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Habitat occupancy of carnivore species in a riverine forest

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Key words: Riverine forest, Carnivore species, Habitat occupancy, Distribution, Relative frequency.

Abstract

Present study was conducted to check the distribution and habitat occupancy of carnivore species in riverine forest of Dera Ghazi Khan Forest sub-division, covering 1400 km² area during 2013-14. Direct observations and indirect signs were employed in seven selected sites on 52 fixed width transects which were seasonally surveyed (n=84) on foot and motor bike for observing carnivores using reference photographs and a field data sheet for each transect to record species signs and habitat type. Presence of five carnivore species was confirmed in the study including Asiatic Jackal (*Canis aureus*), Jungle Cat (*Felis chaus*), Small Indian Mongoose (*Herpestes javanicus*), Bengal Fox (*Vulpes bengalensis*) and Smooth-coated Otter (*Lutrogale perspicillata*). Relative frequency of signs for Asiatic Jackal was (0.459), followed by Jungle Cat (0.379), Small Indian Mongoose (0.116), Bengal Fox (0.031) and Smooth Coated Otter (0.013). Maximum sign density was found in site IV as 0.185. followed by site II (0.169), site VII (0.056), site I (0.048), site III (0.036), site VI (0.035) and 0.019 in site V. Seven habitat types were identified with highest species diversity in Grassland and Shrub land (five spp) followed by Forest and Crop land (four spp); three spp in Barren land and one species for Marsh land and Human habitation each. Sign observation points were plotted on map using GIS tool. Results showed that increasing human pressure, livestock grazing and change in land use pattern have adverse effect on habitat occupancy of these carnivore species.

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Introduction

Mammals being grazers, predators, pollinator and seed disperse,rs play an important role in sustaining an ecosystem structure and it's functioning. Small mammal influence vegetation, soils, and other animals; as influences on primary productivity of vegetation, plant species composition, and decomposition rates of plant materials. Furthermore influence concur on physical and chemical properties of soils. Small mammals prey on insects, invertebrates and other small mammals providing a prey base for large carnivores, and alter their environments by manners to provide habitat for other animals in that ecosystem (Hull and Carolyn, 1987).

Mammalian carnivores can serve as useful tools for the study of ecological disturbances of wildlife species or for conservation planning. Small carnivores prey on invertebrates and other small mammals, directly influencing prey populations densities and indirect influences on primary production. Insectivorous species may exert a regulatory effect on invertebrate populations as a high percentage of invertebrate consumption has been recorded in diet of small carnivores nearly in all grassland types (French *et al*., 1976).

Jungle Cat (*Felis chaus*) is an adaptable and most widely distributed small cat, is not strictly nocturnal and can be seen hunting in afternoon, inhabiting Pakistan (Roberts, 1997). It is also well adapted to live in forest plantations and known to occur at elevations of up to 2500 m, but are more common in lowlands (Nowell and Jackson, 1996, Ogurlu *et al*., 2010, Sunquist and Sunquist, 2002). Asiatic Jackal (*Canis aureus*) is a widespread species in Pakistan which is fairly common throughout its range having higher densities in areas with abundant food and cover. Their feeding habit indicate that they are beneficial for controlling the population of rodents in agricultural areas (Roberts, 1997).

Bengal Fox (*Vulpes bengalensis*) is omnivorous and opportunistic feeder, prefers semi-arid, flat to undulating terrain, scrub and grassland habitats where it is easy to hunt and dig dens. The species prefers areas with low rainfall having typically scrub vegetation, thorn or dry deciduous forests, or short grasslands (Johnsingh, 1978). Small Indian Mongoose (*Herpestes javanicus)* is a ground foraging, burrowing species, well adapted to live near human habitations (Mahmood *et al*., 2011). Generally *H. javanicus* occurs in agricultural areas, coastland, desert, natural forests, planted forests, range/grasslands, riparian zones, disturbed scrub, shrub lands, urban areas and also wetlands habitats (Nellis, 1989). In Pakistan, small Indian mongoose is most common carnivore species, distributed widely in southern Sindh and north-east Punjab (Roberts, 1997).

Smooth Coated Otter (*Lutrogale perspicillata*) is found through the lower riverine system of river Indus and up to the outer foothills of the Punjab. The otter hunts every fish species which can be found in Indus River. They travel considerable distances on dry land, when necessary (Roberts, 1997). River stretches with bank side vegetation and marshes are used in proportion to their availability especially in summer as these sites provide ample cover while travelling and foraging. Open clayey grounds and sandy banks are largely avoided as they lack escape covers (Hussain and Choudhury, 1997). Present study was conducted to confirm the presence and habitat occupancy of carnivore species in a Riverine forest habitat along River Indus.

