On the move: spatial ecology and habitat-use of red fox in the trans-Himalayan cold desert

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An animal may move because of various reasons and the space-use depends upon its behaviour and responses to the environment. The causes of these movements, directionality and their consequences are of great significance to understand several aspects of an animal's ecology. A mosaic of different habitat types are required to fulfill different life stages of an individual. Red fox is the most widespread wild carnivore in the world occupying myriad habitats. They are also known for their adaptability to survive in the dynamic anthropogenic landscapes. Despite being one of the most extensively studied carnivore, there is a dearth of information on the red fox from the Trans-Himalayan region. In this study we explore the home ranges, daily movements, habitat-use and directionality of red fox in the arid Trans-Himalayan cold desert. We radio-collared seven red fox individuals in Ladakh, India. The home range of red fox ranged from 3.81 to 49.22 km^2. Red fox significantly preferred lower elevations and lesser rugged terrains ($P < 0.01$). They were also positively associated with water. The daily average movement of red fox was 13.28 ± 1.38 km/day. Downscaling of GPS fixes from 15 minutes to 2 hour interval fixes significantly reduced the daily average movement of red fox ($P < 0.05$). Red fox did not show any significant directional preference ($P>0.01$). The daily movements are crucial not only for understanding the individuals, but also for understanding species requirements at the population level. The daily movements further aids to comprehend the daily energetics and nutritional requirements of species. The daily movements of red fox have been examined for the first time across its global distribution. The study holds great significance as it helps in understanding the spatial ecology of an abundant and highly adaptable meso-carnivore which is important for managers to develop conservation strategies for red fox and its associated species.

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Abstract

An animal may move because of various reasons and the space-use depends upon its behaviour and responses to the environment. The causes of these movements, directionality and their consequences are of great significance to understand several aspects of an animal's ecology. A mosaic of different habitat types are required to fulfill different life stages of an individual. Red fox is the most widespread wild carnivore in the world occupying myriad habitats. They are also known for their adaptability to survive in the dynamic anthropogenic landscapes. Despite being one of the most extensively studied carnivore, there is a dearth of information on the red fox from the Trans-Himalayan region. In this study we explore the home ranges, daily movements, habitat use and directionality of red fox in the arid Trans-Himalayan cold desert. We radio-collared seven red fox individuals in Ladakh, India. The home range of red fox ranged from 5.81 to 49.22 km^2. Red fox significantly preferred lower elevations and lesser rugged terrains ($P < 0.01$). They were also positively associated with water. The daily average movement of red fox was 13.28 ± 1.38 km/day. Downscaling of GPS fixes from 15 minutes to 2 hour interval fixes significantly reduced the daily average movement of red fox ($P < 0.05$). Red fox did not show any significant directional preference ($P > 0.01$). The daily movements are crucial not only for understanding the individuals, but also for understanding species requirements at the population level. The daily movements further aids to comprehend the daily energetics and nutritional requirements of species. The daily movements of red fox have been examined for the first time across its global distribution. The study holds great significance as it helps in understanding the spatial ecology of an abundant and highly adaptable meso-carnivore which is important for managers to develop conservation strategies for red fox and its associated species.

Keywords

Home range, Daily-movement, Directionality, Ladakh, space-use, step-selection function.

Introduction

The space use of an animal depends upon its behavioural and physiological responses to the environment (Horne et al., 2007; Vanak & Gompper, 2010). It is also influenced by ecological and evolutionary factors (Cody, 1985). One of the most basic fundamental for understanding the ecology of an animal is the study of home range size. Home range is generally defined as an area that an individual utilizes for its normal activities like gathering food, mating and raising the young (Burt, 1943). An animal may move for several other reasons. The causes of these movements and their consequences are of great significance to understand several aspects of an animal's ecology like their dispersal (Small & Rusch, 1989), social interactions (Minta, 1993), space-use (Kenward et al., 2001) and population distributions (Turchin, 1991). The continuous movements when directly monitored is the most powerful tool to quantify an animal's daily movement and home-range size (Turchin, 1998). However, in nature it is impossible to monitor animals continuously, especially in the rugged terrains with adverse climatic conditions such as that prevailing in the Trans-Himalayan cold desert (Mishra & Humbert-Droz, 1998). GPS telemetry is now commonly used for this purpose, as it aids in continuous monitoring of animals spread over large distances and is particularly helpful for animals which are elusive, nocturnal and present in areas that are otherwise not accessible by researchers.

