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Factors influencing seasonal changes in the herd size and composition of swamp deer in Jhilmil Jheel Conservation Reserve, Haridwar, Uttarakhand, India

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Abstract
A small population of swamp deer (320 in number) was recently rediscovered in Uttarakhand state (in 2005) at Jhilmil Jheel (Sinha *et al.* 2006). Seasonal variation in herd size and composition of vulnerable swamp deer (*Rucervus duvaucelii duvaucelii*) were studied in this area using scan sampling technique. Largest herds (13) and highest male to female ratio (145:100) were observed during summer when deer congregate. Smallest herds were reported in monsoon due to poor sighting in dense vegetation cover. In monsoon, pregnant adult females observed to separate from the herds. The fawn to female ratio was highest in winters (59:100), as fawns were big enough to follow the mothers. It was concluded that the population structure variables are therefore most suitable tools to assess impact of habitat changes on swamp deer populations.

Key-Words: Bachelor group, Congregation, Jhilmil Jheel, Mean group size, Mixed group, Swamp deer

Introduction
Understanding behavioural and demographic aspects of wild animals facilitates population monitoring and effective conservation planning (Caughley 1977 and Khan *et al.* 1995). Swamp deer is a tropical gregarious cervid and it is known that the group size of gregarious cervids constitutes the most basic element of their social organization (Eisenberg 1966 and Crook *et al.* 1976). Their group size is more likely a sensitive reflection of the immediate effect of such important ecological parameters such as habitat structure, spatio-temporal distribution of food and predation pressure on group formation (Barrette 1991 and Raman 1997). Inter-related aspects, such as body size, metabolic requirements, home range and mating system also influence the group composition (Jarman 1974, Geraldeau 1988 and Fritz *et al.* 1996).

Age structure of a population is useful for understanding dynamics of population growth and estimating life history parameters (Spillett 1966, Caughley 1977 and Stearns 1992). It is expressed as the distribution of the number of individuals in each age group and reflects fecundity, mortality, reproductive status and population increase.

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A population consists of different age categories that exert an important influence on formation and shaping up of different groups (Krasinski 1978). A high percentage of young as compared to adults generally indicates a thriving population and vice versa.

The sex ratio is one of the important demographic parameters as in some species. The sex ratio is one of the important demographic parameters as in some species adult males have significantly altered the sex ratio in their populations due to poaching (Clutton-Brock and Albon, 1989). A solitary male dispersing from mixed group (due to wider movements into less well known areas, reduction of alertness during pursuit of females) is more vulnerable to predation (Karanth *et al.* 1995, Ramesh *et al.* 2009 and Ramesh 2010). De *et al.* (1966) suggested that more or less 1:1 sex ratio may usually be found in an area free from selective shooting or predation. In addition to above two factors, the intensity of intra-male competition results in greater male mortality (Berger *et al.* 1999). A population with more females than males generally has a higher reproductive potential than the one that is predominantly composed of males (De *et al.* 1966).

The barasingha or swamp deer (*Rucervus duvaucelii duvaucelii* Cuvier), an endemic cervid of the Indian subcontinent, is known to exhibit inconsistent grouping behaviour (Schaller 1967). The smallest groups (5-15) were formed during winter, followed by monsoon (10-

25) and summer (10-50) (Martin 1977, Schaff 1978, Singh 1984, Sankaran 1989 and Qureshi *et al.* 1995). The single individuals were observed largely during rutting season (winter and late monsoon) and large groups (mean 32, range 2-250) were found more common during summer, which is largely a congregation in response to new flush in burnt flood plain grasslands (Schaff 1978 and Qureshi *et al.* 1995). The all male group is largely seen during summer and late winter, while mixed groups are seen throughout the year with highest proportion in summer. Based on these studies, two main hypotheses have been put forward to explain the patterns of grouping behaviour in swamp deer. The first suggests that when in groups the animals can prevent or avoid the predation better than when alone (Hamilton 1971, Giest 1974 and Eisenburg 1981). The other hypothesis links the animal social organization with the breeding opportunities (Graf *et al.* 1966 and Fuchs 1977) and availability of its food supply (Altman 1952, Jarman 1974 and Lowe 1966). In the current article, we test these hypotheses using seasonal group size data collected over two years from six different vegetation types, viz., grasses, sedges, marshes, bare, tree meadows and paddy fields. One way ANOVA has been used to examine effects of season and vegetation types on group size and composition.

