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Status, Population Structure and Conservation of Swamp Deer (*Cervus duvauceli duvauceli*) in Dudhwa Tiger Reserve, Uttar Pradesh, India

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ABSTRACT

We studied status, distribution, social organization and the conservation problems faced by endangered swamp deer (*Cervus duvuaceli duvuaceli*) in Dudhwa Tiger Reserve (DTR). We estimated total population to be 1016 (578 in Dudhwa National Park (DNP) and 438 in Kishanpur Wildlife Sanctuary (KWS)). The mean group size in DNP and KWS was 21.40±1.71 and 11.89±1.72, respectively. Overall mean group size in DTR was 18.37±1.71 animals/group. Group size showed significant difference across difference habitat types ($F = 28.3$, d.f. = 2, $P<0.01$). Adult females formed major share of population in the study area. The male: female: fawn ratio in DNP and KWS was 57:100:28 and 62:100:19, respectively. Overall sex ratio in DTR was 58:100:26. All male groups were larger than female groups but the group size was highest for mixed groups. The major threat to swamp deer conservation throughout DTR is the destruction of its habitat and illegal poaching. As a result, it has become locally extinct from many areas. We recommend restriction on grass cutting in Satiana area, creation of some artificial taals (swamp) for wallowing, protection of taals for aquatic vegetation, relocation of Ghola and Ghajrola villages and intensive patrolling of these areas during monsoons.

Key Words: Terai Grasslands, Group size, Sex Ratio, Kishanpur Wildlife Sanctuary, Management.

INTRODUCTION

The swamp deer (*Cervus duvauceli duvuaceli* Cuvier) is highly endangered deer species listed in schedule I of the Indian Wildlife Protection Act (1972) and Appendix-1 of the Convention on International Trade of Endangered Species (CITES). Despite its legal status, the distribution range of swamp deer has been reduced considerably due to habitat destruction and hunting. At present large populations are found only in few areas like Dudhwa, Kaziranga and Kanha National Parks and Sukla Phanta Wildlife Reserve in Nepal (Schaaf 1978). The rapid decline of *Cervus duvauceli duvauceli* in the terai area of Uttar Pradesh (UP) over recent years is a case in point.

Preferred habitats of the swamp deer are marshes and grassland (Sankaran 1990, Ahmed 2007) but the ruthless destruction of terai ecosystem for agriculture and human settlements has led to large-scale fragmentation, shrinkage and degradation of these unique vegetation types. Due to repatriation of settlers through out the terai of UP, most of the grasslands have been converted into agriculture in the past (Sankaran 1990).

The status of *Cervus duvauceli duvuaceli* in northern India was first assessed by Schaller (1967) and later revised by Holloway (1973). Sankaran (1990) estimated the swamp deer population to be 765 in whole of the Dudhwa National Park (DNP). The latest estimate of 1,270-1,450 was reported by Qureshi et al. (1995). Despite the establishment of DNP in 1977 for providing strict legal protection to the habitat of largest surviving herd of this subspecies, the population of swamp deer has been declining and it faces major conservation problems. At present many techniques are used to manage the grassland in DNP and indirectly the population of this endangered species. However, we need the knowledge and understanding of the

population structure of swamp deer and the conservation issues, in order to better equip the managers and ensure the long term survival of this subspecies. In the present study, we did extensive field surveys to study status, population structure and conservation problems faced by this subspecies in these areas.

STUDY AREA

The DNP lies between 28° 18′ N to 28° 42′ N latitudes and 80° 28′ E to 80° 57′ E longitudes with an area of 49029.19 ha. The Kishanpur Wildlife Sanctuary (KWS) lies between the latitudes 28°14′ to 28° 30′ N and longitudes 80° 18′ to 80° 30′ E and covers an area of 20341.00 ha. The two protected areas constituting the tiger reserve, though separated physically, are by themselves compact and consist of continuous forest tracts (De 2001). These areas totalling 88373.90 ha represent one of the few remaining examples of a highly diverse and productive terai ecosystem (Figure 1).