Red fox is the most widespread wild carnivore in the world (Hoffmann & Sillero-Zubiri, 2016) and is known for its adaptability to survive in all sorts of environments (Geffen et al., 1996). The generalist and opportunistic nature of red fox in terms of its diet, habitat and movement patterns has contributed to its success (Geffen et al., 1996; Walton et al., 2017; Reshamwala et al., 2018). But on the other hand, mid-sized carnivores also face competition because of its wide spectrum of diet which overlaps with the energetic needs of myriad other sympatric competitors (Caro & Stoner, 2003). Small carnivores may often face the highest competitive pressure (Hunter & Caro, 2008) as they constantly survive in a landscape of fear (Laundre, Hernandez & Ripple, 2010). As a result they may have to make tradeoffs either temporally or spatially (Schuette et al., 2013). In comparison to the large carnivores, there have been fewer studies pertaining to the meso-carnivores and there are knowledge gaps even in understanding their basic life-history traits like home range size (de Satgé, Teichman & Cristescu, 2017).

Although red fox is one of the most extensively studied carnivore in the world, there is a dearth of information on the mountain red fox (*Vulpes vulpes montana*) found in the Trans-Himalayan cold desert. Mountain red fox are unique and may be threatened like the Sierra Nevada red fox (Aubry et al., 2009; Sacks et al., 2010). There have been only a handful of studies from India on the mountain red fox, which are confined to the dietary habits (Ghoshal et al., 2016; Maheshwari, 2018; Reshamwala et al., 2018). Despite having GPS telemetry technology, most studies aim at obtaining home ranges where the GPS fixes are taken at large time intervals, which are unsuitable for studying daily movements. The daily movement data is expensive at the cost of battery life. However, it can provide important information such as the breeding and non-breeding individuals in a population (Jedrzejewski et al., 2001; Alfredéen, 2006), human activity and disturbances (Theuerkauf et al., 2007) and can also act as an indicator for the health of an ecosystem by identifying food deficient habitats (Owen-smith, 2013).

A mosaic of different habitat types are required to fulfill different life stages and these are reflected in the animal's movement at larger spatial scales (Ims, 1995; Benson & Chamberlain, 2007). Intra and inter-specific interactions in terms of competition, predation or facilitation also determines animal spatial distributions. In some cases, the directionality of movements may also have a great biological significance (Michael J. Freake, 2019). Ecologists are often interested in understanding these spatial distribution patterns to know about an animal's requirements and how these requirements are fulfilled (Johnson, 1980; Manly, McDonald, Thomas, McDonald, & Erickson, 2007). The resource selection function and resource selection probability functions have been widely used to identify the habitats used by radio-collared individuals (Manly *et al.*, 2007; Lele, 2009). A more advanced and robust method that is now adopted is the use of step selection function (Thurfjell, Ciuti & Boyce, 2014). In step selection function, the consecutive time locations taken at regular intervals are defined as steps and compared with the random steps that are available for an animal to choose (Thurfjell, Ciuti & Boyce, 2014). Step selection function provides the advantage of incorporating the actual movement data of an animal as opposed to comparing with just random points used in resource selection function (Johnson et al., 2008).

The movement of an individual gives an insight on the population distribution of a species and thereby, aids in understanding population level processes (John A. Wiens, Nils Chr. Stenseth, 1993; Ims, 1995). To the best of our knowledge, this is the first study that aims at understanding the daily movements of the red-fox. Besides this, our study also holds great significance as it helps in understanding the spatial ecology of an abundant and highly adaptable meso-carnivore which is often important for managers to develop conservation strategies not only for this species but also other associated species.

Materials and methods

Study area

The study was conducted in Ladakh which belongs to the North-western Trans-Himalayan region of India (Fig. 1). The area is characterized by dry rugged terrain with very little precipitation of about 100 mm (Bharti et al., 2016). The cold desert has an elevation of 3000 to 7000 m above sea level and harsh winter temperatures which go up to - 30 °C in winters. The vegetation is very sparse and patchy with alpine meadows in certain areas (Kachroo P, Dhar U, 1977). The area is also very scarcely populated in terms of human density i.e. 4.9 individuals/km^2 (Chandramouli, 2013). Six foxes were radio-collared in the village of Chiktan, which is a small hamlet 80 km from the city of Kargil. The people comprise of the Muslim community and there is high amount of anthropogenic food subsidy and fox abundance in this area (Reshamwala et al., 2018). One vixen (F3) was collared in Hemis National Park at Rumbuck. People are majorly associated with agriculture or agro-pastoralism and sometimes involved with tourism, especially in Hemis National Park (Reshamwala et al., 2021). Besides red fox; snow leopard, wolves, Ladakh urial, bluesheep, ibex, weasel and stone marten are other animals found in this landscape.