Material and Methods

Study area

Jhilmil Jheel is a saucer shaped wetland located between Haridwar–Najimabad highway and the River Ganges, in Chidiyapur Range of Haridwar Division, Uttarakhand state (India), covering an area of 37.83 km² of Reserve Forest and elevation ranging from 200 to 250 m asl (Anonymous 2005). The spectacular *terai* landscape of the study area is a mosaic of short and tall grasslands, tropical mixed moist deciduous forests, and secondary scrub (Fig. 1). Throughout the landscape, shifting of river channels (of the original river) over time has left behind many old channels where numerous seasonal and perennial swamps (‘*tals*’) or wetlands occur. The central swamp zone represents one such oxbow lake formed along the eastern bank of River Ganges. Surrounding areas get submerged during the monsoon. A number of small rivulets (total 32 in number) emerge from the woodland and discharge into Jhilmil Jheel, which ultimately drain into the Ganges. Most of them provide water throughout the year, while some dry up for about 6-7 months. The reserve area also receives water from the Shivalik formations of adjoining forests, as underground streams, locally called ‘*Choyas*’. The area experiences sub-tropical climate. Annual rainfall averages about 1300 mm (recorded between 1997 and 2007) and is most prominent during June-September (monsoon). Temperature soars up to 44°C in May and drops to 2°C in January. The texture of the soil varies from fine sand to clayey loam. The area is rich in faunal and floral diversity including spotted deer, elephant, blue bull, wild boar, monkey, *langur*, mongoose, hare, common leopard and occasionally tiger, jungle cat, otter, porcupine, *sambar*, barking deer and hog deer are also seen in the area. Avifauna includes a large number of resident and winter migratory birds. The dominant vegetation types include *Typha elephantine* L., *Phragmites karka* Retz., *Imperata cylindrical* L., *Vetiveria zizanioides* L., *Zizyphus mauritiana* Lam. and *Salix tetrasperma* Roxb.. The local inhabitants of Tantwala village, adjacent to Jhilmil Jheel consist of 146 households. They are of different communities’ viz., Punjabis, Sainis, Garhwalis, and Gujjars who settled here in early 1950’s. Before the enforcement of Wildlife (Protection) Act of 1972, limited wildlife shooting was permitted here. The working plans in the initial 70-80 years of the management history (1896-1973) aimed only at obtaining more revenue out of the forest wealth. Later in 1973’s onward there was a shift; with inclusion of wildlife conservation initiatives in the working plans (B.K.P.Sinha plan of 1973-89). On August 05, 2005 the government of Uttarakhand declared the area as a Conservation Reserve. Before this declaration people (villagers and illegally settled nomads, ‘gujjars’) were freely grazing their livestock in the grasslands of Jhilmil Jheel area. Later, gujjars were rehabilitated outside of reserve area (in adjoining forest divisions) along the River Rawasan (Figure 1).

Field methods

The number of individuals and age-sex composition of groups of swamp deer were recorded using instantaneous scan sampling (Altmann, 1974). The term, ‘group’ applies to all units of animals seen in one sighting (Khan *et al.* 2004). Over 250 detections of swamp deer groups were made over the two years of the study. Observations were made from selected vantage points in the area using a pair of 8X40 binoculars and 15X45 spotting scope. A scan was taken once in 15 minutes. Study time was from June 2006-2008 and was divided into four-month period corresponding to summer, monsoon, and winter. Monitoring was carried out from 0600-1800 hours. For each sighting of swamp deer, data were recorded on

(a) Vegetation/ habitat type

(b) Group composition and number of individuals

Individuals in the group were classified into different age and sex classes following Martin (1977) with appropriate modifications.

