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Amir Naseer

Department of Wildlife Management, PMAS-Arid Agriculture University Rawalpindi, Pakistan, amirnaseer431@gmail.com

Muhammad Bilal

Department of Biology, Virtual University of Pakistan, Lahore, Pakistan, shbilal7707@gmail.com

Umar Naseer

Institute of Molecular Biology and Biotechnology, University of Lahore

Naureen Mustafa

Department of Wildlife Management, PMAS-Arid Agriculture University Rawalpindi, Pakistan

Bushra Allah Rakha

Department of Wildlife Management, PMAS-Arid Agriculture University, Rawalpindi, Pakistan

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POPULATION DENSITY, HABITAT CHARACTERISTICS AND PREFERENCES OF RED FOX (*VULPES VULPES*) IN CHAKWAL, PAKISTAN

AMIR NASEER^{1*}, MUHAMMAD BILAL², UMAR NASEER³, NAUREEN MUSTAFA¹ AND BUSHRA ALLAH RAKHA¹

¹Department of Wildlife Management, PMAS-Arid Agriculture University Rawalpindi, Pakistan

²Department of Biology, Virtual University of Pakistan, Rawalpindi, Pakistan

³Institute of Molecular Biology and Biotechnology, University of Lahore, Pakistan

Corresponding Author*: Email: amirnaseer431@gmail.com

ABSTRACT

The Red fox (*Vulpes vulpes*) is a least concern carnivore according to the IUCN Red List of Threatened Species (2016). However, in Pakistan Red fox is considered as Near Threatened (NT), due to habitat destruction and depletion of food resources. The objective of the study was to identify habitat preferences and population density of Red fox in District Chakwal, Pakistan. Line transect census method was used to estimate the population density of Red fox through direct sighting and indirect method of burrow counting, presence of footprints and scats. A total of 10 transects were carried out at three potential sites: Devi, Photaki and Chumbisurla Wildlife Sanctuary (CWS) in Chakwal based on preliminary surveys. Habitat preference was estimated by comparing three different study sites by quadrat method and found that CWS area is preferred habitat for Red fox. A total of 24 plant species were recorded in the study areas, among them *Cynodon dactylon* is major herb found to provide shelter to Red fox in all study sites based on Importance value Index (I.V.I) at CWS (IVI=208.8) followed by Devi (IVI=185.93) and Photaki (IVI=142.33). The maximum population density of Red fox through direct sighting at CWS having 0.26 individuals/km² compared to Devi and Photaki having 0.16 and 0.13 individuals/km², respectively. The indirect estimation method revealed that maximum dens were found in CWS area compared to Devi and Photaki, while footprints and scats were found maximum in Devi and Photaki, respectively. It is concluded that Red fox preferred habitat is CWS site. Habitat destruction and conflicts with fox are causing the population of the Red fox to dwindle in Chakwal, Pakistan.

Keywords: Chumbisurla, wildlife sanctuary, habitat preferences, red fox, population density.

INTRODUCTION

Common red fox (*Vulpes vulpes*, Family, Mammalia: Linnaeus, 1758) is the most wide dispersed carnivore reported from North America, Europe, Asia, Africa and Australia (Cavallini and Lovari, 1994; White, et al., 2006). In the Palearctic and Indian zoogeographical region, including Pakistan, hold no less than 3 subspecies, viz., *V. v. montana*, *V. v. griffithii* and *V. v. pusilla* (Ellerman and Morrison-Scott, 1951; Roberts, 1997; Sheikh and Molur, 2004; Kumara and Singh, 2012). Convention on International Trade in Endangered Species of Wild Fauna and

Flora (CITES) places all three subspecies in Appendix III (Willem, 2001). IUCN considers common red fox as least concern (LC) globally (IUCN, 2020), while. In Pakistan, red fox is declared as regarded as near threatened (NT) due to habitat loss and reduction in the availability of food resource (Sheikh and Molur, 2004) and it ranges from plains and forests to high elevations (Roberts, 1997).

