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Habitat Use of Swamp Deer (*Rucervus duvaucelii duvaucelii*) in Jhilmil Jheel Conservation Reserve, Haridwar, Uttarakhand, India

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ABSTRACT

We studied the seasonal variation in the habitat use pattern of swamp deer (*Rucervus duvaucelii duvaucelii*) at Jhilmil Jheel (Uttarakhand, India). Swamp deer is categorized as vulnerable on the IUCN Red list. A small population of swamp deer (320 in number) was recently rediscovered in Uttarakhand state (in 2005) at Jhilmil Jheel. This population warranted a conservation initiative because the habitat around this study area is heavily fragmented due to expansion of agriculture, habitation and various other land use practices. The animals were observed from vantage points to record data on habitat utilization. In addition, relative abundance of swamp deer pellets was quantified in various areas to get an idea of relative use of habitat. The study reveals that swamp deer in Jhilmil Jheel prefer areas high in hydrophytes such as *Typha* which meet various cover requirements viz. food, hiding, fawning, rutting, basking, resting etc. Dense thickets of *Phragmites karka* were avoided during all seasons. In summers, sedge meadows are preferred for feeding, resting, wallowing, and drinking water.

Key Words: Cover; Directs Sightings; Habitat Selection; Pellet Groups; *Typha* sp.; Vegetation Types

INTRODUCTION

The swamp deer or *barasingha* (*Rucervus duvaucelii duvaucelii*, Cuvier, 1823) is a large, graceful deer, standing 135 cm at the shoulder and scales 170 to 180 kg. It is listed by IUCN as vulnerable, with the few remaining populations declining or already affected by habitat fragmentation due to expansion of agriculture, habitation and various other land use practices (Duckworth et al. 2008, Midha et al. 2010). The total world population of swamp deer is estimated less than 5,000 animals, occupying an area of less than 2,000 km² in isolated localities of north and central India, and southwestern Nepal. The species is extinct in Pakistan and Bangladesh (Qureshi et al. 2004).

Swamp deer is highly dependent on the availability of water. Historically, its preferred habitat was swampy grasslands and floodplains of Indian sub continent, but surrounding riverine forests and woodlands were also utilized. Swamp deer is mainly a grazer, eating grass and leafy aquatic vegetation. It feeds mainly in the morning and evenings, and in the midday heat it retreats to the shade or rest in the open. Where there is substantial human disturbance, the swamp deer is mainly nocturnal (Schaller 1967).

Schaller (1967), A. Singh (1978), Prater (1980), Singh (1984), Sankaran (1990), Qureshi et al. (1995), Qureshi et al. (2004) and Khan et al. (2004) studied habitat use by swamp deer of Dudhwa, and Schaaf (1978), Moe (1994), Pokharel (1996), Gyawali et al. (2005) and Bhatta (2007) studied swamp deer of Suklaphanta. They concluded that preferred habitats of swamp deer are marshes and short diverse grassland. Wooded grassland is utilized during hot season for resting. Tall grassland is required during mating and fawning period. The extent of use of a habitat by an

animal is determined largely by the extent to which the habitat can supply these requirements. Specific habitat requirements of a species need to be determined for their effective management and conservation (Eisenberg et al. 1976, Ben-Shahar 1990). Ungulates, especially the gregarious ones, often respond to climatic changes and the resultant changes in the habitat by altering herd size and patterns of habitat utilization (McNaughton 1985). For sexually dimorphic ungulate, gender may also influence the habitat utilization pattern (Xu et al. 2012).

In this context the present study became more important because the study area Jhilmil Jheel, a Conservation Reserve, is in the midst of human settlement and forms the natural habitat of swamp deer. The habitat utilization pattern of the animal was therefore much influenced by the existing human activities and increased the relevance of the study. It was hypothesized that the habitat utilization pattern of the swamp deer (both sexes) would differ from those of protected areas. So, the present study focuses on understanding the pattern of habitat use by swamp deer and at identifying the factors that govern such a pattern.