Data analysis

The sightings of swamp deer in different vegetation types were summarized for each season. One way ANOVA was used to test the variation in the group composition and mean group size in different vegetation types and seasons. All statistical tests were done using software SPSS. Sex ratio was taken as number of males in proportion to 100 females.

Results and Discussion

Group size

The overall mean group size of swamp deer for all the three seasons was 10±0.47. It was highest in summer 13±0.75 and lowest in monsoons 3±0.25 (Table 1). The mean group size varied significantly across different seasons ($F=34.780$, $df=2$, $p<0.05$).

Age and sex ratio

In winter, stags and hinds were found in 36:100 ratios in bare patch but mixed herds (1: 1) were found in marsh meadows. Fawn to female ratio was 1: 1 both in bare and marsh meadows. In summer, male herds were seen feeding in marsh meadows and bachelor herds were resting in tree patch. All other vegetation types witnessed mixed herds. 2 out of 10 females were accompanied by fawns. The male: female ratio varied significantly across different sites ($F=11.460$, $df=5$, $p<0.05$). In monsoon, paddy field witnessed male: female in 1:1 ratio and marsh meadows had 17:100 ratio. On an average, 4 out of 10 females were seen with fawns. The male: female ($F=6.016$, $df=1$, $p<0.05$) and fawn: female ($F=52.364$, $df=1$, $p<0.05$) ratios varied significantly across different sites. Overall 100 females had 122 males and 34 fawns. Highest number of males (145) was found in summers and lowest in monsoons (55). Maximum number of fawns was evident in winter (59) and lowest in summers (18) (Table 2). The male: female ($F=3.734$, $df=2$, $p<0.05$) and fawn: female ($F=10.340$, $df=2$, $p<0.05$) ratios varied significantly across different seasons.

Largest herds were found in summer similar to reports of previous authors (Martin 1977, Schaff 1978, Singh 1984, Sankaran 1989, and Qureshi *et al.* 1995). In contrast to observations of authors in past, smallest herds were reported in monsoon instead of winter, the reason being poor sighting on account of dense vegetation cover. Other observations (like bachelor herds, mixed herds, and single individuals seen in various parts of the year) were similar to those of earlier authors. In Jhilmil, it was observed that swamp deer form largest herd in sedge meadows. On the other hand, all the earlier studies have reported largest congregation of swamp deer from *Imperata* grasslands. The formation of largest herd could have been a response to feeding in open areas. Any kind of predator would find it difficult to approach and harm any individual animal in these large herds. This finding coincides with observation of Khan *et al.* (2004) and other above mentioned authors.

The fawn to female ratio was highest in winters, as fawning was over by this time and fawns were big enough to follow mother. Highest male to female ratio was observed in summer when deer congregate on the large meadows with new sedge (*Carex myosurus*) sprout. This means largest sized mixed groups were witnessed in summer. This finding is in contrast with observations of Khan *et al.* (2004). He observed that after rutting, in summer, the swamp deer group tended to segregate into their own group sex categories with an increase in group size of all male and all female groups. In monsoon, fawning affect the group structure. Single female in advanced pregnancy tend to separate from herd. The overall sex ratio for swamp deer in Jhilmil was 1:1. It was reported as 62 males: 100 females by Khan *et al.* (2004), 50 males: 100 females by Singh (1984), 45 males: 100 females by Sankaran (1989) and 75 males: 100 females by Martin (1977). All these studies showed biased sex ratio in favour of females. A contrast finding of the current study is probably due to uneven sampling.

Schaller (1967) stated that barasingha groups tend to break up and reassemble in different groups. It was observed during this study also, that barasingha groups occasionally changed their composition several times a day. These changes were particularly conspicuous during the dry season. This was the pinch period for swamp deer survival, when the daily movement pattern was strongly influenced by the availability of food, water, and shade. These frequent changes and the adaptation to different vegetation types lead to the conclusion that barasingha groups have no real constancy in the social sense. The highest degree of stability in this respect was noted during monsoon when food was abundant and daily movements at minimum. The only stable relationship between two animals seemed to occur between a hind and her fawn, until the latter was approximately one year old.