The vegetation of DTR is chiefly moist deciduous forest, dominated by Sal (*Shorea robusta* Roxb.). Typical of terai, these forests are interspersed with tracts of low lying grasslands which tend to get flooded during the monsoon. These grasslands are the prominent feature of both the DNP and KWS. The grasslands cover about 19% of the DNP and 21% of the KWS and can broadly be classified into two types. Wet low lying areas are dominated by tall grass species such as *Schlerostachya fusca* Linn., *Phragmites karka* Trin., *Arundo donax* Linn. and *Saccharum spontaneum* Linn. While the drier high grounds are dominated by grasses like *Imperata cylindrica* Linn., *Desmostachya bipinnata* Miers, *Erianthus munja* Michx and *Cymbopogon martini* Linn. (Sankaran 1990, Kumar et al. 2001). Majority of the areas are upland phantas and form the major habitat of swamp deer (*Cervus duvuaceli duvuaceli*), hog deer (*Porcunis axinus* Dufresne) and greater one horned rhinoceros (*Rhinoceros unicornis* Linn.). The temperature ranged from 8°C in winter to 45°C in summer during the study. The annual climate cycle of DTR includes three seasons: Summer (mid-March to mid-June), monsoon (mid-June to mid-October) and winter (mid-October to mid-March). The Dudhwa was declared as sanctuary for swamp deer in 1956 covering a total area of about 63 km^2. The area was declared as a national park in 1977 with an area of 614.32 km^2. In 1987 the Park was brought under the umbrella of the Project Tiger with an addition of 214 km^2 of the KWS.