Materials and methods

Study area

The study was conducted in Riverine forest of Dera Ghazi Khan Forest sub-division in the Punjab lying at 29°43'15"N to 70°41'16"E and 30°23'15"N to 70°54'16"E, 113 meter - 433 meter elevation having area of 4303 ha (Fig. 1). The area comprised 70 km long and 18 km wide strip along the River Indus. The area falls under sub-tropical thorn forest zone comprising of scrub forest, man-made sheesham plantations, marshy places and rangelands having

dominant plant species of Babool (*Acacia nilotica),*Sheesham *(Dalbergia sissoo),* Whistling thorn *(Acacia Arabica),* Athel pine *(Tamarix aphylla)* and Safeda (*Eucalyptus camaldulensis)* among trees while grasses and herbs included Puthkanda (*Cynodon dactylon),* Jangli Chulai *(Amaranthum viridis),* Takri *(Digitaris ciliaris), Conyza* spp, Charchitha *(Achyranthes aspera), Alhajai mororum,* Molk *(Cyperus rotundus),* Bur grass *(Setaria verticillata),* Wild sugarcane *(Saccharum spontaneum)* and Elephant grass *(Typha elephant).* Climate of study area is arid type with average annual temperature 25.7° C for the last 20 years. Average annual rainfall is 155 mm and humidity varies from 17 percent in the winter season to 73 percent during monsoon.

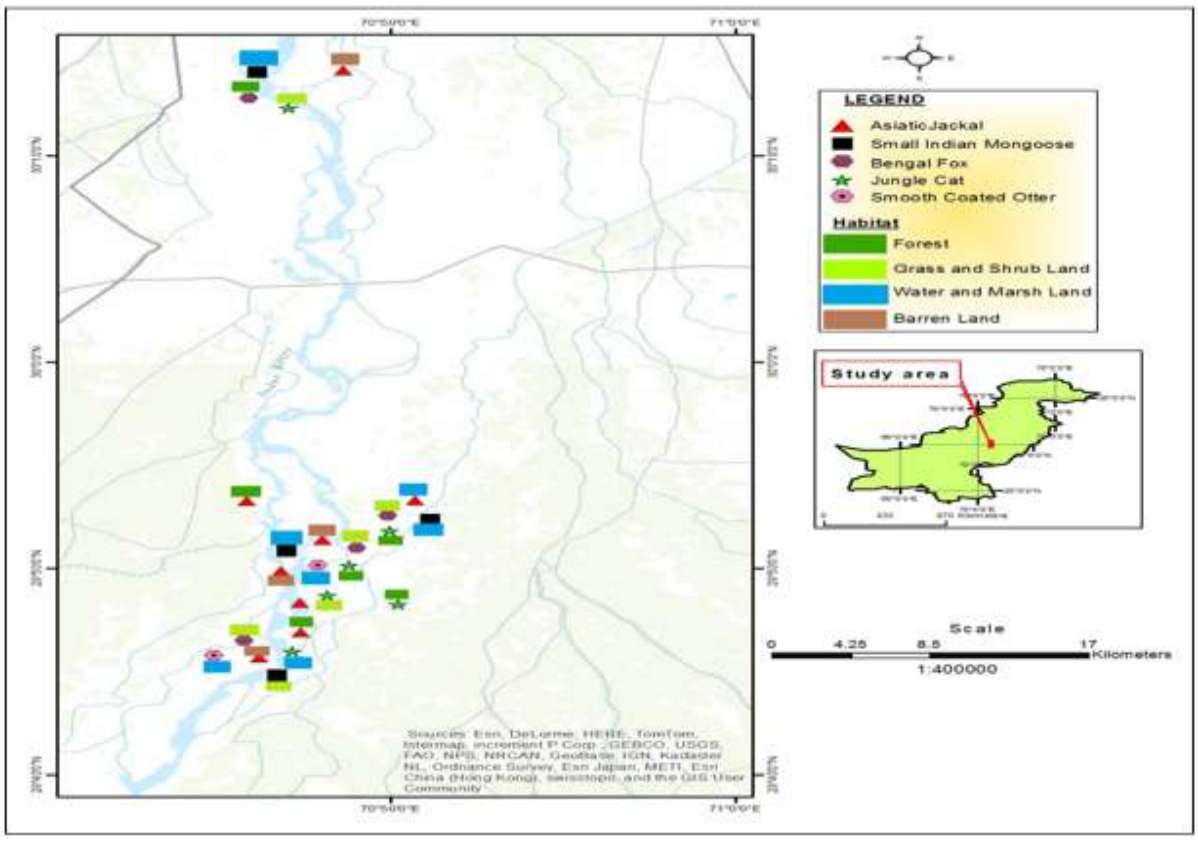

Fig. 1. Distribution of different carnivore species in the study area.

