ABSTRACT

1. INTRODUCTION

The large scale destruction of forest for various purposes has left the Haryana state in northern India with very little natural forest cover. It has resulted in complete destruction of natural habitat of a large number of wild fauna and flora. As a consequence of destruction of natural habitat, many generalist species have adapted to survive in agro-ecosystems. The implementation of Wildlife Protection Act (1972) led to increase in population size of a number of wild species. Species with crop raiding behavior thus pose a serious conservation problem since their conservation is directly dependent on the farmers who owns these crop fields. Locally overabundant populations of nilgai (*Boselaphus tragocamelus*) in Haryana is one such species which is thriving in crop fields and is responsible for large scale damage to the crops. The Wildlife Institute of India initiated a research program to assess the nilgai-farmers conflict and to suggest mitigation measures. The following are the objectives of the study:

a) to estimate the current population status, density, distribution, social organization and reproductive biology of nilgai.

b) to study the dietary pattern, habits and habitat use by nilgai.

c) to investigate the time budget, activity and ranging pattern of the species.

d) to quantify the crop damage by nilgai in the study area.

e) to suggest feasible measure for control of crop damage and for
conservation of the species.

The field work for this study was done from April 1989 to March 1992. The study was carried out in four districts of Haryana, viz. Hissar, Bhiwani, Rohtak and Mahendragarh. The vegetation of the area is classified as Desert thorn forest types. The "rabi" and "kharif" crops are grown in the area during winter season (late November to mid March) and during summer and rainy seasons (July to October) respectively. In addition, a few crops are grown in between "rabi" and "kharif" seasons, which are called "zaid" crops.

2. METHODS

2.1 Population density estimation

A survey was conducted in four districts of Haryana, viz. Hissar, Bhiwani, Rohtak and Mahendragarh, to determine the status of nilgai population. The following methods were employed:

a) Questionnaire survey

A questionnaire survey was carried out in all the districts to assess the population size of nilgai by interviewing the farmers community.

b) Vehicle transects

As the intensive study area encompassed four districts, road vehicle count method seemed appropriate for data collection. Counts were done in morning and evening hours and data on perpendicular distance, species and group size were recorded. Data were analyzed by King's method and by Fourier Series Estimator using computer program TRANSECT.

c) Line drive count
Line Drive Count method was also used in population size estimation.

The observed animals were classified into seven age classes: a) adult male, b) sub-adult male, c) yearling male, d) adult female, e) sub-adult female f) yearling female and g) calf based on coat, color and size of horns. Based on direct observations, information on calving season, number of calves born, multiple births was also collected. Farmers were the main source of information about mortality. Dead animals were examined carefully to establish the cause of death.

2.2 Dietary pattern, habitat use, time budget, activity pattern and movement pattern

The nilgai groups were observed by scan sampling method as described by Altman (1974). Data on habitat use, food habits, time budget, activity pattern and movement of free ranging nilgai were collected by direct observations. Individual activity was recorded from dawn to dusk. Most of the continuous observations lasted for 10-12 hours.

2.3 Crop damage assessment

Quantitative assessment of damage to "rabi" crops: wheat, gram and mustard, and "kharif" crops: bajra, guar, cotton and moong was done in the cultivated areas at Nahar and Kairu. The extent of damage was assessed on the basis of difference in yields from protected and unprotected plots. Within these plots, 5x5 m crop area was marked using wooden pegs. Similarly, unfenced plots of 5x5 m were randomly taken and marked with pegs in the same crop.
field. Yields from the 5x5m of both fenced plots and unfenced plots were weighed and compared to find out the effectiveness of the protection devices. Five to six random transects each of about 3 km length running through crop fields were laid and monitored to assess the extent, nature and pattern of crop damage on a monthly basis. Plots of 1x1m within the cropfields were selected along the transect at every 100 m interval, within which, number of damaged plants, nature of damage and phenology stage were recorded. Eight strand electric fence was put up around 18 ha of bajra, guar, sunflower and vegetables during "Kharif" and "Rabi" which were highly prone to damage by nilgai.