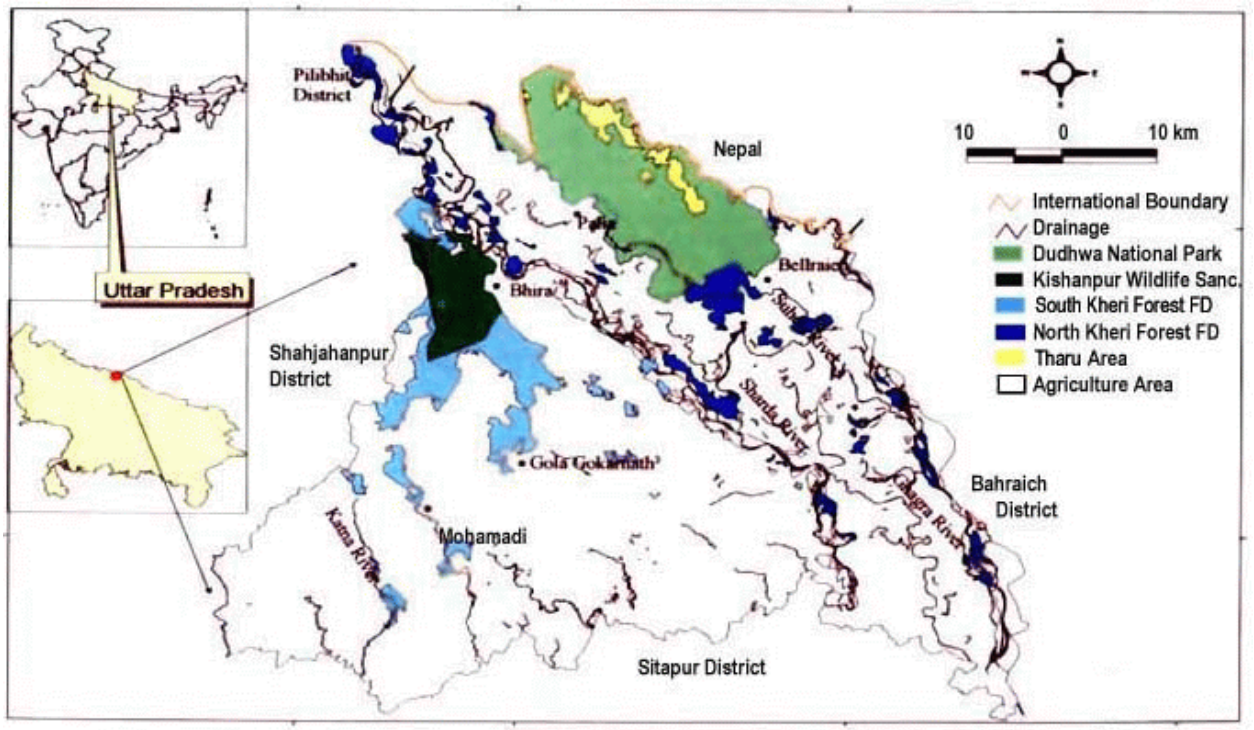

Figure 1. Map showing location of intensive study area (DNP, KWS) (Source WII).

METHODOLOGY

In order to collect data on status, group size, sex ratio and conservation problems faced by this subspecies, field surveys were carried out in DTR from November 2005 to March 2007. Counts of swamp deer were carried out while travelling through the park on elephant back, from the machan and vehicles. Apart from this, random searches were also attempted in different grassland patches.

The grassland area of Kakraha and Satiana were surveyed regularly through fixed routes between dawn and dusk. The areas not accessible by road network were visited on foot. All groups of swamp deer encountered were aged and sexed, whenever possible and location and activity of each group was also recorded during the time of observation. On the basis of age and sex five different categories were distinguished (Schaller 1967, Martin 1977). These were adult males, adult females, yearling males, yearling females and fawn. Based on 322 sightings of groups aggregating 5923 individuals, groups were categorised as all male groups, female groups and mixed groups. Single animals were considered as group consisting of one animal. Sampling was not carried out during the monsoon due to extensive rains and inaccessibility.

RESULTS

Status

Comparative data on population status and distribution of swamp deer population from 1972 to 2006 in DTR is given in Table 1. Across different months in DTR, the largest numbers of swamp deer observed in a single day in KWS were 351 individuals and the lowest number of swamp deer were recorded in Nagra taal (n = 6).

Group Size

The mean group size in the DNP, based on observation of 220 groups, was 21.40±1.71 with a range of 1-210. The mean group size in the KWS, based on observation of 102 groups, was 11.89±1.72 with a range of 1-250.The overall mean group size of swamp deer in DTR for the whole duration was 18.37±1.71 animals/group. Table 2 provides data on group size of swamp deer across different sites in DTR. The mean group size of swamp deer was highest in April (32.5) as compared to other months and difference was found to be significant ($F = 4.80$, d.f. = 6, $P<0.01$) (Table 3). Figures 2 and 3 provide data on segregation of swamp deer into different categories of groups. Mean group size of swamp deer was higher in short grassland (33.2±4.2) as compared to swamps (11.6±1.0) and tall grassland (2.0±0.3) and difference was found to be significant ($F = 28.3$, d.f. = 2, $P<0.01$).

Table 1. Population of swamp deer in Dudhwa National Park as reported by Holloway (1973), Schaaf and Singh (1977), V.P. Singh (1984), Sankaran (1990) and this study.

Area	1972		1977		1984		1988		1989		2005		2006	
	Act	Est.	Act	Est.	Act.	Est.	Act.	Est.	Act	Est.	Act.	Est.	Act.	Est.
Satiana	627	1200	950	–	932	–	262	400	287	300	93	–	171	213
Kakraha	12a	20	276	–	221	–	150	250	302a	325	246	–	231	256
Bankey taal	40a	50	18	–	173	–	64	100	71	100	19	–	34	42
Nagra taal	c	20	b	–	40	–	b	–	4a	–	3	–	6	–
Bhadi taal	12a	30	b	–	35	–	10	35	18	40	20	–	61	67
Jadi taal*	–	–	–	–	–	–	–	–	–	–	293	–	351	438
Total	691	1320	1244	–	1401		486	800	682	765	674	–	854	1016

a = reported (not personally seen by author), b = not counted, c = present, Act = Actual, Est = Estimate, * = KWS.