Study sites

Riverine forests of Dera Ghazi Khan Sub-division consist of two Blocks, Jhok Utra block and Shah Sadar Din block. Ten beats of these forest blocks were selected for data collection which lie under Riverine forest category and are not contiguous except Golewah beat and Hadair Malana beat. Natural forest in these beats was patchy mostly surrounded by river water, agricultural lands and human habitations. For this study seven out of 10 beats which lie out of water were surveyed for data collection on carnivore species. Basic information regarding study sites is provided in Table 1.

Questionnaire survey

Initially, a questionnaire survey was conducted to collect information regarding the presence/absence of carnivore species in the study area. Twenty six respondents were contacted from the local community and were asked that which species was observed by the respondents and what was intensity of encounter with the species. For this purpose meetings were arranged by staff of forest and wildlife departments with local inhabitants. Before conducting interviews, it was confirmed whether the respondent can recognize the carnivore species from their pictures.

Sign survey

Footprints are commonly used in carnivore studies to record the presence/absence data (Palomares *et al*., 1996, Wilson *et al*., 1996). Feces sampling have been one of the most used techniques for surveying carnivores (Wilson *et al*., 1996). Footprints (one trail as one sign), fecal samples, denning/burrowing sites and dead animals were used to record the data for species presence. Reference photographs of footprints were taken following Chris and Tilde (2007) and fecal samples following Chame (2003). In addition, experienced hunters from the region were contacted for identification of denning/burrowing sites, footprints and feces. Fifty-two data sheet were used to record field observations such as footprints, fecal samples, denning sites and dead animals and photographs of these signs were cross-matched with reference photographs following Mosheh (2009) and Sadlier *et al*. (2004).

Survey was conducted on 32 pre-determined line transects (500 m long & 50 m wide) for foot survey and 20 transects (1000 m long & 50 m wide) for motorcycle survey. Line transects were walked on foot and on motorcycle following Caughley and Sinclair, (1994). In motorcycle survey, a constant speed of 10-15 km/hour was maintained. Around 10-15% (360 ha) of total study area was covered under transects. Each transect was visited eight times, twice in each season i.e. Autumn (Sep 13-Nov 13), Winter (Dec 13-Feb 14), Spring (Feb 14-April 14), and Summer (May 14-July 14) for collecting data. GPS coordinates of transects as well as habitat type were recorded.

Habitat analysis

Habitat assessment of carnivore species was carried out in terms of physical features and types of vegetation which different habitat types in each transect were identified and recorded following May *et al.* (2008) and Copeland *et al.* (2007). Frequency of signs for different carnivore species in each habitat type was also calculated. Along with these, human disturbance and hunting pressure on carnivore species and their prey species was also recorded from local community and officials of Forest and Wildlife departments.

Statistical analysis

Analysis of 2-WAY ANOVA was carried out to find the significant interaction between species and between seasons. Where significant interaction was found LSD was applied. One sample T-Test was applied for significance difference between signs of the species, between seasons and in different habitats. For this analysis SPSS 20.0 was used.

Results

Prevalence of carnivore species

Five carnivore species were recorded in the study area including Asiatic Jackal (*Canis aureus*), Jungle Cat (*Felis chaus*), Bengal Fox (*Vulpes Bengalensis*), Smooth Coated Otter (*Lutrogale perspicillata*) and Small Indian Mongoose (*Herpestis Javanicus*) (Fig. 2).