Red fox is very adaptable species. It is different from jackals (*Canis aureus*) in having more robust body, a longer, bushy and tapered tail with pure white tip and back of the ears velvety-black. The proximal regions of tails are wider

(Roberts, 1997). Red fox avoids thick forest and is found in all open countryside, especially in fragmented and mixed shrub areas (Albes, 1975; Nakazono, 1989; Cavallini and Lovari, 1994). In the Indus plains it prefers extensive uncultivated tracts with sand-dunes. It occurs throughout the mountainous areas, valleys and higher mountain slopes of Baluchistan, Khyber Pukhtunkhwa and the Himalayas (Roberts, 1997).

Many abiotic and biotic factors like temperature, day length, climate, season, shelter, habitat productivity, prey availability, inter and intraspecific competitions affect the population density of animals (Barton and Zalewski, 2007). Habitat preferences affect the population density of red fox (White et al., 2006). Also habitat productivity has the strongest impact on the population sizes of predators but it may vary from species to species and environment.

Carnivores of Pakistan are under severe pressure of human-wildlife conflict carrying wild fauna to the verge of extinction. In developing countries the killing of livestock by canines is a major cause of human-wildlife conflict (Distefano, 2005). It was the need of time to study the habitat preferences and population density of red fox for better conservation of this important carnivore species in the country. The magnitude of human-wildlife conflict, related to livestock predation, obviously affects the abundance of their predators (Mahmood et al., 2013), due to illegal poaching and killing.

Therefore a reliable study for aforementioned parameters was of paramount significance. There were a few studies for the population density characteristics and habitat preferences of red fox in Pakistan, especially in the District Chakwal. So the present study was designed to find out the population density and habitat preferences and to determine the fox presence and its other characterises

in the disturbed and relatively undisturbed areas of District Chakwal, Pakistan.

MATERIALS AND METHODS

Study Site

Chakwal (32.9328° NL, 72.8630° E; Pothohar Plateau) is hilly country with reddish-brown soil. The environment is arid and cool, with sub humid climate. This area comprises of hilly undulates, with sandy patches (Chaudhry, et al., 2001). Almost 80% of human population lives in rural areas (Figure 1).



Figure 1: A satellite image showing location of the three selected study sites namely Devi, Photaki, Chumbisurla Wildlife Sanctuary (CWS) in District Chakwal, Pakistan. (Taken and modified from Google My Maps).

The average rainfall is 800 mm mostly received during monsoon between mid-July and mid-September. The winter rain begins in January and persists up to early March. The mean monthly temperature ranges 5.9-38.4°C, January being the coldest and June the hottest month of the year. Temperature during summer is 15-40°C and during winter is 4-25°C. In winter the temperature often drops to below freezing level, usually in December and January.

Devi, Photaki and Chumbisurla Wildlife Sanctuary (CWS) were selected to study habitat preference and population density of red fox. Devi (Site-I) 32.2088° NL 73.0496° E has a relatively undisturbed wild area having forest. Photaki (Site-II:

32.9725° NL, 73.1706° E) have widely distributed agricultural field having some irrigation from small dams and is human disturbed. . CWS (Site-III: 32.6268° NL, 72.1772° E) comprises of forested area, with higher human population and disturbances.

Study Design

Potential sites were selected on the basis of preliminary surveys and visited on weekly basis between November, 2013 and November, 2014, with a total of 96 field hours.



Figure 1: Topography of the Photaki site. Soil of the area is reddish-brown with mountainous and stony patches.

A total area of 30 km² was selected, 10 km transect from each selected site. Line transect sampling (Anderson et al., 1979; Varman and Sukumar, 1995) was used to estimate the population density (Burnham et al., 1980) of red fox through direct and indirect method (dens counting, footprints, scats) sightings.