Sex Ratio

Out of a total number of 4710 individuals classified in DNP, 1991 (42.27%) were adult females, 1137 (24.14%) were adult males, 566 (12.02%) were fawns

and 1016 (21.57%) were unclassified. Male: female: fawn ratio in DNP was 57:100:28. Out of a total of 1223 individuals observed in KWS, 609 (49.79%) were females, 379 (30.99%) were males, 121 (17.0%) were fawns and 116 (9.89%) were unclassified. The male: female: fawn ratio was 62:100:19. Overall the male: female: fawn ratio in DTR was 58:100:26. The yearling male to female ratio in DNP was 90:100 while in KWS it was 61:100 females. In all the five sites swamp deer population showed biased sex ratio in favours of females (Table 4).

Table 2. Mean group size of swamp deer at different sites of DTR. * = Kishanpur Wildlife Sanctuary.

Area	N	Mean	±S.E	Minimum	Maximum
Satiana	48	25.52	5.36	1	171
Kakraha	76	31.67	5.52	1	210
Jadi taal*	102	11.99	1.73	1	120
Bankey taal	89	10.52	0.975	1	34
Bhadi taal	7	12.00	5.84	1	43
Total	322	18.25	1.71	1	210

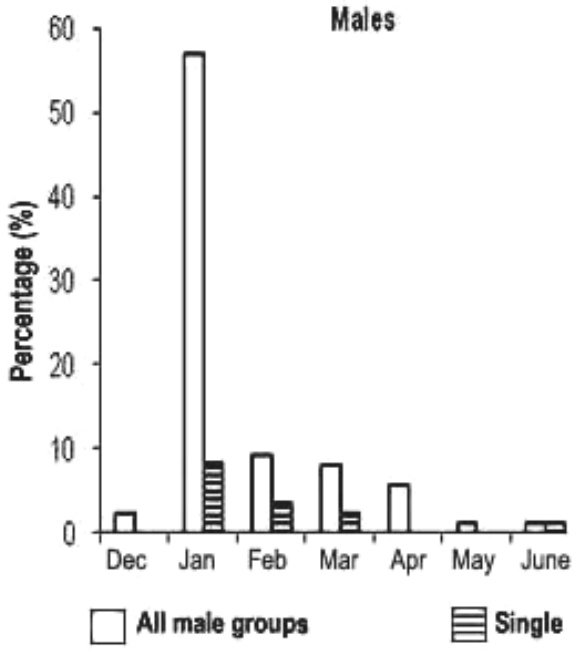

Figure 2. Monthly segregation of male swamp deer into mono-sexual groups in DTR.

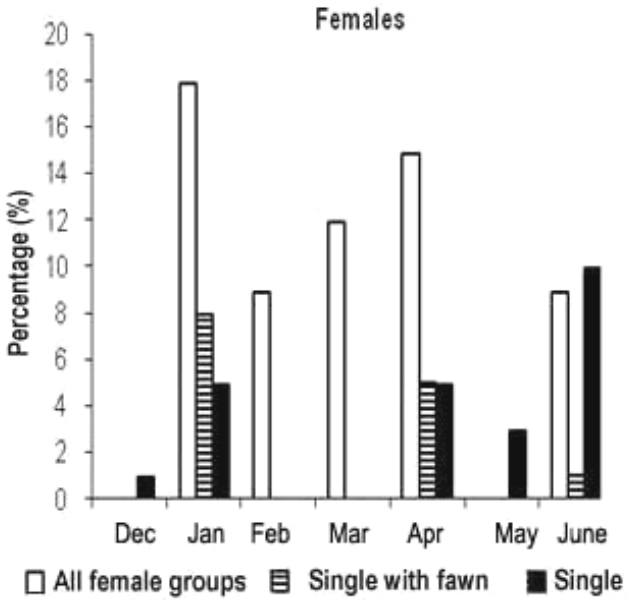

Figure 3. Monthly segregation of female swamp deer into monosexual groups in DTR.