Fox capture

We captured seven red fox from November 2018 to January 2019 using five Victor soft catch #3 leg hold traps. The animals were immediately collared with Sirtrack (Litetrack 150 iridium, weighing ~ 200 grams) collars and released within 20 - 30 minutes at the place of capture. Animal handling, capture and release were approved by the Department of Wildlife Protection Department Jammu and Kashmir (CCFWL\Permission\2016\575-76). No drugs were administered to the animals and the methodology was refined to ensure minimum stress, handling time, and injury to the captured individual, approved by Wildlife Institute of India, Animal Ethics Committee. The foxes were measured, weighed and sexed before release. The collars were programmed to record GPS fixes for every 15 minutes intervals and transmit the same at every 3 hours. We chose 15 minutes time interval as it gives robust results for the actual daily distance travelled by animals (Musiani, Okarma & Jędrzejewski, 1998). The collars also had an auto drop-off scheduled for 364 days. For individuals M3 and M4 the collars were reprogrammed to take GPS fixes every 2 hours and 10 minutes after one month to increase the battery life.

Data analysis

The data ~~constituted~~ from seven red foxes ~~of~~ 32,711 GPS fixes ~~was~~ filtered in ArcGis 9.2.1 with the ArcMet tool (Wall, 2014). The filtered data excluded fox locations that exceeded > 48 km/hr as this is the highest speed of the fox (Haltenorth, T., & Roth, 1968). Home-ranges were estimated using minimum convex polygon (MCP), Kernels, localized convex hull (LoCoH) and Brownian-bridge movement model (BBMM). Displacement was calculated with the help of the net square displacement obtained from the trajectory details from the ArcMet tool in ArcGIS. Angular data was analyzed in the R package circstat, spatstat and circular (Agostinelli & Lund, 2011).

To calculate the daily movements of the red fox we encountered two false positive errors. Type 1 error - when the foxes were in the den and the GPS fix was at a place well within the home range with speeds less than 48km/hr. Type 2 error - when the fox was travelling far at the boundary of its home range but the GPS fix was near its den or at the other end of its territory. To eliminate these errors we utilized the speed data to identify erroneous spikes and restricted the data containing speeds to ≤ 9.35 km/hr (Fig. S.1). The daily movements of the red fox were then plotted using the violin plots in R.

Habitat-selection analysis for red fox was done using step selection function in the animal movement tool package of R (Signer, Fieberg & Avgar, 2019). We used conditional logistic regression with 10 random steps available for each true step of red fox for the variables: - distance to road, distance to water, distance to human settlements, ruggedness, elevation and slope. We used the Biodiversity Information System portal of the Indian Institute of Remote Sensing (http://bis.iirs. gov.in) land-use land-cover map and classified our field area into agriculture, vegetation, barren, snow and others (Roy et al., 2015).

Results

Spatial distribution of the red fox

We used different methods to evaluate the home ranges (95% contour) and core areas (50% contour) of each individual of the red fox. The red fox showed high variation in the size of their home ranges and core area utilization (Table 1). We found the highest home range using BBMM of the individual F3 from Hemis National Park (49.23 km^2). The smallest home range was for the individual F1 (3.81 km^2). The highest core area using BBMM was for M3 (2.69 km^2) and the smallest was found for F1 (0.55 km^2). The results showed that the M1, M2 and F3 individuals utilise multiple core zones.

Identification of dispersing animal

The individual F3 collared in Hemis National Park was a dispersing individual as it showed displacement from its collared area and shifted from its original place of collaring (trend line of F3, Fig. S.2).

Directionality in red fox

The red fox moved in all directions across different areas of its home range with dens at the center. We conducted a Rayleigh test to find out if the red fox prefers to orient themselves in a particular direction. The Rayleigh test results showed no significant directionality for the movement of red fox ($P > 0.01$ for all individuals, Table S.1).

The daily movement of red fox

The individual F2 showed the highest daily average movement of 20.88 km/day and the least movement was shown by M4 of 6.50 km/day (Fig. 2). The daily average movement of red fox was 13.28 ± 1.38 km/day.

The downscaling of data from 15 minutes GPS fixes to 2 hour interval fixes significantly ($P < 0.05$ one tail T test) reduced the average distances walked by red fox (S.4). Since for M3 and M4 individuals 15 minute GPS locations were obtained for the first 30 days, only these were used to examine the effect of down-sampling.