STUDY AREA

Jhilmil Jheel is a saucer shaped wetland located between Haridwar–Najibabad highway and the River Ganga, in Chidiyapur Range of Haridwar Division, Uttarakhand, covering an area of 37.83 km² of Reserve Forest and elevation ranging from 200 to 250 meters above MSL (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 (Figures 1 and 2). Throughout the landscape, shifting of river channels 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. Thirtytwo small rivulets emerge from the woodland and discharge into Jhilmil Jheel, which finally drains into the Ganga. Most of them provide water throughout the year, while some dry up for 6-7 months. The reserve area also receives water from the Shivaliks formations of Chidiyapur and adjacent ranges as underground streams, locally called ‘*Choyas*’. The area experiences sub-tropical climate. Annual rainfall averages about 1300 mm (recorded between 1997 and 2007) and most of it occurs during June-Septem-

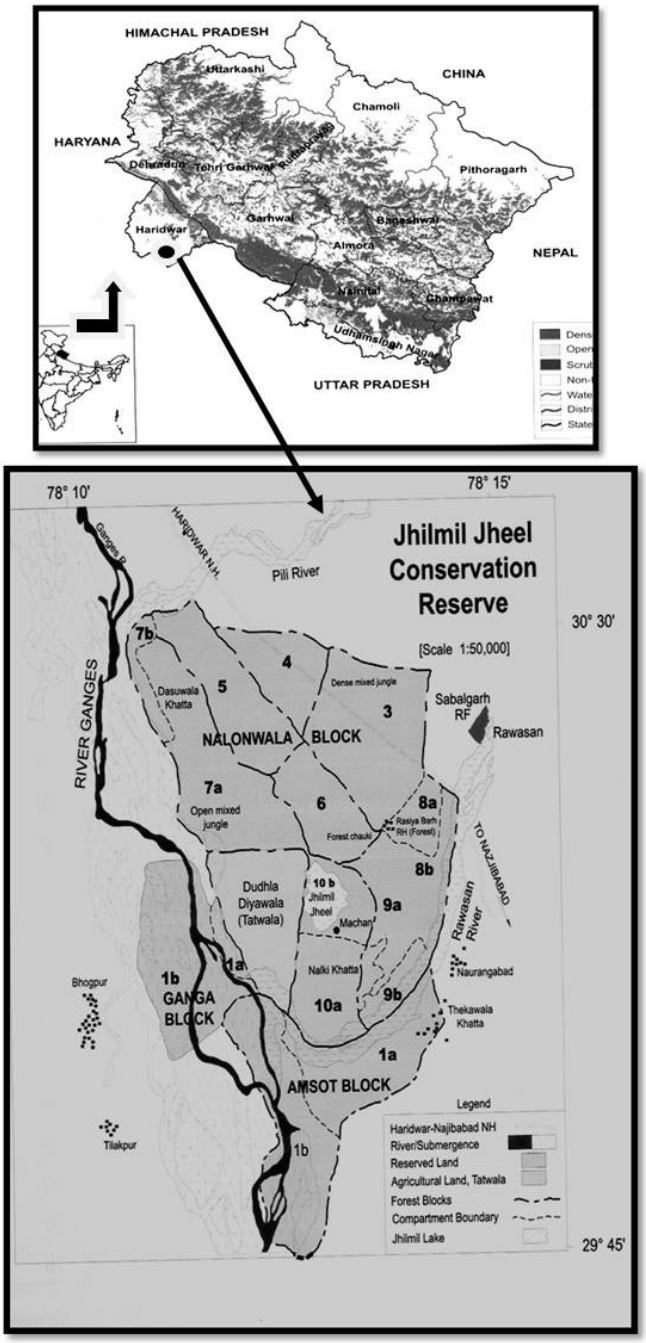

Figure .1 Location map of Jhilmil Jheel Conservation Reserve

ember (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 elephantina*, *Phragmites karka*, *Imperata cylindrica*, *Vetiveria zizanioides, Zizyphus mauritiana* and *Salix tetrasperma.* 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 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, g*ujjars* were rehabilitated outside of reserve area along the River Rawasan.