Table 4. Number of adult males (AM), and fawn (FN) per 100 females in five different sites of DTR. N = no. of animals classified, * = KWS.

Sites	N	AM	FN
Kakraha	1829	45.13	34.84
Satiana	954	49.75	40.98
Jadi taal*	1107	50.73	22.15
Bankey taal	920	54.95	36.23
Bhadi taal	83	34.78	10.86

DISCUSSION

The Satiana area of DNP showed a drastic decline in population size of swamp deer for last 34 years between 1972 to 2006 (82.25%). Loses of swamp deer were severe between 1981 and 1989 (57.1%) and comparatively less between 1972 and 1981 (22.3%) between 1988 and 1989 (25%).

Table 3. Monthly group size of swamp deer group types in DTR.

Month	Total Sample		All Groups		Male Groups		Female Groups		Mixed Groups	
	NG.	NI	Mean	Range	Mean	Range	Mean	Range	Mean	Range
December	9	48	5.33	1-12	2.00	2-2	1.00	1-1	7.17	4-12
January	122	1373	11.25	1-120	8.76	1-65	5.75	1-28	21.28	2-120
February	47	876	18.64	1-76	3.82	1-10	13.36	2-22	28.42	3-76
March	40	819	20.48	1-202	4.42	1-9	9.25	3-21	40.94	2-210
April	65	2117	32.57	1-210	11.75	3-17	3.69	1-15	57.41	2-210
May	15	473	31.53	1-103	2.00	2-2	5.75	1-20	44.80	10-103
June	24	217	9.04	1-61	7.44	1-13	2.79	1-18	50.00	37-61
Total	322	5923	18.39	1-210	7.44	1-65	5.86	1-28	36.55	2-210

NG = number of groups, NI = number of individuals.

Data from this study favours the finding of Sankaran (1990), but contradicts Singh (1984) who postulated that one reason for decline of swamp deer population was due to high fawn mortality. Fawning success rate of 27.58% in 1980, 30.14% in 1988, 30% in 1989 and 37.08% in 2006 indicate normal fawning success as compared to other mono-tocous deer (Martin 1977, Schaaf 1978, Sankaran 1990). Moreover, percentage of females with fawn was higher in Satiana (12.96%) as compared to Kakraha (10.88%) and Jadi taal (8.89%) where population seems to be increasing from last few years. Moreover, fawning takes place in end of May to end of July. Swamp deer is a monoestrous deer with a gestation period of 240-250 days (Asdell 1964). The first fawn seen in this study was on 20 May 2006 suggesting conception starts in early September. Between 10th to 15th of July 2006, we searched entire grassland area of Satiana, but no swamp deer could be seen. This suggests that swamp deer starts migrating before the start of monsoon.

