India*. University of Chicago Press, Chicago.

Sokal, R.R. and F.J. Rolf (1981). *Biometry*. New York: Freeman & Co.

Zar, J.H. (1984). *Biostatistical analysis* (2nd edn.). Prentice-Hall, New Jersey.