Ten transects (each 3 km long) were laid. Four experienced observers randomly searched while walking along the transect line in morning and evening hours (Sutherland, 1996). Reinforcing inferential surveys were also done during day time. We searched red fox by naked eyes and/ or using Russian Tecno-Sehfeld Military Binoculars (20 x 56) without causing disturbances for the animal (Bilal et al., 2020).

Pugmarks were identified by using guide book (WWF-India, 2005). Scats are the sign of the presence and activity of an animal (Telfer, et al., 2006). The finding of relationship between species' habitat and scats are utmost important to study scats (Telfer et al., 2006). Scats were collected, packed separately in in plastic bags, labelled, brought back to the laboratory and stored at 0°C for further analysis. Scats appearing too old, completely dried decayed were excluded from the analysis.

All types of data were noted on a data sheet (Bilal et al., 2020) in the field, such as habitat characteristics, vegetation and area type. Fox abundance was estimated by using direct and indirect signs data. Photographs were also made (Bilal et al., 2020) with the help of Nikon d5300 (18-55 mm) DSLR Camera.

Vegetation Analysis

For habitat characterization samples of trees, shrubs and herbs species of both study sites were collected, identified and preserved on herbarium sheets as reference materials. For trees, shrubs and herbs species, data were recorded following quadrat-count Method (Haggett et al., 1965; Diggle, 2003). Quadrats were laid out randomly in each sampling site. For trees 10 m x10 m, for shrub species 4 m x 4 m and for herb species 1 m x 1 m quadrats were established to calculate density, frequency, cover and for calculation of importance value index (IVI).



Figure 2: Habitat of red fox at Devi site. There were agricultural fields but undisturbed side-patches provided a red fox suitable habitat.

Following formulae were used for various calculations:

$$\text{Relative density} = \frac{\text{Total number of individuals of a specie}}{\text{Total number of all individuals of all species}} \times 100$$

$$\text{Relative frequency} = \frac{\text{Frequency of a specie}}{\text{Total frequency of all species}} \times 100$$

$$\text{Relative cover} = \frac{\text{Cover of individuals of a specie}}{\text{Total cover of all individuals of all species}} \times 100$$

(IVI)

Importance Value Index (IVI) for plant species (trees, shrubs and herbs) was calculated by the following formula:

$$\text{Importance value index (IVI)} = \text{Relative density} + \text{Relative frequency} + \text{Relative cover}$$

RESULTS AND DISCUSSIONS

Red fox prefers a mixture of forest and open country. Farmland with woodlots and brushy areas near marshes and swamps are ideal habitat for this species. Red fox is mostly considered as nocturnal (Albes, 1975; Maurel, 1980; Blanco, 1986) though some high diurnal activity of the species has been recorded by some other workers (Lovari et al., 1991; Cavallini and Lovari, 1994). In the present study we found its diurnal activity with the evidence in the Figure 6. The habitat there was stony, mountainous and rugged with redish soil, such a habitat provide good camouflage to this animal.

Red fox is very adaptable species and can be found in many habitat types, including, shrub-land. This is shown in the Table 1. During the surveys in winter seasons it was observed that Red fox remain more or less in their shelter. In rainy days it was found more frequently in *Cynodon dactylon* while confining there

for a day or two. We found that different patterns of the use of space by Red fox depend mainly on the undisturbed habitat, distribution and availability of food patches.

Nevertheless, suitable areas for dens can also influence population density and habitat utilization. In fact, landscape modifications such as habitat patchiness made by human activities (agricultural practices and urbanization) should create ample inauspicious zones for den settlement. Habitat selection was influenced by water availability and irrigated tree plantations that modify soil textures allowing digging of dens. Moreover, asphalt roads limited den settlements that restricted its population abundance.