Holloway (1973), Singh (1984) and Sankaran (1990) recognized poaching as one of the cause for decline of swamp deer population in Satiana. Khan and Khan (1999) also recognized hunting solely responsible for decline of swamp deer population in Hastinapur Wildlife Sanctuary. The poaching of the swamp deer in Satiana may not occur inside the park boundary after establishment of National Park in 1977. It is fairly common outside the park in the agriculture fields. The swamp deer are therefore vulnerable to hunting when they leave the park and move towards their monsoon and early winter range in Ghola and Ghajrola taals. Swamp deer have been using Ghola and Ghajrola taals as rutting ground for several years. So, they traditionally move to these rutting grounds every year. Swamp deer are known to be traditional and have strong tendency to return to their seasonal ranges over the years (Martin 1977, Schaaf 1978, Ahmed and Khan 2005). Martin (1977) in Kanha National Park found that one wallow remained same between 1964-65 and 1972-73. This suggested strong traditional bond of swamp deer for their rutting ground which may force them to move outside the park boundary during monsoon and early winter in DNP. During this study Ghola and Ghajrola taals were visited frequently and it was seen that swamp deer used these areas not only during the breeding periods but also in other seasons. They took refuge inside the park boundary during the day time and raided the crops during the night. This mainly happened due to lack of aquatic vegetation and change in grassland composition due to siltation during annual flooding. As compared with terrestrial grasses, aquatic plants have higher sodium (Moe 1993). Natural salt licks containing high levels of Sodium have been found in Sal forest in the park. Swamp deer was never recorded at these salt licks during the entire study period. The other most common ungulate species in DNP, chital (*Axis axis*) was frequently observed at these salt licks, but it has never been reported feeding on aquatic vegetation (Dinerstein 1979b, Moe 1994). Although there are several taals in Satiana area in DNP, but actually none of them meet the requirements of swamp deer during the breeding season as these are quite deep. Therefore the protection of areas, like Badi taal, Jadi taal, Kakraha taal, Bankey taal carrying aquatic vegetation

will be essential for the long term conservation of the swamp deer and also for other endangered species which also feed on aquatic vegetation such as the greater one horned rhinoceros (*Rhinoceros unicornis*). The population of swamp deer is in good health in jadi taal area of KWS. The population of swamp deer in this area too has two distinct ranges. During winter and summer they remain in the Jadi taal but in monsoon population was not seen in this area. It is not clear where this population goes during monsoon. The overall mean group size in DTR was 18.25 which is similar to that reported by Sankaran (1990), but slightly lesser than that reported by Singh (1984) in DNP. The swamp deer in DTR shows monthly variation in-group size. It was highest in the month of April and lowest in December. Swamp deer forms larger groups after advancement of summer, when grasslands of DNP were burnt for management practices. Monthly variation in group size of swamp deer was also reported from other studies (Schaller 1967, Martin 1977, Khan and Khan 1999). Species which exhibit open membership social structure may show temporal variation in group size not only on seasonal basis but also during different time of the day (Sharatchandra and Gadgil 1975, Khan et al. 1995). Different group size categories showed that all male groups were consistently larger than female groups. Highest group size was recorded for mixed groups. After rutting the group tended to segregate into their own groups sex categories. The months thereafter from December onwards, brought a progressive segregation of swamp deer into groups of their own sex accordingly with an increase in group size of all male and all female groups. After the onset of the monsoon, swamp deer congregate on the large meadows with new grass sprout. The highest mean group size of 39.5 was recorded at this time. The situation drastically changed by the beginning of fawning period in May-June. Highest numbers of groups of single individuals were seen in these months. The sighting of maximum number of single females in these months, indicated separation of females for parturition. The group size differed between habitats and it formed larger groups in open areas (swamps and short grassland) than that in tall grassland. Several hypotheses have been proposed to explain this very pronounced inverse relationship between group size and cover density. By far the strongest and most widely accepted is that it is an adaptation among ungulate for predator avoidance (Dasmann and Taber 1956, Hamilton 1971). A single individual can effectively conceal in dense cover, where as this concealing effect is lost with a large group or herd. In open habitat reverse is true. Most ungulate are too large to be able to feed in the open and be concealed from potential predators at the same time. For that reason, species which normally utilize open grassland habitat typically occur in large groups or herds (Hirth 1977). In a large group, the collective senses of many animals can be used to detect approaching predators, and the probability that a given animal will be selected by a predator is reduced by a factor roughly equal to the number of animals in the group. The density of food resources alone may well explain the prevalence of small groups of ungulate in woodland habitat. Because of restricted sunlight at the forest floor, vegetation may be too sparsely distributed to support large feeding groups. In open fields or grasslands, all incoming solar energy strikes at the ground level and food resource may be dense enough to support large feeding groups of ungulate. However greater density of available food alone does not explain larger group size in open habitat as large group size means increased feeding competition for members of groups. On the other hand, several authors (Krebs et al. 1972, Bell 1973) have suggested some advantage to individual animals for feeding in large groups that may outweigh the competitive disadvantage. Intensive grazing by large groups of ungulates would clearly identify those areas that have been fed upon and those that had not and that would reduce search time spent covering areas that had been grazed earlier. In summary, a definite pattern relating group size to habitat type exists among ungulates. This relationship appears to have evolved as a means of avoiding predation and perhaps also as a means of optimizing feeding efficiency and forage production. Considering the high predator pressure on swamp deer as evident from scat analysis data (Ahmed 2007), predator avoidance seems to be far more important influence on group size than interaction with plant growth. Jungius (1971) noted the same effect with reedbuck (*Redunca arundinum*) in Kruger National Park, South Africa. Reedbuck normally occupies tall grass savanna areas with dense cover and occurs either solitarily or in small mother young groups. However during dry season the tall grass cover is frequently burnt and reedbuck are forced to feed in the open in large groups.

