

Status, abundance and population ecology of Nilgai (*Boselaphus tragocamelus* Pallas) in Aligarh District, Uttar Pradesh, India

Khursid A. Khan^{1,2*} and Jamal A. Khan¹

¹Department of Wildlife sciences Aligarh Muslim University, Aligarh 202002 (Uttar Pradesh), INDIA

²Bombay Natural History Society, Hornbill House, Opposite Lion gate, Shaheed Bhagat Singh Marg, Mumbai - 400 001 (Maharashtra), INDIA

*Corresponding author. E-mail: khursid.amu@gmail.com

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Abstracts: The data on population ecology of nilgai was collected in Aligarh District, Uttar Pradesh, India from August 2013 to June 2014. A total of 108 herds of nilgai 54 in each season (summer and winter) were encountered, respectively. The density of nilgai was found 0.49/km² in Aligarh district. While the encounter rate was found 0.66 individuals per km. There was a marked seasonal change seen in group size of nilgai i.e. 11.38 ± 2.76, and 22.83 ± 5.40 in winter and summer, respectively. The overall mean group size was found 17.10 ± 4.08. The sex ratio of nilgai was female biased, adult male:adult female ratio was found 1:3 while overall sex ratio was found 61.55%, 26.32% and 44% male, yearling and calves on per 100 females, respectively. The nilgai shows marked seasonal change in their group structure. The group size was found maximum at 25% in 0-5 individual category and minimum 9.25 in >21 category in winter, while about 30% were seen in >21 category and only 11% were seen in between 0-5 category in summer season. Thus, the nilgai was found less sociable in winter and more gregarious in summer season.

Key words: Aligarh district, Density, Mean group size, Nilgai, Population structure

INTRODUCTION

There are 17 mega diverse countries in the world; India is one of the like-minded mega diverse countries. There are about 5488 mammalian species found in the worldwide (IUCN, 2014). India encompasses about 400 mammalian species (Menon, 2014). There are 31 species of ungulates found in India of which 25 ungulate species are protected in Wildlife Protection Act, 1972. There are 6 antelope species, namely Nilgai, Four horned antelope, Indian gazelle, Blackbuck, Tibetan antelope and Tibetan gazelle found in India. Out of these 6 antelope species 3 are endemic to the Indian sub continent. The nilgai or blue bull (*Boselaphus tragocamelus*) is one of the largest antelope in Indian sub continent (Prater, 1971). Nilgai belongs to the family Bovidae, subfamily Bovinae and tribe boselephini. The populations of several species have declined, some species have been extinct and some are at the verge of extinction due to habitat loss and poaching. While some species have become pest due to their over abundance in some areas. After introduction of Wildlife Protection Act 1972 hunting become totally proscribed for the wild animals and the population of some species which were present outside the protected areas were increased abruptly (Chauhan and Singh, 1990), land use pattern, development in the agriculture, industries and increased urbanization have seriously effected

the population of these ecological dislocates (Chauhan and Sawarkar, 1989). The reason for their augment is absence of the natural predator in these areas. Nilgai is one such species which is overabundant in some states of India and it may be regarded as pest (Chopra and Rai, 2009). The encroachment into grasslands by farmers and government policies which consider the grassland and fallow land as the wasteland is another reason of habitat loss and overabundance of these animals. The Aligarh district has no natural forest except the *Prosopis* plantation. These were planted to stop the invasion of the semi arid region into gangetic planes. This technique is said to be triumphant to check this problem (Hussain, 2014). Therefore the present investigation was conducted to study the status, abundance and population ecology of Nilgai (*Boselaphus tragocamelus* Pallas) in Uttar Pradesh, India.

MATERIALS AND METHODS

Study area: The Aligarh district is the one of the western most district of the Uttar Pradesh. It is bounded by the river Ganga and Yamuna for short distances, they forms separately the district from Badaun while the later constituted the dividing line between Aligarh and Gurgaon district of Haryana, bounded in the north by Anoopshaher and khurja tehsil of Bulandshaher district. To the west and south-west lie the Tehsil of Mahabar and Sadabad of Mathura district, while to the

east and the south-east lie Hathras, Etah and Kasganj district. The extreme parallels of latitude are $27^{\circ}29'$ and $28^{\circ}11'$ north and $77^{\circ}38'$ and $78^{\circ}38'$, east longitude with an area of 3747 km^2 . The length from east to west is about 112 km and breadth from north to south is 72 km.