Habitat selection by red fox

F1 preferred agricultural land as compared to other land-use categories, while F2 was mainly found in barren land (Fig. 3). F3 vixen in Hemis National Park preferred barren land and alpine vegetation. Both M1 and M2 utilized agriculture and barren land. M3 and M4 were found in barren and agricultural land; but they utilized the snow in higher proportions.

The red fox preferred lower elevations and lesser rugged terrains ($P < .001$, Fig. 4). With respect to human settlements only F1 showed significant negative association ($P<0.001$), while F3, M2, M3 and M4 were positively associated ~~with~~ human settlements ($P< 0.01$). Individuals F2 and M1 did not have any significant association with human settlements ($P>0.01$). The red fox ~~showed preference~~ for water bodies~~, however for M3 and M4 individuals it was non-significant (P>0.01).~~

Except for F2 and F1 all individuals had a significant negative association with roads and slope ($P< 0.001$).

Discussion

Spatial distribution of red fox

Rugged terrains often have cliffs and hard boundaries that force animals to follow a fixed path. In such areas, Localised convex hull (LoCoH) gives a reliable home range of animals as this method can identify hard boundaries such as rivers, lakes and even inhospitable terrain (Getz et al., 2007). Although, most studies pertaining to home ranges refer to the traditional use of minimum convex polygon (MCP) or the Kernels method, in our study we found LoCoH and BBMM were the best suitable methods for estimation of home range (LoCoH 1.17 - 78.43 Km^2 and BBMM 3.81 - 49.23 Km^2). Estimates from MCP and Kernal were large and overestimated the home range utilization distribution (MCP 1.95 - 672.19 Km^2 and Kernals 1.62 - 269.15 Km^2) .The BBMM method takes into consideration the time and probability of movements, thereby models the animal movements and helps to determine animal home ranges more robustly (Horne et al., 2007). Studies also caution to consider nomadic foxes while calculating home ranges (Jean-Steve Meia, 1995). Similarly, the vixen F3 collared in Hemis National Park was either nomadic or dispersing vixen as it showed large displacement from its initial place of collaring (Fig. S.2) and hence the large estimate of home range (49.22 km^2, BBMM). The home range sizes of red fox are known to have great variations ranging from as small as 0.40 km^2 in urban areas of Oxford to as large as 40 km^2 in Arctic or even larger and is determined majorly by the type of habitat (Sillero-Zubiri, C., Hoffmann, M., & Macdonald, 2004). At higher latitude and altitude animals tend to have bigger home ranges (Mattisson et al., 2013; Morellet et al., 2013). Foxes living at higher elevations are reported to have four times larger home ranges as compared to lower elevations (Walton et al., 2017). In Australia, larger home ranges of red fox were reported in the arid Simpson Desert (Newsome, Spencer & Dickman, 2017). But on the other hand, the use of smaller home ranges by medium sized canids near human settlements are also reported (Coman, Robinson & Beaumont, 1991; Saeki, Johnson & Macdonald, 2007; Rotem et al., 2011). In cities where food is available in abundance the home ranges of red fox tend to be smaller (Newdick, 1983). Our study site is a high altitude cold desert with the presence of anthropogenic food subsidies [13] and hence, we speculate a mix effect of both; the high elevation cold desert and the presence of anthropogenic food subsidies. The home ranges of fox were highly variable ranging from 3.81 to 49.22 km^2 (BBMM). Such results are not uncommon and the home ranges of fox within the same area may often show wide variations; for example, in Illinois it was observed to vary from less than 1 to > 35 km^2 (Gosselink et al., 2003).

Directionality of red fox

The magnetic alignment of animals may have a significant biological reasoning (Cerveny et al., 2011). Recent studies show that resting cattle and deer have a typical north-south alignment along the geomagnetic field (Begall et al., 2008). To maintain these alignments, animals may often have a directional spatial orientation (Schlegel, 2008). In, fox it has been observed that their directional preference enhances the accuracy of catching prey (Cerveny et al., 2011). Since our data was not confined to just the hunting activity and comprised of the overall movement of red fox, we could not find any significant directional preference ($P > 0.01$, Table S.2). The higher movements in the north-west and south-east directions were moreover because of the orientation of the valley (Fig. S.3).