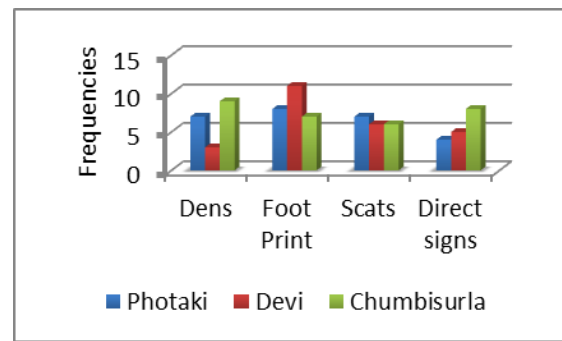


Figure 3: Bar graphs showing frequencies of dens, footprints, scats, direct sightings recorded at three study sites.

Signs survey method was used for the survey (Harrington and Mech, 1982) this method is used when direct signs are difficult to note due to some restraints. So this method has some pros and cons as well (Kendall, et al., 1992; Clevenger and Purroy, 1996). During active searching total 17 red foxes were directly sighted, while 19 active dens were recorded. We identified 26 footprints and 19 scats.

Table 1 showing the relative density, relative frequency, relative cover and Importance Value Index (IVI) of vegetation (trees, shrubs and herbs) present in the habitat of Red fox. In the habitat of Red fox total 6 tree, 6 shrub and 12 herb species were found by quadrat method.

Acacia modesta was with highest IVI providing more cover in all of these sites. Among the shrubs *Ziziphus jujube* was the most abundant at all the sites and with highest IVI value as shown in the Table 1. *Cynodon dactylon* was seen providing shelter and cover to the foxes, it was most abundant at all the study sites.

Devi (Site-I)

At Devi there were fewer disturbances than the other two sites, so the activity of the foxes was more than other sites in term of footprints. Three dens, eleven footprints, six scats were recorded. Figure 4 is showing a den at this site. At this site five foxes with the population density of 0.16 individuals/km² were directly sighted. A large wild area was present there that might be the cause of most sightings there. Moreover, abundant food and shelter was also present there. Due to the competition with other species like Asiatic jackals (*Canis aureus*), Indian monitor lizards (*Varanus bengalensis*), Indian grey mongoose (*Herpestes edwardsii*) for shelter and food, red fox were not thriving as good population. At this site footprints were maximum of all sites that might be due to the clayey soil that retained impression of foot for a longer time with ease. There were found comparable scats than all other sites. Less population density there might be due to the less food availability.

Acacia modesta had the more abundance so having highest IVI (70.0) at the Devi and provide the cover for the habitat of the species. *Dalbergia sissoo* (IVI= 27.5) had the least cover available there. *Melia azedarach*, *Acacia nilotica*, *Morus alba*, *Eucalyptus camaldulensis* were not present at Devi site. *Ziziphus jujube* (IVI= 124.19) and *Cynodon dactylon* (IVI= 185.93) were among shrubs and herbs were providing the shelter and more cover for the Red fox. During the winter season only this cover was observed to provide the shelter and

source of food for the Red foxes.

Shrubs: *Gymnosporia royleana*, *Prosopis julifera*, *Tribulus terrestris* and herbs: *Saccharum bengalensis*, *Babur spp.* *Parthenium hysterophorus*, *Launaea procumbens*, *Rumex obtusifolius*, *Euphorbia helioscopia*, *Malva neglecta* could not be found at Site-I.

Photaki (Site-II)

At Photaki seven dens, eight footprints, seven scats and four direct sightings (0.13 individuals/km²) were made during the surveys. Due to many disturbances in this area relatively lesser abundance than Site-III (CWS) was present there. Pulliam and Danielson described that due to anthropogenic activities, resulting habitat destruction and degradation causes population density of species to dwindle and alter in their composition (1991). The population size may vary with the availability of fragmented habitats after habitat destruction. Dam and agriculture were the main disturbances in this area. Dams restricted their movements during seasons. Also agricultural practices might keep them restrained to a particular habitat. This would be the reason for more scats at this site. Direct sightings in the agricultural area were also observed at this site.