The vegetation of the study area is classified as an arid open scrub commonly known as 'Rakhs' (Champion and Seth, 1968). The vegetation of the study area may be divided into "usarland", *Prosopis* plantation and agricultural land.

Most of the forest patches are dominated by *Prosopis juliflora* followed by the other species like *Acacia catechu*, *P. cineraria*, *P. specigera*, *Melia azadirachta*, *Azadirachta indica*, *Cordia dichotoma*, *Pongamia pinnata*, *Syzygium cumini*, *Dalbergia sissoo*, *Butea monosperma*, *Acacia nilotica*, *Acacia leucophloea* and *Phoenix sylvestris*.

Among the mammalian species Grey wolf (*Canis lupus*), Golden jackal (*C. aureus*), Indian fox (*Vulpes bengalensis*), Palm civet (*Paradoxurus hermaphrodites*), Common mongoose (*Herpestes edwardsii*) and Jungle cat (*Felis chaus*) are the medium size carnivore found in the study area. Rufous tailed hare (*Lepus nigricollis*), Indian gerbil (*Tatera indica*), Five striped palm squirrel (*Funambulus pennantii*), and Bush rat (*Golunda ellioti*) Nilgai (*Boselaphus tragocamelus*) Blackbuck (*Antelope cervicapra*) and Wild boar (*Sus scrofa*) rhesus macaque (*Macaca mulatta*) and Common langur (*Presbytis entellus*) are found in the study area. (Khan, 1992, Qureshi, 1991; Khan, 2014))

Methodology: Basic information (location of forest patches, their areas and nearby villages) was obtained from the forest department. A questionnaire survey was carried out to know the approximate number of nilgai, activity pattern, crop damage and various methods used by villagers to control the crop damage in 14 villages of Aligarh District. A total of 140 people were interviewed in all these localities. The nilgai population was confined in and around the forest patches and therefore the survey was carried out in the villages which were adjacent to these forest patches. The preferences were given to those villagers who were working in the crop fields during the survey. The selected villages were Nagla Beeriya (Pala sallu), Haivatpur and Kiratpur Nimana (Andala), Kasthali vaishya (Pala Kasthali), Madhawgarh (Junglegarhi), Sikanderpur (Sikandapur Cherat), Shekha (Shekha), Mahua khera and Ghursikaran (Ghursikaran), Ladhawan (Akrabad ladhawan) Kakethal, Nagla kosalpur, Gazipur, and Gijrauli (Atrauli).

Vehicle transect: All the major roads and sub roads were used as transects. A motorcycle was used to carry out the survey. A total of 1541 km was travelled on 12 major roads and sub roads which were leading towards the adjacent districts. The roads were passing through the Tehsils, blocks, Panchayats, villages, canals, and plantation. These transects were marked on the map and travelled on a monthly basis. During the vehicle

transects number of encountering animals, their activity pattern and habitat along with the perpendicular distance were recorded.

Total count: Transects were laid in entire forested patches to count the nilgai (Buckland *et al.*, 1993; Burnham *et al.*, 1980). As nilgai prefers the edges of the forested patches (Sankar, 1994) transects were laid at the edges of the forest patch and later on in the zig zag manner in entire forest patches to count all possible numbers of the nilgai. The number of nilgai along with the age, sex, habitat, activity and perpendicular distance were recorded during the line transects. All nilgai group encountered were classified as (a) An adult male (b) adult female (c) sub adult male (d) sub adult female (e) yearlings and (f) calves.

RESULTS AND DISCUSSION

A questionnaire survey was carried out to determine the approximate number of nilgai, in 14 villages of Aligarh District. A total of 140 people were interviewed. The numbers of nilgai reported by villagers in their areas in each location were compared with the observed data in each locality. The results were found insignificant ($Z=-2.547$, $p=0.01$) because the number of nilgai reported by people was found substantially higher than that of observed in the field. This suggests that the figures reported by villagers appeared to be exaggerated.