2.4 Data analysis

Except crop damage, all data were analyzed using computer programs "SPSS" and "TRANSECT". All figures used were prepared using "AUTOCAD" and "HARVARD GRAPHICS" while data were stored in "FOXBASE". The data were subjected to statistical analysis using "SPSS" package.

3. RESULTS AND DISCUSSION

3.1 Population Density Estimation

The number of nilgai reported by villagers in their areas in each district were compared with the estimates obtained during this study. There was a significant positive correlation for Bhiwani (r=0.87, d.f. = 24, P<0.05) and Rohtak (r=0.34, d.f. =29, P<0.05), and insignificant correlation for Hissar (r= -0.08959, d.f. =18, P>0.05) and Mahendragarh (r= 0.20, d.f. = 23, P>0.05). The overall density in Hissar, Bhiwani, Rohtak and Mahendragarh comes to 75.4,
115.5, 59.4 and 55.6 individuals/km² respectively. The population density differed significantly between districts (K-W One Way Anova, Chi-square = 8.5875, df = 2, 6, 7, 4; P<0.0535).

Nilgai population densities in all the four districts were calculated from vehicle transects. The overall density figures for Hissar, Bhiwani, Rohtak and Mahendragarh were 4.8, 7.7, 5.1 and 5.1 individuals/km² respectively. The densities estimated by two methods were not significantly different, whereas the densities differed significantly from one district to another irrespective of the method applied (Mann-Whitney U-test: n 1 = 3, n 2 = 4, P=0.0339; M-W U-test n 1 = 7, n 2 = 6, P=0.0027; M-W U test n 1 = 8, n 2 = 7, P=0.0012; and M-W U test n 1 = 5, n 2 = 6, P=0.0061 for Hissar, Bhiwani, Rohtak and Mahendragarh districts respectively).

Animals were classified in four group size categories i.e. single, 2-9, 10-17 and >17 individuals. There was no difference in group size values between two years (P>0.05). However, the group size values differed significantly between seasons for two consecutive years for all male group, mixed group and female with calves (K-W One Way Anova df = 86, 154 & 39; P=0.1795, 0.8012 and 0.0869, corrected for ties). Males were mostly found either singly or in small groups of 2-9 individuals during April-July 1990 and 1991. Single males were observed most frequently during December-March. The mean group size was largest in August-November 1990 (4.6) and was smallest in December 1989-March 1990 (2.74).

A majority (72%) of females were seen in groups of 10-17 individuals during December-March period. The mean group size was
largest (7.87) during December 1989-March 1990. The smallest mean group size was observed during April-November 1991 (3.96-4.08). Most of the females and calves were observed in groups of 2-9 individuals in all seasons.

Calves were first observed in June and the sightings of calves increased steadily till August. But there was a spurt in sightings in January which lasted for less than a month. Breeding activity occurred throughout the year, with two peaks; one in December-January and again in April-May in the study area.

Out of 2147 nilgai observed from December 1989-November 1991, 41.8% were males and 45.3% were females (the sex of the remaining 12.9% animals could not be identified), and overall mean ratio was 92.3 males:100 females. The male to female sex ratios varied from a maximum of 119.7 males:100 females in April-July, 1991 to minimum of 56.9 males:100 females in August-November, 1991. The overall sex ratio of nilgai for the entire study area taken together was 92 males:100 females in Haryana.

Altogether 21 animals were found dead during 1989-90 and 24 animals during 1990-91. Out of the 1989-90 total of 21 dead animals there were 9 males and six females.

3.2 Food and Feeding Habits

A total of 426 observations on feeding were made in Nahar reserve forest from December 1989 to November 1991. In various seasons, 71.7% to 90.8% of the animals were found grazing and 9.1% to 28.2% of the animals were seen browsing. The plants or plant matter consumed by the animals were mainly doob grass (Cynodon
dactylon), dry shed green leaves of Salvadora oleoides, Prosopis cineraria, Capparis sepiaria and pods of Prosopis juliflora. Similarly 330 observations on feeding were made in crop fields. In various seasons, 37.86% to 81.31% of the animals were found grazing and 18.69% to 62.14% of the animals were seen browsing. The browse species mainly included leaves of Prosopis cineraria, Salvadora oleoides and Acacia nilotica.

