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Foraging habits of the Red Fox *Vulpes vulpes* (Mammalia: Carnivora: Canidae) in the Himalaya, India

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The Red Fox *Vulpes vulpes* is one of the most widely distributed and extremely adaptable carnivore in the world (Macdonald & Reynolds 2004), and found in a variety of habitats ranging from the arctic to temperate deserts (Macdonald & Reynolds 2004). It is an omnivorous opportunistic predator and feeds on essentially anything easily available or small enough to catch, from the wilderness to cities (Harris & Smith 1987; Jędrzejewski & Jędrzejewska 1992; Scott et al. 2014). Small mammals, birds and insects are the major food materials recorded in the Red Fox diet (Goszczynski 1974; Meisner et al. 2014). Red Foxes are mostly nocturnal (Ables 1969; Macdonald 1980; Travainiet et al. 1993; Weber et al. 1994) but their activity pattern and movement may overlap with the availability of forage and level of disturbance (Macdonald 1980; Lovari et al. 1994; König 2008). Keeping this in view, the present study is an attempt to understand if the nocturnal behavior of the Red Fox alters due to the easy availability of food resources in the daytime.

The study was conducted in 12 villages covering approximately 1,000km^2 of Kargil District with an area of about 14,000km^2 (Fig. 1). Kargil is a mountainous cold desert in Ladakh region with little or sparse vegetation and represents the biogeographic zone 1B (Trans-Himalaya-Tibetan Plateau) of India (Rodgers et al. 2000). The general elevation of Kargil ranges from 2,934–7,410 m with an average elevation of 3,400m (Maheshwari 2016).

Observations on the Red Fox were recorded during field studies on snow leopards *Panthera uncia* and associated species with special reference to large carnivore-human conflict, conducted from April 2009 to November 2012 (Maheshwari 2016). Due to the topography and remoteness of the area, all fieldwork was carried out in the form of discrete field expeditions that involved camping in the different areas. Each field survey usually lasted 10–15 days. Altogether, 1,100km were traversed on foot covering an altitudinal zone of 3,000–5,200 m. Every sighting of the Red Fox was recorded during the fieldwork, and interviews were conducted of all the 664 households across 12 villages in the study landscape. Information was gathered on livestock predation such as species and number of attacks with time and place of attack by Red Fox during the study period. While collecting data on Red Fox predation on livestock in order to reduce probability of response bias and avoid overestimation of livestock predation, protocols under participatory rural appraisal (PRA) (Maheshwari et al. 2014) were employed by using the semi-structured interview technique of PRA.