Conclusion

This study attempt to simultaneously examine the influence of several environmental and social variables on two measures of herd structure and it suggests that the fluid group formation in swamp deer is due to the behavioral modifications in lieu with the availability of preferred palatable species and breeding activity. Other factors, such as habitat structure and social behaviour too play a role, and our ability to detect their effects may depend on the habitats and index of group size used for comparisons. An admonition that needs to be added is that the swamp deer population in the study

area is a high-density population, thriving in the near absence of predation, and is therefore unlike many other natural habitats of swamp deer. Comparable studies from adjoining habitats (i.e. Banganga Wetlands) will be required to assess the generality of these results. It is recommended that future studies also focuses on the changes in probability of groups or individuals uniting as function of animal density, the effects of predator avoidance, and inter-annual variability in relation to per capita food availability, to further ascertain the factor(s) responsible for uneven sex ratio and seasonal variation in it, as well as in group composition of swamp deer.

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References

1. Altman M. (1952). Social behaviour of elk (*Cervus candensis* Nelsomi) in the Jackson hole area of Wyoming. *Behaviour* **4**: 116-143.
2. Altmann J. (1974). Observational study of behavior: Sampling methods. *Behaviour* **49**: 227-267.
3. Anonymous. (2005). *Jhilmil Jheel Conservation Reserve.* Forest Department, Government of Uttaranchal.
4. Barrette C. (1991). The size of Axis deer fluid groups in Wilpattu National Park Sri Lanka. *Mammalia* **55:** 207–220.
5. Berger J. and Gompper M.E.. (1999). Sex ratios in extant ungulates: products of contemporary predation or past life histories? *Journal of Mammalogy* **80:** 1084–1113.
6. Caughley G. (1977). *Analysis of vertebrate populations.* (Chichester: John Wiley).
7. Clutton-Brock T.H. and Albon S.D. (1989). *Red Deer in the Highlands*. Blackwell Scientific, Oxford.
8. Crook J.H., Ellis J.E. and Goss-Custard. (1976). Mammalian social system: structure and function. *Animal Behaviour* **24:** 261–274.
9. De R.C. and Spillet J.J. (1966). A study of the chital or spotted deer in Corbett National Park Uttar Pradesh. *Journal of the Bombay Natural History Society* **63:** 576–598.
10. Eisenberg J.F. (1966). The social organization of mammals. *Handbook of Zoology* **19:** 1–92.
11. Eisenberg J.F. (1981). *The Mammalian Radiation: An Analysis of Trends in Evolution; Adaptation and Behaviour*. Chicago University Press.
12. Fritz H. and Garine-Wichatitsky M. de. (1996). Foraging in a social antelope: Effects of group size on foraging and resource perception in impala. *Journal of Animal Ecology* **65**: 736–742.
13. Fuchs E.R. (1977). Behavior; In: *The Axis deer in Texas* (ed.) E D Abies (Texas: Caesar Kleberg) pp 24–52.
14. Geist V. (1974). On the relationship of social evolution and ecology in ungulates. *American Zoologist* **14**: 205-220.
15. Geraldeau L.A. (1988). The stable group and the determinants of foraging group size; In: (C.N. Slobodchikoff, ed) *The ecology of social behavior* Academic Press San Diego CA. pp 33–53. M.
16. Graf W. and Nichols L. (1966). The axis deer in Hawaii. *Journal of the Bombay Natural History Society* **63:** 629–734.
17. Hamilton W.D. (1971). Geometry for the selfish herd. *Journal of Theoretical Biology* **31:** 295–311.
18. Jarman P.J. (1974). The social organization of antelope in relation to their ecology. *Behaviour* **48**: 215–267.
19. Karanth U.K. and Sunquist E. (1995). Prey selection by tiger, leopard and dhole in tropical forests. *Journal of Animal Ecology* **64:** 439–450.
20. Khan J.A, Chellam R. and Johnsingh A.J.T. (1995). Group size and age-sex composition of three major ungulate species in Gir Lion Sanctuary, Gujarat, India. *Journal of the Bombay Natural History Society* **92:** 295–302.
21. Khan J.A. and Ahmed K. (2004). *Ecology and conservation of barasingha (Cervus duvauceli duvauceli) in Northern India*. Wildlife Society of India. Technical report no.16.
22. Krasinski Z.A. (1978). Dynamics and structure of the European bison population in the Białowieza Primeval Forest. *Acta Theriologica* **23:** 13–48.
23. Lowe V.P.W. (1966). Observation on the dispersal of red deer on Rhum; In: *Play Exploration and Territory in mammals* (Eds. P.