Density: Densities of nilgai in India vary widely depending on habitat conditions; competition with domestic livestock, predation, and degree of protection. Table 1 showed the density of nilgai in different forest patches of Aligarh. The density of nilgai was found to be 34 animals per km^2 in winter season and it was 42 animals per km^2 in summer in same patches. The overall density was found to be 38 animals per km^2 in the forest patches. The density was found maximum in and around the Shekha jheel i.e. 132 individuals per km^2 followed by the Pala sallu 126 individuals per km^2 . The density in Shekha is much higher because the protected area is only 25 ha, and the rest of the area is crop land. Nilgai utilizes all the areas including the crop field, but only the protected area is engaged in the density estimation. The minimum density of nilgai was found in the Pala kasthali and Akrabad Ladhawan where the density was 14 and 15 individuals per km^2 respectively. Table 2 showed the nilgai densities recorded in different study areas. The nilgai density ranges from 0.43 to 7 individual/ km^2 . The minimum density was recorded in Pench Tiger Reserve (0.43 individual/ km^2) and maximum was recorded in Keoladeo National Park (7 individual/ km^2). The density of nilgai was found to be 0.39–1.47 individual/ km^2 in Gir Lion Sanctuary (Berwick, 1974; Berwick and Jordan 1971, Khan, 1997; Khan, 1996), 0.44–7.81 individual/ km^2 in Panna National Park (Chundawat *et al.*, 1999), 6.60–11.36 individual/ km^2 in Ranthambhore National Park (Bagchi *et al.*, 2003), 5.67 individual/ km^2 in Haryana (Singh, 1995) and 3.93 individual/ km^2

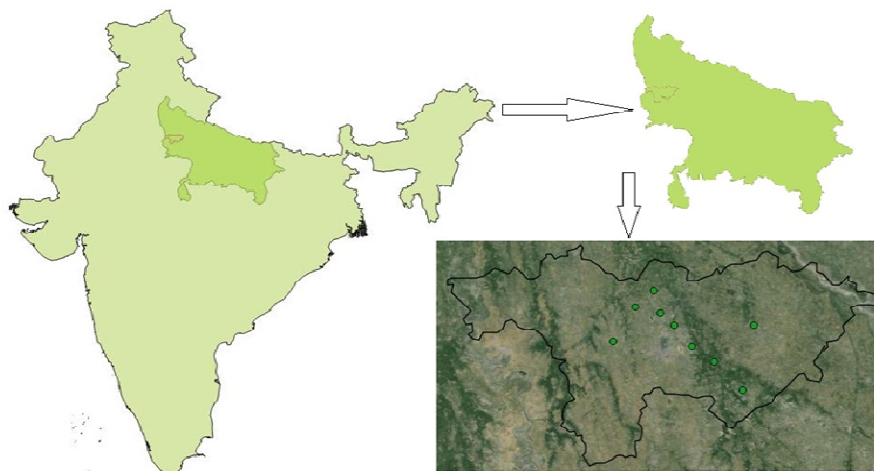


Fig. 1. Showing the study area with forest patches in Aligarh district.

Table 1. Density of Nilgai in different forest patches of Aligarh district.

S.N.	Block Name	Name	No. of Nilgai in Winter (Mean)	No. of Nilgai in Summer (Mean)	Area (ha)	D/ha in winter	D/ha in summer	Overall density/ha
	Gabhana	Pala Sallu	46	61	42.11	1.09	1.44	1.265
	Jawan	Jungle Gadhi	27	26	102.21	0.26	0.25	0.255
	Jawan	Kasthali Vaisya	14	15	90.28	0.15	0.16	0.155
	Lodha	Ghursikaran	58	45	178.06	0.32	0.25	0.285
	Akrabad	Akrabad Ladhawa	18	24	140.11	0.12	0.17	0.145
	Lodha	Andla	55	51	70.12	0.78	0.72	0.75
	Jawan	Sikandarpur ©	18	20	67.20	0.26	0.29	0.275
	Dhanipur	Shekha	22	44	25	0.88	1.76	1.32
	Atrauli	Gazipur	26	58	101.21	0.25	0.57	0.41
		Total	284	344	816.30	0.34	0.42	0.38

Table 2. Density (No./km²) of nilgai in different areas in India.