The sex ratio was 57 adult males to 100 females in DNP and 62 Adult males to 100 females in KWS. Other studies have also reported sex ratio biased in favour of female for this species (Schaller 1967, Singh 1984, Sankaran 1990 in DNP, Schaller 1967, Martin

1977 in Kanha National Park, Khan and Khan 1999 in Hastinapur Wildlife Sanctuary, Ahmed and Khan 2005 in Northern India). However the sex ratio was closed to 1:1 among yearlings in DNP, which points parity among sexes at birth. Martin (1977) also found equal sex ratio among yearlings in Kanha National Park. The sex ratio biased in favour of females has also been reported for other species of ungulate. Khan et al.1995 found biased sex ratio for chital, sambar and nilgai in Gir. There are several factors, which attributes disparity in adult sex ratio such as misclassification of individuals (Sharatchandra and Gadgil 1975 for chital), unequal probability of observation of adults in different season (Martin 1977 for swamp deer) higher mortality of male fawns (Schaller 1967) and selective predation on males (Schaller 1967, Berwick 1974, Johnsingh 1983). In South Asian ungulates solitary habits, proneness to injuries from intra-specific aggression, lack of alertness during rut and dispersal behaviour have also been considered some of the factors which make males more vulnerable to predation (Karanth and Sunquist 1992, Khan et al. 1995). Under the present study, considering the months of March, April and May, when large herd formation occurred after rut and controlled burning of grasslands, the entire population congregated at one place which allowed correct age and sex classification and therefore there was very little chance of misclassification and observed sex ratio of 57 adult males to 100 females in DNP and 62 adult males to 100 females in KWS is correct.

CONSERVATION MEASURES

Intensive patrolling of Ghola and Ghajrola taal which are outside the Park during monsoon and early winter is the immediate step to protect this endangered subspecies. Steps should also be taken to relocate the Ghola and Ghajrola villages, so that swamp deer of Satiana moves freely to its seasonal ranges. Steps should also be taken to create some artificial taals inside the Satiana grassland as an alternative so that swamp deer finds some suitable habitat inside the Park for their breeding and aquatic vegetation during monsoon. Intensive patrolling is also needed in Madraiya grassland to restrict the regular movement of villagers for grass cutting.

Protection of areas carrying aquatic vegetation like Badi taal, Jadi taal, Kakraha taal, Bankey taal and Nagra taal will be essential for the long term conservation of the swamp deer and also other endangered species like the greater one horned rhinoceros in DTR. In KWS (Jadi taal), immediate step would be to (construction of bandh check dam) on the Sarda river is required to save the area from flooding in monsoon. Long term study with radio collaring technique in both the sites will also help to understand seasonal migration pattern of swamp deer in both the areas.

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