The encroachment of human hamlets and disturbances upon surrounding ecosystems causes degradation of those ecosystems (McKinney, 2002; Dudus, et al., 2014). Less population density might be due to the vulnerability of the prey species and more competition with other species viz. Asian Jackal, Indian Monitor Lizard. Nine dens were identified as the shelter of foxes.

At Photaki *Acacia modesta* (IVI= 83.47) was find out to be the most abundant tree species and shrub *Ziziphus jujube* (IVI= 71.72) cover was the more abundant and only second to *Gymnosporia royleana* (IVI= 89.31).

Table 1: Relative cover, relative frequency, relative density and importance value index (IVI) of plant species in red fox habitat.

Species	Relative Cover			Relative Frequency			Relative density			Importance Value Index (IVI)			
	Site I	Site II	Site III	Site I	Site II	Site III	Site I	Site II	Site III	Site I	Site II	Site III	
Trees													
<i>Acacia modesta</i>	20.0	33.47	22.72	25.0	25.0	22.22	25.0	25.0	21.43		70.0	83.47	66.38
<i>Dalbergia sissoo</i>	8.57	12.55	-	12.5	8.33	-	6.25	6.25	-		27.5	27.13	-
<i>Melia azedarach</i>	-	4.18	17.68	-	8.33	22.22	-	12.5	21.42		-	25.01	61.32
<i>Eucalyptus camaldulensis</i>	-	15.48	-	-	16.67	-	-	18.75	-		-	50.9	-
<i>Acacia nilotica</i>	-	10.04	-	-	16.67	-	-	12.5	-		-	39.21	-
<i>Morus alba</i>	-	-	9.09	-	-	11.11	-	-	7.15		-	-	27.35
Shrubs													
<i>Adhatoda zeylanica</i>	51.16	-	-	40.0	-	-	40.0	-	-	131.16	-	-	-
<i>Ziziphus jujube</i>	44.19	19.45	52.01	40.0	25.0	42.86	40.0	25.0	40.0	124.19	71.72	134.98	-
<i>Calotropis procera</i>	4.65	5.54	5.79	20	6.25	14.29	20.0	6.25	20.0	44.65	20.89	40.08	-
<i>Gymnosporia royleana</i>	-	37.04	15.06	-	25.0	28.57	-	25.0	20.0	-	89.31	43.75	-
<i>Prosopis julifera</i>	-	18.52	-	-	18.75	14.28	-	18.75	20.0	-	55.45	61.31	-
<i>Tribulus terrestris</i>	-	19.45	27.03	-	25.0	-	-	25.0	-	-	62.63	-	-
Herbs													
<i>Dab spp.</i>	12.05	12.47	-	20.0	10.0	-	5.20	10.0	-	37.28	37.85	-	-
<i>Cynodon dactylon</i>	65.06	35.46	78.34	40.0	76.0	36.37	80.92	76.0	94.09	185.93	142.23	208.8	-
<i>Lilihe spp.</i>	8.03	1.38	-	10.0	0.66	-	2.31	0.66	-	20.34	9.73	-	-
<i>Fumaria indica</i>	8.84	4.99	3.82	20	4.99	9.09	4.62	4.99	1.61	33.46	25.04	14.52	-
<i>Typha spp.</i>	6.02	-	-	10.0	-	-	6.95	-	-	22.97	-	-	-
<i>Saccharum bengalensis</i>	-	44.32	-	-	7.34	-	-	7.34	-	-	74.74	-	-
<i>Babur spp.</i>	-	1.38	-	-	1.34	-	-	1.34	-	-	10.41	-	-
<i>Parthenium hysterophorus</i>	-	-	2.87	-	-	9.09	-	-	1.08	-	-	13.04	-
<i>Launaea procumbens</i>	-	-	4.78	-	-	18.18	-	-	1.61	-	-	24.57	-
<i>Rumex obtusifolius</i>	-	-	1.59	-	-	9.09	-	-	0.54	-	-	11.22	-
<i>Euphorbia helioscopia</i>	-	-	3.82	-	-	9.09	-	-	0.54	-	-	13.45	-
<i>Malva neglecta</i>	-	-	4.78	-	-	9.09	-	-	0.54	-	-	14.41	-



Figure 4: Red fox den at Devi site located at the unreachable place.