A. Jewell and C. Loizos) pp 211-228, Academic Press London and New York.

24. Martin C. (1977). Status and ecology of the Barasingha (*Cervus duvauceli branderi*) in Kanha National Park (India). *Journal of the Bombay Natural History Society* **74**: 60-132.
25. Qureshi Q., Sawarkar V.B. and Mathur P.K. (1995). *Ecology and Management of swamp deer (Cervus duvauceli) in Dudhwa Tiger Reserve U.P (India).* Project Report, Wildlife Institute of India, Dehradun.
26. Raman T.R.S. (1997). Factors influencing seasonal and monthly changes in the group size of chital or axis deer in southern India. *Journal of Biosciences* **28:** 203–218.
27. Ramesh T. (2010). *Prey selection and food habits of large carnivores: tiger (Panthera tigris), leopard (Panthera pardus) and dhole (Cuon alpines) in Mudumalai Tiger Reserve, Tamil Nadu.* Ph.D. Thesis, Saurashtra University, Rajkot, Gujarat.
28. Ramesh T., Snehalatha V., Sankar K. and Qureshi Q. (2009). Food habits and prey selection of tiger and leopard in Mudumalai Tiger Reserve Tamil Nadu India. *Journal of Scientific Transactions in Environment and Technovation* **2:** 170–181.
29. Sankaran R. (1989). *Status of the swamp deer in Dudhwa National Park (1988-1989).* Technical Report No. 14, Bombay Natural History Society, Bombay.
30. Schaff D. (1978). *Population size and structure and habitat relations of the Barasingha (Cervus d. duvauceli) in Suklaphanta Wildlife Reserve, Nepal.* Ph.D. Dissertation, Michigan State University, USA.
31. Schaller G.B. (1967). *The deer and the tiger.* Chicago University Press.
32. Singh V.P. (1984). *Bio-ecological studies on Cervus duvauceli duvauceli, swamp deer (Barasingha) in Dudhwa forest near Indo-Nepal border*, Ph.D. Dissertation, D. A. V. College, Kanpur University.
33. Sinha S.P. and Chandola S.S. (2006). Swamp deer sighting in Uttaranchal State, India. *Oryx*, **40** (1): 14-14.
34. Spillett J.J. (1966). The Kaziranga Wild Life Sanctuary, Assam. *Journal of the Bombay Natural History Society* **63** (3): 494-528.
35. Stearns S.C. (1992). *The Evolution of Life Histories.* Oxford University Press.

Table 1: Mean group size of swamp deer in different seasons
(N=No. of observations)

	Group size				
Season	**N**	**Mean**	**±S.E.**	**Minimum**	**Maximum**
Monsoon	83	3	0.25	1	11
Summer	688	13	0.75	1	104
Winter	371	6	0.24	1	38
Overall Mean	381	10	0.47	1	51

Table 2: Number of males (AM) and fawns per 100 females in different seasons
(N=No. of observations)

	Winter			Summer			Monsoon		
Vegetation type	**N**	**AM**	**Fawn**	**N**	**AM**	**Fawn**	**N**	**AM**	**Fawn**
Grass meadow				14	145	16			
Bare patch	11	36	73	3	78	0			
Marsh meadow	40	50	29	34	190	16	3	9	0
Sedge meadow				51	233	6			
Paddy field							5	100	80
Total	90	93	59	150	145	18	11	55	36