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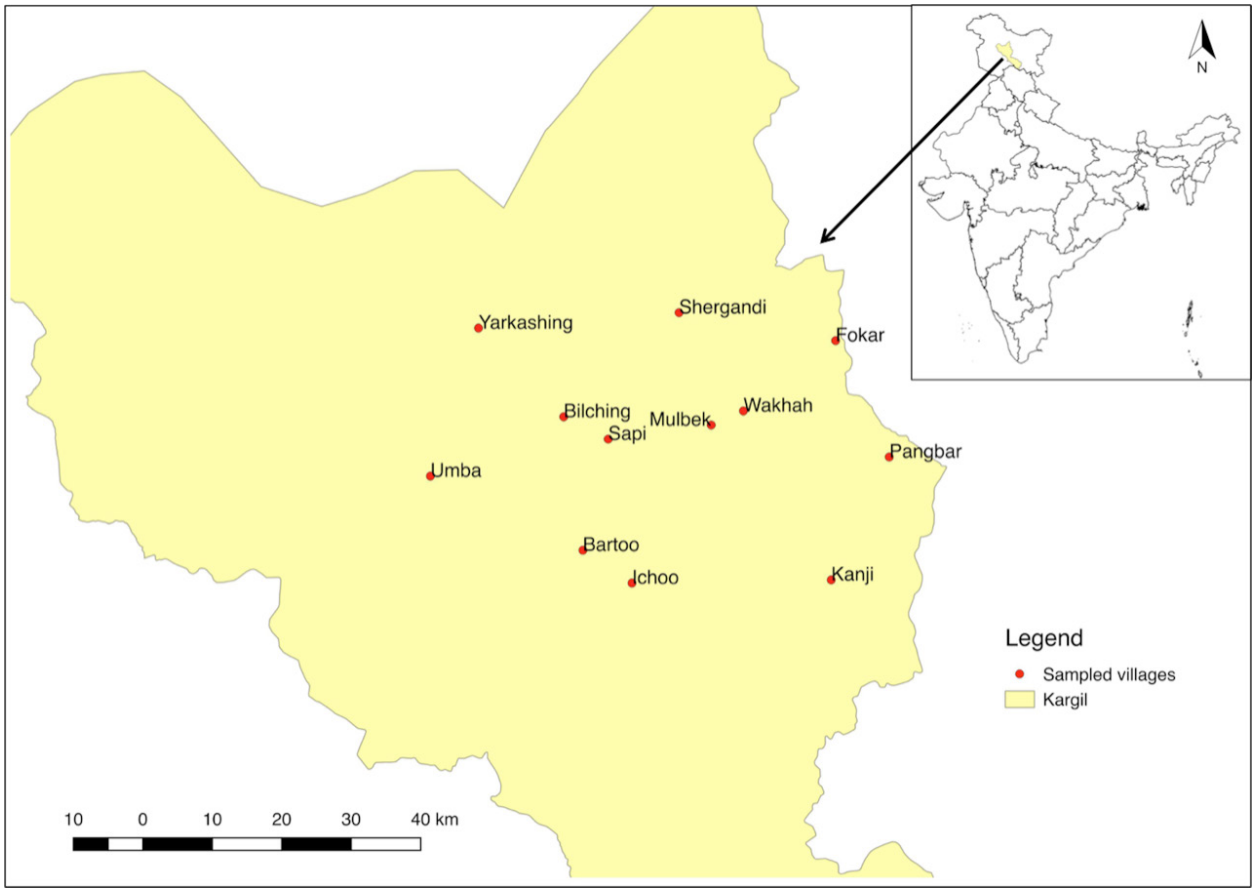

Figure 1. Study Area: location of the 12 sampled villages in Kargil, Ladakh, India

With the help of field assistants data on visual encounters (n=220) of the Red Fox from April 2009 to November 2012 were gathered. The maximum sightings were recorded during 15.01 to 18.00hr (45.4%) followed by 12.01 to 15.00hr (25.9%), 09.01 to 12.00hr (25.4%) and 06.00 to 09.00hr(13.2%). To understand Red Fox movement during day-light hours in a human dominated landscape, data were also collected on the availability of food resources, e.g., free ranging domestic fowls and inattentive young ones of the sheep/ goats in the villages (Image 1). A total of 230 domestic fowls and 74 young ones of the sheep/ goats were reportedly killed by the Red Fox in Kargil. Of 12 villages, the highest livestock attacks were recorded in Sapi (15.8%) followed by the remaining 11 villages (Table 1).

Data obtained from locals on the time of predation was overlapping with the time of sighting of the Red Fox in the villages. Most (40.9%) of the domestic fowls and 35.1% of sheep and goats' predation events were recorded during 09:01–12:00 hr followed by 34.3% (domestic fowls) and 27% (sheep and goats) during 12:01–15:00 hr (Table 2).

During the day time, when most of the family members were engaged in domestic work and other livestock grazing, they set free the fowls and young ones of the sheep and goats to move on their own and feed upon freely and naturally accessible food. At this point they were vulnerable for predation by the Red Fox.