Figure 5: Red fox at Photaki site during its diurnal activity.

In the grasses *Cynodon dactylon* (IVI= 142.23) and *Lilihe spp.* (IVI= 9.73) were the most and least frequent species. These species provided adobe in the same manner. Among trees: *Morus alba*, shrubs: *Adhatoda zeylanica* and herbs: *Typha spp.*, *Parthenium hysterophorus*, *Launaea procumbens*, *Rumex obtusifolius*, *Euphorbia helioscopia*, *Malva neglecta* could not be found at this site.

Chumbisurla Wildlife Sanctuary (Site-III)

Chumbisurla Wildlife Sanctuary (CWS) is characterized by red sandy clay having mountainous rocks and stones (Rais, *et al.*, 2012). It is a thorn scrub forest (Chaudhry, 2001). At Site-III there were highest disturbances but interestingly population of Red fox was 0.26 individual/km² which were relatively more than other two sites. More number of dens and direct sightings at this site might be due to the

protected areas e.g. CWS Wildlife Sanctuary, reserved forests and other forest patches. These areas were providing adobe and availability of more favourable sites to Red fox. While surveying at CWS eight direct sightings of Red foxes were recorded. During the whole study seven footprints and six scats were recognized as of Common Red fox

At CWS cover of trees was very dense which give shelter, support and good food for the foxes. *Acacia modesta* (IVI= 66.38) was the most abundant of all the trees present at CWS and other trees were not present with much cover density. *Morus alba* (IVI= 27.35) was with least frequency. Shrub *Ziziphus jujube* (IVI= 134.98) was the most important cover for the habitat of the species present there. *Cynodon dactylon* was the most important herb (IVI= 208.8), while other grasses were not much abundant and have lesser IVI.

Trees: *Dalbergia sissoo*, *Eucalyptus camaldulensis* and *Acacia nilotica*, shrubs: *Adhatoda zeylanica* and *Tribulus terrestris*, and herbs: *Dab spp.*, *Lilihe spp.*, *Typha spp.*, *Saccharum bengalensis* and *Babur spp.*, were not present at Site-III.

CONCLUSION

In District Chakwal, Red fox is present in low density as we could only observe 17 individuals, 19 scats, 26 footprints and 19 dens which are the signs of presence and activity of this species. During the whole study period from November, 2013 to November, 2014, for a total of 96 field hours. Among the other sites, CWS was found out to have more population density, due to suitable habitat and more spaces for shelter.

In the habitat of Red fox total 6 tree, 6 shrub and 12 herb species were found by quadrat method. *Acacia modesta* was with highest IVI providing more cover in all of these sites. Among the shrubs *Ziziphus jujube* was the most abundant at

all the sites and with highest IVI. At all sites *Cynodon dactylon* was seen providing shelter and cover to the foxes. People often seen to burned the most important herb (*Cynodon dactylon*) in the wild area. This is causing their habitat degradation. Thus this high importance value vegetation should be conserved. As in Chakwal urban sprawl has directed to the rapid loss of rural and undeveloped land to urban development. Development projects of urbanization for example dams and highways are causing habitat destruction and degradation. Local people of Chakwal also rely on the forest for cooking and heating, this attitude is further causing habitat loss for Red fox.

In Chakwal, open-shed poultry farming is causing more conflicts between poultry farmers and carnivores especially Red foxes and Asiatic Jackals (*Canis aureus*) due to their depredation on poultry. We need to provide education towards carnivores in this region to support wildlife and save this Near Threatened (NT) specie in Pakistan. We have to expand Chumbisurla Wildlife Sanctuary for the conservation of Red fox.

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