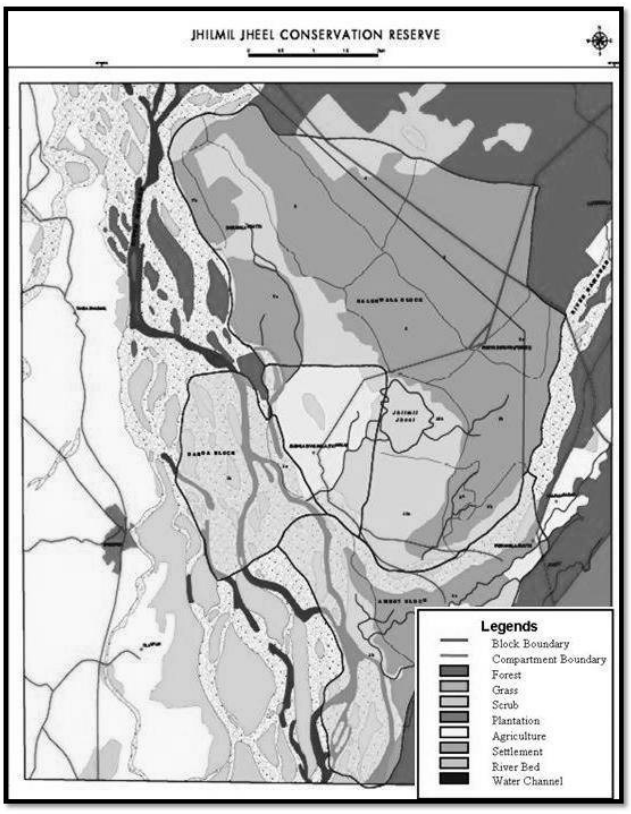

Figure 2. Land use/land cover map of Jhilmil Jheel Conservation Reserve

METHODS

Two approaches were used for quantification of habitat utilization. The first based on the direct sighting, while the second based on indirect evidences e.g. pellet groups.

Analysis Based on Direct Sightings

Monitoring was done from the vantage points/ observation post (Buckland et al 1993). Animals were observed with the aid of 15x45 spotting scopes and 8x40 binoculars. Only the major vegetation types (representing the prominent habitat categories viz., swamp, agricultural fields, and dry grasslands), recorded during the dawn to dusk observation were considered for analysis. For each sighting the vegetation type within 10m radius of animal was recorded. A chi-square goodness-of-fit test was carried out to determine whether vegetation types were used according to their abundance. To determine which vegetation types were preferred or avoided, Bonferroni simultaneous confidence intervals (Marcum et al. 1980) were calculated for the usage proportions. The proportions of different vegetation types within the study area were taken to represent the expected proportions of swamp deer usage, to which the confidence intervals were compared.

Analysis Based on Indirect Evidences

On the basis of year round utilization by swamp deer, 50 permanent circular plots of 10m radius were laid representing all the habitats in the study site. These plots were cleared before the onset of each season and counted for pellet groups at the end of each season to get a better picture of the overall seasonal utilization. Data on habitat parameters (tree canopy cover, shrub density, ground cover viz., grass, sedge, herbs and water) was collected from these plots. This quantification was repeated in each season (monsoon, winter, summer) as some parameters change with season.

The number of pellet groups of swamp deer in each sampled plot was used to calculate pellet group density (pellet group/m^2) in each plot.

The one way ANOVA was used to test for significant differences in mean pellet group densities vis-à-vis different habitat types, percentage grass/ sedge/ herbs etc. To understand habitat use of swamp deer, data were subjected to Principal Component Analyses (PCA).

RESULTS

Marcum-Loftsgaarden Analysis

Bonferroni's analysis showed that swamp deer consistently preferred tall marsh meadow (*Typha* spp.) during all the seasons. During monsoons, swamp deer avoided short grass meadow (*Cyrtococcum accrescens*). Herb meadow (*Mosla dianthera*), paddy field and tall grass (*Phragmites karka*) were used according to availability ($\chi^2 = 9.49$, d.f. = 4, $P<0.05$). During winters, swamp deer avoided short grass (*Imperata cylindrica*) and used open marsh according to availability ($\chi^2 = 5.99$, d.f. = 2, $P<0.05$). During summers, swamp deer avoided short grass (*Imperata cylindrica*) and open marsh, and preferred short sedge meadow (*Carex myosurus*). Short marsh (*Hygrophila polysperma*), herb (*Mosla dianthera*), tall grass (*Phragmites karka*) and tree patch (*Salix tetrasperma*) were used according to availability ($\chi^2 = 14.07$, d.f. = 7, $P<0.05$) (Table 1).