A total of 224 signs of all five species were recorded including 204 footprints, five denning sites and six fecal samples during the survey. In addition, four denning sites, three fecal samples and two dead animals were recorded outside the transects in the study area. Out of total 224 signs, maximum signs were recorded for Asiatic Jackal, followed by Jungle Cat, Small Indian Mongoose, Bengal Fox and Smooth Coated Otter (Table 2, Fig. 3). Frequency of different signs is given in Fig. 3. Maximum signs were recorded from Rakh Bhatti Metla (I) followed by Rakh Patti Mir Mirani (II), Rakh Jhalar Latif Shah (IV), Rakh Goley Wah (III), Rakh Hadair Malana (VI), Rakh Rind Sewra (VII) and Rakh Khai Mahesran (V) (Table. 3).

The lowest sign density (0.019 signs/ha) was recorded in site V while highest sign density (0.185 signs/ ha) was recorded in site IV showing highest population of carnivore species in this site. The mean value for sign density was 0.078/ha (Table 3). Statistical analysis showed that signs were

significantly different between study sites (t=3.93, df=5, p=0.032) (Table 4).

Maximum signs were recorded during Autumn season (66) with slightly lesser (64) signs during Summer season while 50 signs were recorded during Winter season and 44 signs in Spring season with a mean of 54.50. Results showed that signs were significantly different between seasons (t=11.917, df=3, p=0.001) (Table 4). A significant interaction (p=0.046) of species was recorded between seasons and highly significance interaction (p<0.05) between species (Table 5).

Table 1. Characteristics of study sites in the study area.

Sr. No.	Forest Beat	Site code	Area (ha)	Coordinates	No. of Transects laid	Forest Block
1	Sabon Machi	X	478	under water	0	Shah S. Din
2	Rakh Bhatti Metla	I	1235	30°11′48.50″N , 70°48′43.93″E	11	,,
3	Rakh Patti Mir Mirani	II	271	30°03′03.29″N , 70°50′45.06″E	9	Jhok Utra
4	Jhalar Lateef Shah	IV	227	29°51′16.61″N , 70°40′31.42″E	10	,,
5	Rakh Khai Mahesran	V	255	29 45.923N, 70 45.593E	7	,,
6	Jampur Brahim	IX	409	Under water	0	,,
7	Patti Imam Bux	VIII	72	Under water	0	,,
8	Rakh Goley Wah	III	904	29°56′35.10″N , 70°48′25.08″E	7	,,
9	Rakh Hader Malana	VI	732	29°54′26.35″N , 70°43′44.58″E	6	,,
10	Rakh Rind Sevra	VII	213	29°25′13.54″E, 70°49′38.48″E	2	,,

Table 2. Types of signs of carnivore species recorded in the study area.

Carnivore Species	Footprints	Feces	Dead animal	Dens	Total	Relative frequency
Jungle Cat	81	4	0	0	85	0.379
Asiatic Jackal	93	5	2	3	103	0.459
Bengal Fox	5	0	0	2	7	0.031
Small Indian Mongoose	22	0	0	4	26	0.116
Smooth Coated Otter	3	0	0	0	3	0.013
Total	204	9	2	9	224	0.998

Habitats of carnivore species

Seven habitat types were documented in the study area which were being used by carnivore species including Forest Land, Shrub Land, Grass Land, Agricultural Land, Barren Land, Marsh Land and Human Habitation. Off the Total Transect Area (TTA), grass land habitat was recorded as 29 percent having dense vegetation of tall grasses providing cover habitat to carnivore species while 81 signs were observed in this habitat type. Shrub land habitat was 15 percent with thick cover of thorny bushy vegetation having comparatively lesser disturbance by humans and livestock with 67 signs.

Twenty three percent of land was covered by Forest land with 42 signs, eleven signs in Agriculture Land, nine Signs were recorded in Barren land while signs recorded from Marsh land were fourteen (Table 7), while table S6 defines the dominant vegetation type with species signs found. Results (t=2.93, df=5, p=0.032) showed that signs were significantly different between habitats (Table 4).

Table 3. Signs of carnivore species at different study sites in the study area.

No.	Species Name	Total observations of signs in the study area							
		Bhatti Metla (I)	Mir Mirani (II)	Goley Wah (III)	Latif Shah (IV)	Khai Mahesran (V)	Hadair Malana (VI)	Rind Sewra (VII)	Total
1	Jungle Cat	22	17	11	19	0	13	3	85
2	Asiatic Jackal	29	22	18	16	4	9	5	103
3	Bengal Fox	3	2	0	1	0	1	0	7
4	Smooth Coated Otter	0	0	1	1	1	0	0	3
5	Small Indian Mongoose	6	5	3	5	0	3	4	26
Total		60	46	33	42	5	26	12	224
Sign density (no. of signs/ha)		0.048	0.169	0.036	0.185	0.019	0.035	0.056	Mean = 0.078

Table 4. Summary on interaction between signs in different sites.