S.N.	Locations	Density	Encounter rate	Mean group size	Investigators
	Pench	0.43	NA	NA	Biswas and Sankar (2002)
	Gir	0.58	NA	1.9	Khan (1996)
	Sariska	5.19	0.41	2.4	Sankar (1994)
	Ranthambore	6.98	NA	2.9	Bagchi <i>et al.</i> (2003)
	Keoladeo	7.00	NA	NA	Haque (1990)
	Haryana	5.67	NA	5.97	Singh (1995)
	Panna	6.02	NA	NA	Chundawat <i>et al.</i> (1999)
	Kuno	3.93	NA	NA	Benerjee (2005)
	Aligarh (Present study)	0.49	0.66	17.10 ± 4.08	Khan (2014)

Table 3. Population structure of Nilgai in Aligarh District.

S.N.	Location	Herd	AM	AF	SAM	SAF	Yearling	Calves	Un Id	Total
1.	Pala Sallu	17	32	96	32	66	26	82	0	334
2.	Andla	14	49	60	37	55	36	46	0	283
3.	Pala Kasthali	5	6	19	4	10	4	10	0	53
4.	Jungle Gadhi	8	17	32	13	25	16	24	0	127
5.	Sikandarpur ©	9	12	18	10	20	12	19	1	92
6.	Shekha	8	22	37	27	30	25	32	2	175
7.	Ghursikarn	15	37	61	25	41	23	40	2	229
8.	Akrabad Ladhawa	7	15	22	9	14	11	14	0	85
9.	Atrauli	9	26	39	27	26	22	30	0	170
10.	Road Side	16	33	82	28	56	38	59	1	297
	TOTAL	108	249	466	212	343	213	356	6	1845

AM= Adult male, AF=Adult female, SAM= sub adult male, SAF= Sub adult female, Un. Id =Unidentified individuals

Table 4. Sex ratio of Nilgai in Aligarh District.

S.N.	Location	Males	Yearlings	calves
1.	Pala Sallu	39.50	16.04	50.61
2.	Andla	85.21	31.30	40.00
3.	Pala Kasthali	41.37	13.79	34.48
4.	Jungle Gadhi	59.64	28.07	42.10
5.	Sikandarpur ©	63.15	31.57	50.00
6.	Shekha	65.67	37.31	47.76
7.	Ghursikarn	72.54	22.54	39.21
8.	Akrabad Ladhawa	83.33	30.55	38.88
9.	Atrauli	80.00	33.84	46.15
10.	Road Side	47.82	27.53	42.75
	TOTAL	61.55	26.32	44.00

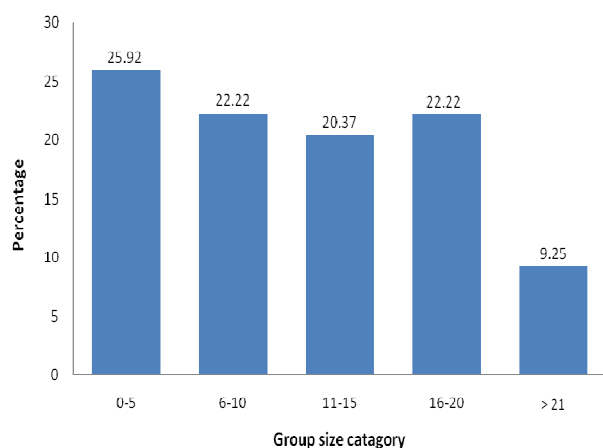


Fig. 2. Percentage of animals in different group size categories in winter season.

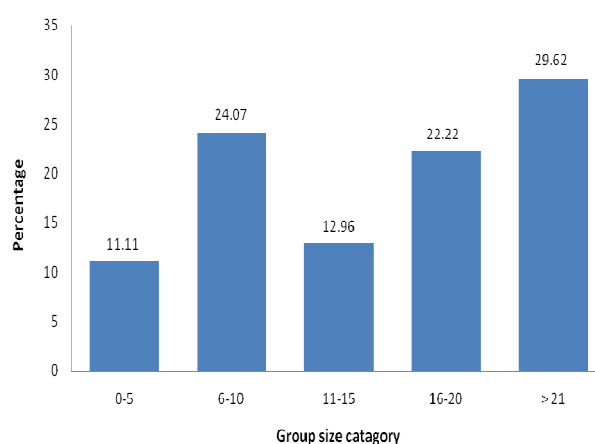


Fig. 3. Percentage of animals in different group size categories in summer season.