Based on 1-way ANOVA, mean pellet group densities differed significantly among different habitat types (p=0.000, df=4, F=15.331), (p=0.006, df=4, F= 3.702) and all the seasons (p=0.000, df=4, F=35.491).

Factors Governing Habitat Use

The PCA performed on the habitat parameters of utilized and available plots extracted three components. In summers, the PC I was positively correlated with tree canopy cover, shrub height and herb cover. The PC II was positively correlated with sedge, hydrophyte, and herb cover. While PC I was the 'woodland factor' (strongly related to tree and shrub attributes), PC II was the 'grassland factor' as it had strong relation with ground covers. The distribution of pellet groups in relation to first and second components is shown in Figure .3. It indicates that swamp deer prefer habitat with open canopy, low shrub density, good sedge, and hydrophyte cover.

During monsoons, swamp deer hardly utilized wooded areas and restricted itself to open grassland (Figure . 4).

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Table 1. Marcum-Loftsgaarden analysis for monsoon, winter and summer

Vegetation types	Expected Use	Season	Actual Use	Bonferroni Confidence Interval (Habitat Use)	Significance
Short grass meadow (*Cyrtococcum accrescens*)	0.3	Monsoon	0.03	$0.14 \le P \le 0.4$	Avoided
Herb meadow (*Mosla dianthera*)	0.09	Monsoon	0.01	$0 \le P \le 0.16$	Used in proportion
	0.06	Summer	0	$-0.02 \le P \le 0.14$	Used in proportion
Paddy field	0.21	Monsoon	0.15	$-0.07 \le P \le 0.19$	Used in proportion
Tall grass meadow (*Phragmites karka*)	0.02	Monsoon	0.02	$-0.05 \le P \le 0.05$	Used in proportion
	0.13	Summer	0.08	$-0.05 \le P \le 0.15$	Used in proportion
Tall marsh meadow (*Typha* sp.)	0.38	Monsoon	0.79	$-0.57 \le P \le -0.27$	Preferred
	0.66	Winter	0.78	$-0.24 \le P \le -0.01$	Preferred
	0.01	Summer	0.66	$-0.69 \le P \le -0.61$	Preferred
Short grass meadow (*Imperata cylindrica*)	0.22	Winter	0.06	$0.07 \le P \le 0.27$	Avoided
	0.42	Summer	0.07	$0.20 \le P \le 0.51$	Avoided
Open marsh meadow	0.12	Winter	0.16	$-0.12 \le P \le 0.03$	Used in proportion
	0.21	Summer	0.01	$0.07 \le P \le 0.32$	Avoided
Sedge meadow (*Carex myosurus*)	0.08	Summer	0.17	$-0.18 \le P \le -0.01$	Preferred
Short marsh meadow (*Hygrophila polysperma*)	0.08	Summer	0	$-0.01 \le P \le 0.16$	Used in proportion
Tree patch (*Salix tetrasperma*)	0.01	Summer	0	$-0.03 \le P \le 0.04$	Used in proportion