Foxes may be found during the day pursuing prey and resting (Meisner et al. 2014). One breed of fox that is definitely diurnal is the Island Fox *Urocyon littoralis* (U.S. Fish & Wildlife Service 2015). Red Foxes are typically nocturnal animals, especially inhabiting in and around urban areas, to avoid being seen or disturbed by humans (Scott et al. 2014). Local people report that the Red Fox has got accustomed to raiding villages and houses for food. As it takes a lot of energy to scare these foxes, some locals are retaliating by killing the Red Foxes. Anthropogenic feeding has been reportedly supporting an increase in density of Red Fox range from 2–30 adults/ km^2 (Baker et al. 2000; Soulsbury et al. 2010; Scott et al. 2014) in the urban areas. But in Kargil, where local communities are primarily agro-pastoral and livestock rearing is one of the major sources of livelihood, loss of

Table 1. Red Fox predation on domestic fowls and sheep/ goats across 12 villages in Kargil

	Name of village	Total number of fowl predation	Total number of sheep and goat predation
1	Bartoo	14	4
2	Pangbar	7	3
3	Yarkashing	15	4
4	Bilching	4	2
5	Umba	30	9
6	Ichoo	12	3
7	Mulbek	22	7
8	Shergandi	12	1
9	Fokar	26	9
10	Kanji	28	12
11	Sapi	38	10
12	Wakhah	22	10
Total		**230**	**74**

Table 2. Red Fox predation during different time intervals of the day

Time interval (hr)	Domestic fowls	Sheep and goats	Total
06:00–09:00	30 (13.0%)	14 (18.9%)	44 (14.5%)
09:01–12:00	94 (40.9%)	26 (35.1%)	120 (39.5%)
12:01–15:00	79 (34.3%)	20 (27.0%)	99 (32.6%)
15:01–18:00	27 (11.7%)	14 (18.9%)	41 (13.5%)
Total numbers	230	74	304

Image 1. Red Fox predation on domestic fowl

Image 2. Red Fox road kill

livestock leads to retaliatory killing (Maheshwari 2016). Thus, similar to other carnivores in the global scenario, the Red Fox is also a victim of retaliation in Kargil. During the study five cases of retaliation against the Red Fox were recorded. Besides, there were two records of road kills during the same period (Image 2). In the absence of a proper mechanism to monitor and record Red Fox killing at landscape level this study presents only a fraction of the actual cases of retaliation and road kills. Nevertheless, retaliation and road kills constitute the major threats to the overall survival of the Red Fox population.

The lack of livestock guarding practices and poor or no search efforts by people to locate 'missing' animals are two of the major factors responsible for livestock loss in Kargil. The loss of domestic fowls and livestock constitute one of the major threats to the rural economy and the Red Fox is one of the major predators in Kargil. Diurnal alteration in foraging behavior of the Red Fox could be due to competition with the Snow Leopard and Wolf *Canis lupus chanco* (Maheshwari 2016). About 8.3% livestock loss (2009-2012) was due to predation by large carnivores, i.e., a total of 1113 heads of livestock were reportedly killed by wolf (43.6%) followed by unknown predators (31.4%) and Snow Leopard (21.5%) in the study site, which comes to 2.8% of total annual livestock losses (Maheshwari 2016). This study adds to the limited information available on the dynamics of human-Red Fox interaction in Kargil.

The Red Fox is a well-studied species across the world (Macdonald & Reynolds 2004), but information regarding its distribution, ecology, and subspecies remains rather limited in India (Maheshwari et al. 2013). The species in India, which is relatively better studied among the fox species, is the Indian Fox *Vulpes bengalensis* (Home 2005; Kumara & Singh 2012; Maurya et al. 2012). One of the important notes for future studies could be to gather crucial baseline information on the status, distribution, ecology and interaction with human of the other fox species and subspecies (Maheshwari et al. 2013) in India. This is crucial in quantifying changes in Red Fox densities due to interface with anthropogenic dimensions, and

develop strategies for conservation management.

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