Datasheet for questionnaire survey of Nilgai:

Date: Village: Lat. Long. Tehsil : Block:

Demographic & Socio- economic profile:

1. Name of respondent: 2. M/F: 3. Cast: 4. Age:

5. Number of people in the family:
 A. Males: B. Females: C. Children ≤15 yrs

6. Number of Literate family members:

7. Number of family members in working age-
 A. Working Male: B. Working Female:

8. Occupation:

Occupation	No.	Occupation	No.	Employment in days/yr
Govt. Service		Labour		
Pvt. Service		Agriculture		
Other				

9. Land holding in ha: Yes/No

A. Landless: B. Marginal: C. Small (1-2): D. Semi medium (2-4) E. Medium 4-10 F. Large: (>10)

10. Cropping pattern:

A. Rabi: B. Kharif: C. Both:

11. Involvement of men and women in Agricultural activity:

A. Only men: B. Only women: C. Both:

12. Estimated number of Nilgai seen in this area:

13. Human wildlife Conflict: Yes/No

14. Crop raided by wild animal:

A. Blackbuck B. Nilgai C. Wild boar D. None

15. Maximum crop damaged by:

A. Blackbuck B. Nilgai C. Wild boar D. None:

16. Scaring devices use

A. Scaring crow: B. *Prosopis* fences: C. Colourful ribbons:
 D. Drum sound E. Wire fences: F. Firearms G. Fire

in Kuno Wildlife Sanctuary (Banerjee, 2005). All the above studies were conducted inside the protected areas except (Singh, 1995); estimated 5.67 individual/km² in Haryana. While in Aligarh district the density was found 0.49 individual/ km². The density is lower than the study conducted in Haryana and this is due to the population of the Aligarh district is much higher in respect of the area. The forested area in Haryana is 1684 km² while the forested area in Aligarh is only 23.48 km².

Encounter rate: The encounter rate was found maximum on Atrauli – Pali road (0.86) followed by 0.82 individuals per km on Aligarh - Khair road and the minimum was in Aligarh – Gonda road i.e. 0.16 individuals per km in winter season. The overall encounter rate was 0.41 individuals per km in winter season. Nilgai group were not sight on Aligarh – Jawan and Aligarh – Iglas road during the winter. The encounter rate was found maximum on Aligarh – Khair road 2.55 and minimum 0.11 individuals per km in Aligarh - Jawan road. The overall encounter rate was found 1.01 individuals per km in summer season. The overall encounter rate in Aligarh district was found 0.66 individuals per km. The encounter rate of the nilgai was found maximum in the Aligarh- Khair road because these areas enclose small patches of forest and people of these areas have hard religious feeling regarding the nilgai.

Mean group size: A total of 108 groups comprising of 1845 individuals was recorded and the mean group size was found to be 17.10 ± 4.08 . The maximum number of individuals were recorded in Pala sallu (61) while the minimum was in Sikandarpur Cherat (1). 54 groups of nilgai were recorded in winter, comprising 612 individuals and the mean group size was found to be 11.38 ± 2.76 with maximum number recorded in Ghursikarn (58) and minimum on road sides (13). The maximum mean group size was found in Pala sallu 12.81 ± 2.19 and minimum in Sikandarpur Cherat (7 ± 2) in winter season. 54 groups were also recorded in summer season, which comprising of 1233 individuals. The mean group size was 22.83 ± 5.40 . Mean group size was found maximum in Pala sallu (32.16 ± 7.87) and minimum in Sikandarpur Cherat (14.25 ± 3.06). There is seasonal change in mean group size of the nilgai. Nilgai is less gregarious in winter and gregarious in summer. Adult males segregate from females and sub adults during non breeding seasons. Annual group sizes in India are 1.92 individuals (Bagchi *et al.*, 2004; Berwick 1974; Khan, 1996); in Gir mean group size was 1.9 (Khan, 1996); in Sariska 2.4 individuals (Sankar, 1994); in Ranthambhor 2.9 individuals (Bagchi *et al.*, 2003) and in Haryana 5.97 (Singh, 1995). The mean group size was higher than other studies because the nilgai were congregated in the forest patches. This congregation is due to the protection from the farmers as they chase and harass the nilgai to avoid the crop damage. In summer the herd of 35 to 40 individuals were continuously seen in Atrauli, Pala

Sallu and Andla.