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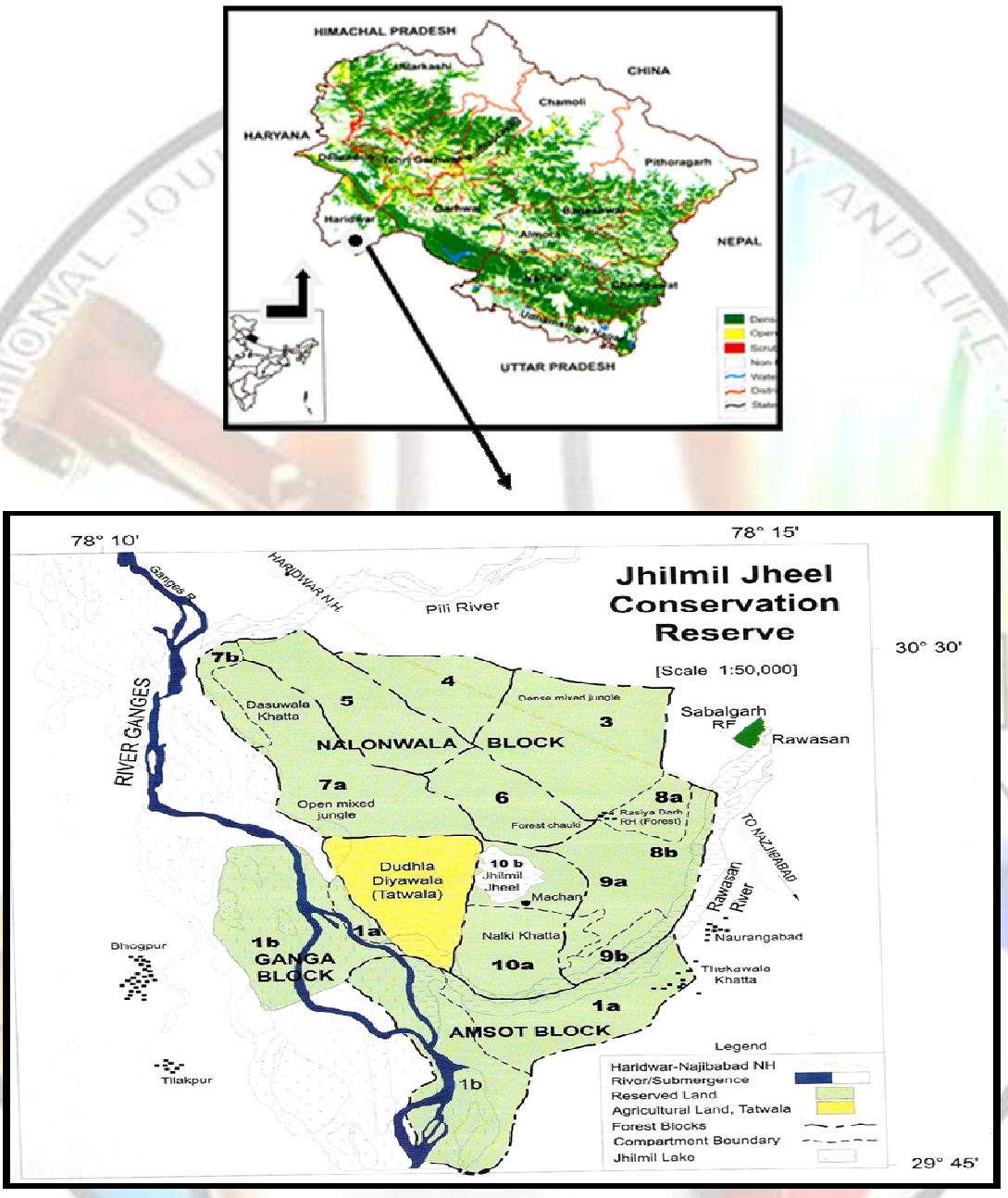

Fig. 1: Location map of Jhilmil Jheel Conservation Reserve*
***Source: Anonymous 2005**