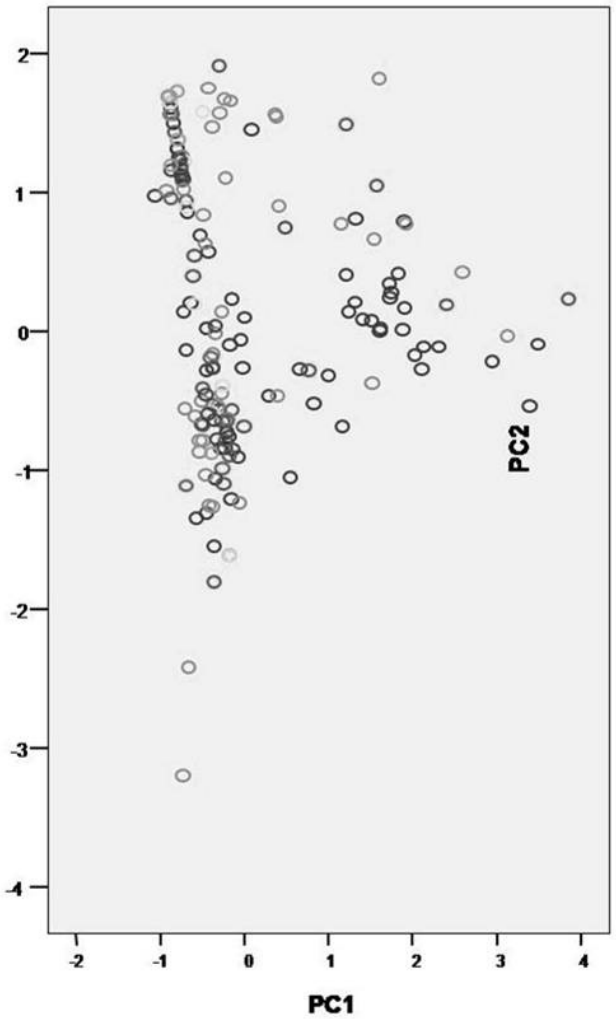

Figure 3. Ordination of pellet groups (PG) along first two components during summers

In winters PC I represented same woodland component as it was highly correlated shrub density, tree canopy cover, and grass cover. PC II was a component mix of both wooded areas and open grassy meadows as was highly correlated with tree canopy cover, shrub density and hydrophyte cover (Figure . 5).

DISCUSSION

We have observed that the swamp deer at Jhilmil avoided tall grassland of *Phragmites karka* possibly due to impenetrability, predation risk (viz. humans, wild boar, and leopard) and deeper water bodies. These observations are in agreement with reports of Arjan Singh (1978), Khan et al (2004), Gyawali et al (2005), and Bhatta (2007). In contrast, Martin (1977), Schaaf (1978), Moe (1994), Qureshi et al (1995), Pokharel (1996) and Qureshi et al (2004) have reported preference for tall grassland by swamp deer. They reported that, specific habitat requirement for rutting and fawning is tall grasslands. In our study area, *Typha* meadows formed rutting and fawning cover.

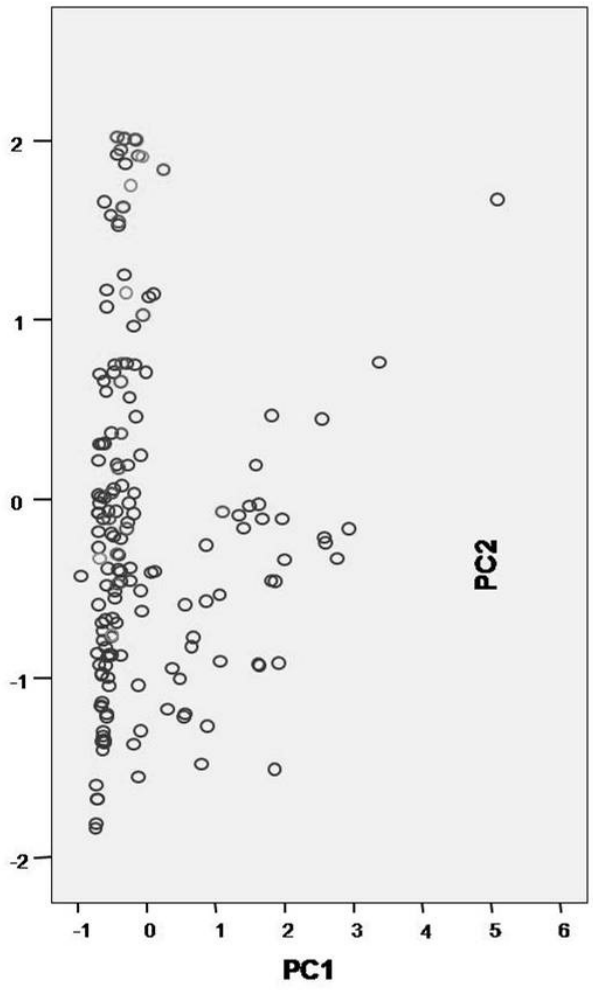

Figure 4. Ordination of pellet groups (PG) along first two components during monsoons

At Jhilmil, swamp deer were not able to utilize riverine forest due to inaccessibility whereas Gyawali et al. (2004) reported avoidance of riverine forest in Suklaphanta, due to lack of water and food plants.