Of all the plant species, Cynodon dactylon formed the major proportion (31.1%-52.6%) of the diet in all the three seasons, followed by Triticum aestivum, Cyamopsis tetragonoloba and dry matter of other species (litter). The consumption of grasses was highest (44%-67%) in Nahar reserve forest, followed by leaves and pods. In agricultural fields, crops were consumed more in winter (73.3%) and in monsoon (78.6%) when this food was available in plenty. During summer, grasses were the predominant proportion of food (56.21%).

3.3 Activity & movement pattern

The time budget has been observed to undergo seasonal variations in Nahar reserve forest. During winter, the maximum feeding activity was from 16 to 17 hours (25.7-31.8%). In summer however, two distinct peaks of feeding activity; one in the morning around 7 to 9 hours (41.7 to 40.5%) and the other at 16 hours (37.9%). While in monsoon season, the feeding did not show much variation during the day hours.

Nilgai groups were followed continuously for 12 hours a day and distance covered by them in every 10 minutes was noted. There
was no significant difference in distance covered in two habitats (t-test, 2 tail probability=0.221, df=47). There was no significant variation in the distances covered by nilgai groups from monsoon to summer at P=0.05 (t value 3.2, 2 tail probability =0.187, d.f.=8). But there was significant difference between the distances covered by nilgai groups during winter and summer in each of the two habitats at P=0.05 (t= 2.51, 2 tail Probability=0.030, d.f.=27).

The average distance covered by the animals daily is more (1199±188.4 and 3520±1165.8 for reserve forest and crop fields respectively) during winter than in summer or monsoon.

3.4 Crop damage assessment

Damage to wheat, gram and mustard crops is caused not only by foraging but also due to various activities of nilgai viz. trampling, resting and movements of the animals. Assessment of damage to "rabi" crops using the transect method was done in Nahar area. The losses to wheat, gram and mustard crops have been estimated to be 24.3, 56 and 42.4 percent respectively. The average productivity of wheat, gram, mustard, bajra, gaur and cotton crops in protected and unprotected plots are as follows: losses to grains/seeds of wheat, mustard and gram during the year 1989-90 and 1990-91 were estimated to be 23, 41.1, 43.4 and 25.8, 44.8 and 42.8 percent respectively for Nahar areas; and 61.7, 60, 68.2 and 9.8, 18, 26.7 percent respectively in Kairu areas. Damage to bajra and guar in Nahar area was 16.24 and 20 percent respectively during 1990. In Kairu area, damage was estimated to be 34.58 and 40.67
The loss values for "rabi" crop calculated through transect method are comparable with the seed losses of the same crop calculated using the plot fencing experiment during 1989-91. Damage to wheat crop was estimated to be the maximum (62%) during growth phase. In case of mustard crop, seed formation and ripening stages were highly susceptible to damage by nilgai, the damage was estimated to be 76.9%. In addition, damage was recorded also during the growth phase of this crop. Ripe pods of mustard when shaken by moving animals were found to burst, and the seeds got scattered. Though the damage to gram was observed in all the phenological stages, maximum damage was recorded at two different stages; during growth phase and second just before harvesting.

By comparing the crop yield of the protected (electric fenced) and unprotected plots, losses of seeds/grains of wheat, mustard, bajra and guar have been calculated to be 11.0, 20.8, 20.3 and 21 percent respectively. Similarly, the difference in the yield of green matter of wheat, mustard, bajra and guar between protected and unprotected plots has been estimated to be 6.1, 18.3, 11.36 and 17.5 percent respectively. The difference in the yield of straw of wheat, mustard, bajra and guar from protected and unprotected plots has been found to be 9.4, 17.8, 11.6 and 27.2 percent respectively.

3.5 Recommendations

The observations suggest that translocation of such large nilgai population is not a viable option due to the cost involved
and feasibility. At the same time the electric fencing is also not a good solution since many farmers can not afford it. Therefore, the cheapest and the most effective way to control nilgai population would be culling and regulated hunting which will generate revenue for further management and conservation of nilgai. Since nilgai is a sacred animal, such a strategy may not work initially. However, people should be educated to promote wildlife ranching as is being done in other countries such as USA.