	Test Value = 0					
	T	Df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Signs density in different study sites	2.936	5	.032	37.33333	4.6511	70.0156
seasonal signs	11.917	3	.001	54.50000	39.9452	69.0548
signs per habitat type	2.936	5	.032	37.33333	4.6511	70.0156

One-Sample Test.

Discussion

Results from this study point out that the carnivore species, Asiatic Jackal, Jungle Cat and Bengal fox, had relatively similar habitat preferences. All three species carefully chosen uneven, forested and agriculture areas, but dissimilarly, Small Indian Mongoose selected open terrain near human habitation and agricultural crops while Smooth Coated Otter was restricted to marshy river patches having ample grassy vegetation cover.

Table 5. Summary of Two-Way ANOVA describing relationship of species with seasons.

Source	Type III Sum of Squares	DF	Mean Square	F	Sig.
Corrected Model	44.365[a]	7	6.338	78.548	.000
Intercept	50.944	1	50.944	631.378	.000
Animal	43.496	4	10.874	134.766	.000
Season	.869	3	.290	3.592	.046
Error	.968	12	.081		
Total	96.278	20			
Corrected Total	45.333	19			

a. R Squared = .979 (Adjusted R Squared = .966).

These results fit with the habitat description of said carnivore species by Majumder *et al.* (2011) and Rais *et al.* (2010). The lowest sign density was recorded in site V showing lowest population of carnivore species as the site was devoid of any vegetation cover except Grass land, and lies in the center of river Indus and remains under water during flooding months, while highest sign density was recorded in site IV showing highest population of carnivore species in this site and this was so because the site comprises six habitat types in good condition with minimum disturbance by humans and livestock, while the results by Sillero-Zubiri *et al.* (2004) and Kingdon (1988) show the similarity of habitat use by Asiatic Jackal ranging from deserts, to grassland and forest, and even semi-urban areas. Majumder *et al.* (2011) described

habitat use by the Asiatic Jackal as short to medium sized grasslands and savannas and in this study maximum signs for the species were found in grass land habitat. Asiatic Jackal was live seen in cotton fields, while denning site and footprints were recorded in agricultural area that shows the similarity of results documented by Nowak (1991).

Table 6. Use of habitat types by carnivore species in the study area with its dominant vegetation.

Sr. No.	Species	Habitats occupied	Dominant Vegetation
1	Jungle Cat	Grass Land	*Cynodon dactylon, Digitaris ciliaris, Conyza spp, Achyranthes spp, Setaria verticillata, Saccharum spontaneum*
		Shrub Land	*Acacia arabica, Tamarix aphylla, Acacia catechu*
		Human habitation	
2	Asiatic Jackal	Forest Land	*Acacia nilotica, Dalbergia sissoo, Acacia arabica, Tamarix aphylla* and *Eucalyptus camadulensis.*
		Agri. Land	Wheat crop, Fodder grasses, Rice crop, Sugarcane fields
		Shrub Land	*Acacia arabica, Tamarix aphylla*
		Barren Land	
		Grass Land	*Cynodon dactylon, Amaranthum viridis, Digitaris ciliaris, Achyranthes spp, Alhajai mororum, Aristida depressa*
3	Bengal Fox	Forest Land	*Acacia nilotica, Dalbergia sissoo, Acacia arabica, Tamarix aphyla* and *Eucalyptus camadulensis*
		Grass Land	*Cynodon dactylon, Amaranthum viridis, Digitaris ciliaris, Conyza spp, Achyranthes spp, Alhajai mororum, Aristida depressa*
4	Small Indian Mongoose	Agri. Land	Wheat crop, Fodder grasses, Rice crop, Sugarcane fields
		Grass Lands	*Cynodon dactylon, Saccharum spontaneum, Amaranthum viridis, Digitaris ciliaris, Conyza spp, Alhajai mororum, Aristida depressa, Setaria verticillata*
		Human habitation	
5	Smooth Coated Otter	Marsh Land	*Aristida depressa, Saccharum spontaneum,Typha elephanta.*

Table 7. Signs and extent of habitat types at different study sites in the study area.