In our study area, swamp deer avoided short grassland due to absence of hiding cover. In contrast, some earlier studies (Schaller 1967; Martin 1977; Schaaf

1978; Prater 1980; Singh 1984; Sankaran 1990; Gopal 1995; Qureshi et al 1995; Pokharel 1996; Banerjee 2001; Gyawali et al 2004; Qureshi et al 2004; Bhatta 2007) showed high preference for open short grasslands (*Imperata cylindrica-Vetiveria zizanioides-Saccharum spontaneum* association) for abundance of food plants and waterholes. In our study area, *Typha spp.* serves as the primary food plant round the year (*Carex myosurus* is the food plant in summers).

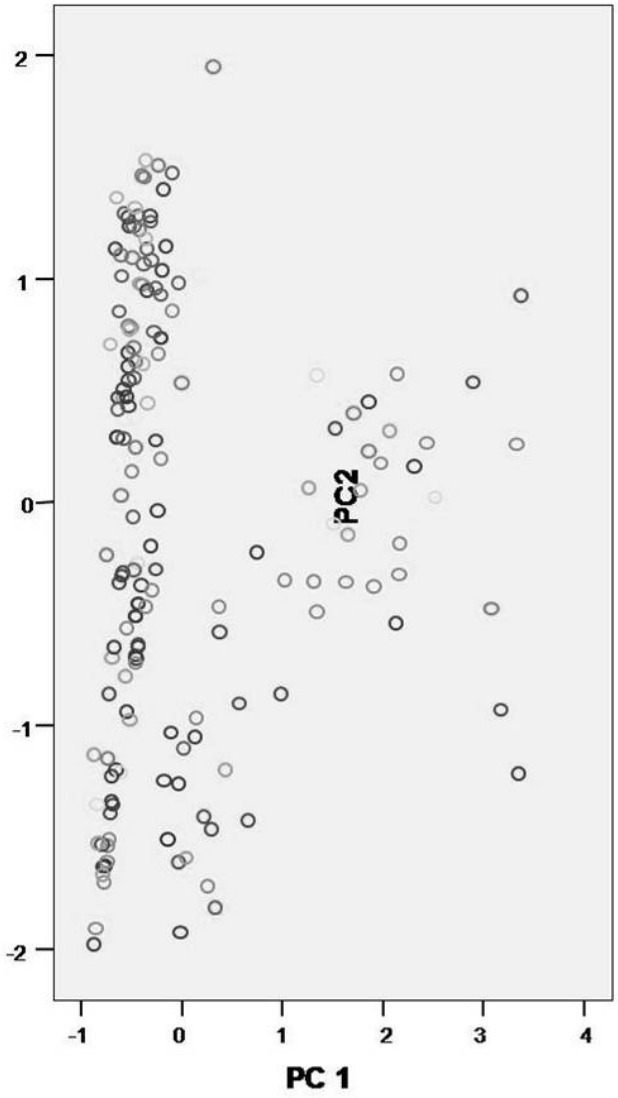

Figure 5. Ordination of pellet groups (PG) along first two components during winters

In the present study, during summer season, swamp deer rested under *Salix tetrasperma* trees in wooded grassland. This observation is in agreement with reports of Schaller (1967), Martin (1977), Schaaf (1978), Singh (1984), Gopal (1995), Qureshi et al. (1995), Gyawali et al (2004), and Qureshi et al (2004).

It is noteworthy here that our study area is a habitat island amidst a mosaic of human dominated landscape. The swamp deer here require a habitat that provides ample escape cover. When threatened, they take refuge in thick vegetation (pers. obs.). This is the other reason (the major being food availability) why *Typha* meadows are preferred in all the seasons.

CONCLUSION

Animals range within their habitat to obtain food, reproduces, and takes care of their young and to minimize chance of getting preyed upon. Therefore, in order to enhance their inclusive fitness, swamp deer should select habitats with an optimal availability of food and structural resources that maximize their survival.

The habitat variables recorded in this study can be grouped into those related to 'security' (hiding cover, distance from livestock), food, and cover which were revealed by factor analyses on the utilization data.

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