Population structure: Table 3 showed overall population structure of nilgai in Aligarh district. A total of 54 groups of nilgai were encountered during winter season, which comprised of 612 individuals. There were 70 adult males, 65 sub adult males, 174 adult females, 98 sub adult females, 52 yearlings, 147 calves and 6 were unidentified. The maximum numbers were recorded in Pala sallu (147 individuals) followed by Ghursikarn (90), while the minimum was recorded in Pala kasthali (24 individuals). A total of 1233 individuals in 54 groups were recorded in summer, which comprised of 179 adult males, 147 sub adult males, 292 adult females, 245 sub adult females, 161 yearlings and 209 calves.

Overall 108 groups were encountered in Aligarh district, in which 1845 individuals were recorded. These comprise of 249 adults, males, 212 sub adult males, 466 adult females, 343 sub adult females, 213 yearlings and 356 calves.

Sex ratio: Table 4 showed the data of overall sex ratio. The male - female ratio was 50:100, female to yearling ratio was 100:19 while the female - calf ratio was 100:54 in winter season. The maximum male to female ratio was found in Atrauli 92:100 and minimum 33:100 in Pala sallu. The maximum number of yearling – female ratio was recorded on road sides (46:100) and minimum in Pala sallu (7:100). The maximum number of calves- cow ratio was recorded in Shekha 78:100 and minimum 38:100 in Ghursikarn, in winter season. While in summer the male - female ratio was 61:100, female – yearling ratio was 100: 30 and calf – cow ratio was 39:100. The maximum male to female ratio was found in Akraabad (94:100) and minimum in Pala kasthali (33:100). The maximum number of yearling – female ratio was recorded in Akraabad 44:100 and minimum 20:100 in Pala kasthali, the maximum number of calves - cow ratio was recorded in Atrauli 45:100 and minimum 30:100 in Andla, in winter season.

The overall sex ratio of the male – female was 62:100, yearling to female ratio was 26:100 and calf cow ratio was 44:100. The male female ratio was the maximum in Andla (85:100) and minimum in Pala kasthali (41:100). The maximum number of yearling female ratio was recorded in Shekha (37:100) and minimum in pala kasthali (14:100), while the calf cow ratio was maximum in Pala sallu (51:100) and minimum in Pala kasthali (34:100).

Fig. 2 and 3 provide the percentage of animals in different group size categories. 26% groups comprised of 0-5 group category, 22% comprised of 6-10 group category, 20% were in the 11-15 group category, 22% in 16-20 group category and 10% in >21 group category in winter season. While in summer 11% groups were comprised of 0-5 group category, 24% comprised were 6-10 group category, 13% were in the 11-15 group category, 22% in 16-20 group category and 30% in >21 group category. In India, the sex ratio

(male:female) of free ranging adult nilgai favours females: 0.59:1 in Bharatpur (Schaller, 1967), 0.39:1 in Vanvihar Sanctuary (Schaller, 1967), and 0.4:1 in Sariska (Sankar, 1994), 0.89:1 (Berwick and Jordan 1971) to 0.71:1 (Khan *et al.*, 1995). In Texas, the observed male:female ratio was 0.81:1 (Sheffield *et al.*, 1983). The female:calf ratios for free-ranging nilgai are: 1:0.23 in Gir (Khan *et al.*, 1995), 1:0.48 in Sariska (Sankar, 1994), and 1:1.03 in Texas (Sheffield *et al.*, 1983). In Aligarh the male: female ratio was also female biased, i.e. 0.61:1. The ratio of yearlings- females were very low (0.26:1) due to high mortality in calves, either due to accidents or due to natural deaths. The calf: female ratio was 0.44:1 in Aligarh. High rates of mortality are common for males in particular, but also females, before age 3 (Berwick, 1974; Brown, 1976). In Gir Forest, India, 34% of calves die each year, and there is a general linear decline of 52% of 2–10-year-olds of both sexes (Berwick, 1974).

Conclusion

This is the first study carried out on nilgai in gangetic plane, except the study carried out in Haryana. The gangetic plane is one of the major crop raided area by wild animals specially by nilgai. Crop raiding in gangetic plane is one of the major concern now a day. The government permitted culling of the nilgai in many central and northern states to regulate crop damage. It is important to know about the status and distribution of wild animals before taking such kind of decision. The density of nilgai is found to be 0.49/ km², encounter rate was found 0.66 individual per km and mean group size was estimated 17.10±4.08. The male – female ratio is found to be 62:100, yearling to female ratio was 26:100 and calf - cow ratio was found 44:100 in Aligarh district.

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