Study Site	Forest land		Shrub land		Grass land		Agri. land		Barren land		Marsh land	
	% area	Signs	% area	Signs	% area	Signs	% area	Signs	% area	Signs	% area	Signs
I	20	14	15	18	35	22	0	0	10	4	5	2
II	40	10	10	13	25	15	10	4	10	2	5	2
III	10	4	15	12	15	14	0	0	0	0	5	3
IV	25	13	10	9	15	12	20	5	5	1	5	2
V	0	0	0	0	10	2	20	1	15	1	10	1
VI	0	0	5	12	10	10	0	0	0	0	5	4
VII	5	1	10	3	15	6	5	1	10	1	5	0
Signs	42		67		81		11		9		14	
TTA	23%		15%		29%		13%		11%		9%	

Bengal Fox signs were recorded from site I, II and IV comprised of forest land habitat as described in a study on ecology and behavior of Bengal Fox by Johnsingh (1978) reveals the use of forest habitat by the species while Roberts (1997) also quoted the use of said habitat by the species. Footprints and feces of Jungle Cat were recorded in shrub and grass land habitat same as Nowell and Jackson (1996), where the habitat types of the species were described as habitats near water, dense vegetation of grasses and shrubs, species also showed its predation on poultry and rodents near human dwellings resembling with Duckworth *et al.* (2005).

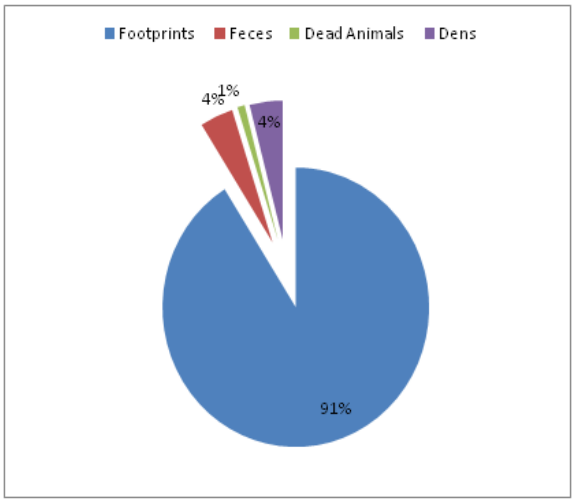

Fig. 2. Cumulative sign type recorded for carnivore species in the study area.

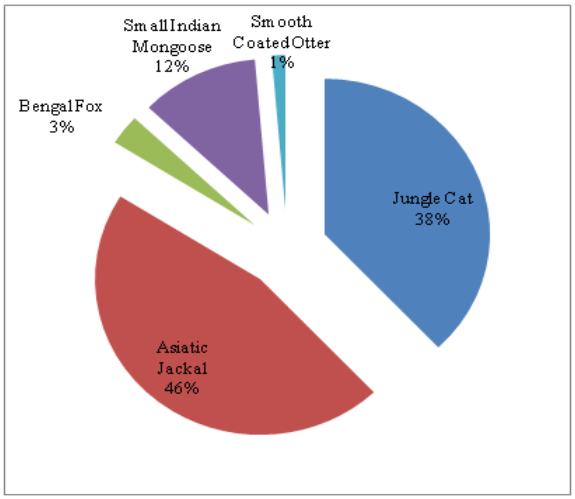

Fig. 3. Cumulative signs recorded for carnivore species in the study area.

Small Indian Mongoose showed burrowing site in wheat crop field adjacent to the study area and Nellis (1989), also described the occurrence of Small Indian Mongoose (*Herpestes javanicus*) in agricultural areas, several direct observations of Small Indian Mongoose in grasslands for burrowing and routine activities showed similarity of habitat use by Siddiqui *et al.* (2004). Footprints of otters were recorded from marsh land habitat along river bank side vegetation of tall grasses and tree dwellings on streams with mud and according to Hussain and Choudhury (1997), river stretches with bank side vegetation and marshes are commonly used in proportion to their availability, especially in summer as these sites provide ample cover while travelling and foraging, results of habitat occupancy by the species were completely overlapped with Rais *et al.* (2010).

Conclusion

The study reveals that highest species diversity can be found in areas with higher habitat diversity as in site (IV) five carnivore species presence was confirmed in seven habitat types while just one species in site (V) having patchy grass land habitat. Connectivity between habitats also accounts for higher species diversity. Rotation of site occupancy among Asiatic Jackal and Jungle Cat during autumn and winter season was also documented in grass and shrub land habitat. Presence of Small Indian Mongoose near human settlements showed its resistance to human disturbance.

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