Daily movement of red fox

The daily average movement ability of fox could be a key factor to understand their home range and defending territory systems. Foxes with smaller home ranges may not necessarily travel less. It is observed that the daily distance travelled by individuals having a smaller home-range may be same as compared to that of an individual having larger home range and the difference may only reflect the different foraging sites used by the individuals (Carter, Luck & McDonald, 2012). Similarly, the individual F1 had a very small home range (3.81 km^2, BBMM), but its daily average movement was 11.10 km/day. It is also very essential to have the GPS fixes at fine scale time interval for calculating the daily average distance travelled by red fox. Our data suggests that increasing the time interval of GPS fixes decreases the daily movement of red fox significantly ($P < 0.01$, Fig. S.4). Fixes at a very small time interval on the other hand may over-estimate the daily average distance travelled due to location error (Poulin, Clermont & Berteaux, 2021). Although the actual distance travelled by an animal as compared to the straight line distances obtained from the GPS fixes may be an under-estimate, we also assume that additional errors pertaining to the accuracy of GPS fixes in the short 15 minute time interval may nullify this effect. For example, despite being inside the den the GPS fixes may vary and show a continuous movement. We found the daily average movement of red fox was 13.28 ± 1.38 km/day. We found only one study pertaining to the daily average movement of red fox which reported 4.8 to 16 km/day. However, the study used VHF telemetry which has its limitations (Carter, Luck & McDonald, 2012). Long distance dispersal events are reported in red fox where foxes have travelled over a distance of 132-1036 km over a short period of time(Walton et al., 2018). The daily average movement travelled by arctic fox is comparatively well studied and is reported to be 51.9 ± 11.7 km/day (Poulin, Clermont & Berteaux, 2021).

Habitat selection by red fox

Red fox are known for their highly adaptive behavior and often show large variations in their space-use depending upon various factors (Walton et al., 2017; Walton, 2020). We found that the dominant larger foxes i.e. F1, M1 and M2 preferred agricultural land, while F2, M3 and M4 were smaller individuals and found in barren and snow land categories. F3 in Hemis National Park was found in both; barren and alpine vegetation. To understand these variations, analyzing step selection modelling at an individual level proves to be more advantageous over population level (Thurfjell, Ciuti & Boyce, 2014). Further, our sample size of seven individuals also advocates for individual modelling. Red fox in the trans-Himalayan landscape have been reported to be at higher densities and often den near human settlements due to the presence of anthropogenic food subsidies (Reshamwala et al., 2018, 2021). In our study with the exception of F1 and F2 all the other individuals were positively associated with human settlements. The presence of water bodies is also known to have a positive influence because of the presence of rodents and has been reported from previous studies (Szor, Berteaux & Gauthier, 2008; Reshamwala et al., 2021). We found that all individuals were positively associated with water. Animals are known to avoid higher elevations, steep slopes and rugged terrains which are known to be energetically costly (Filla et al., 2017; Fullman, Joly & Ackerman, 2017). Similarly, we found red fox significantly preferred lower elevations and lesser rugged terrains ($P < 0.01$). Except for F1 and F2, all other individuals significantly avoided slopes. From our field observations we found both F1 and F2 to be breeding vixens and hence presume that they avoided human settlements and preferred slopes in comparison to others.

Limitations of study

Data on average speeds travelled by red fox is completely lacking, but the average speed with which wolves travel ranges from 0.8 to 1.1 km/hr (Burkholder, 1959; Bibikov, Kudaktin, & Filimonov, 1985; Ciucci *et al.*, 1997; Jedrzejewski *et al.*, 2001). Mech et al. (Mech, 1994) reported that the wolves travelled at speeds of 9.6 to 13 km/hr which had 15 minutes time interval for location of animals. Hence, our method of restraining the maximum speed limit of

9.35 km/hr for red fox may be a fair estimate. The use of speeds to identify GPS errors especially for calculating daily movements has been reported in other studies as well (Bjørneraas et al., 2010; Wysong et al., 2020). However, further studies with greater sample size are warranted to enhance our knowledge on maximum speeds with which red fox can travel.

Although we found the daily average movement for F2 to be as high as 20.92 km/day and as low as 7.46 km/day and 6.50 km/day for M3 and M4 individuals respectively, this could be an effect of sampling bias. The radio-collar for F2 individual worked for lower number of days (56 days). In addition, for the individuals M3 and M4, the collars were reprogrammed for a longer battery life from 15 minutes time interval for the first month to 2 hour time interval which further decreased their daily movements (199 and 212 days respectively). However, based on our field observations, we could confirm that F2 showed greater movements in comparison to other individuals and could be an exception. We also presume the movements for F2 to have reduced after the short collaring period, however we lack the GPS data to prove so. Further, when we compare the daily average movement of F2 with 30 days data of M3, M3 showed higher daily average movement (34.22 km/day, Fig. S.4). This is also due to the fact that M3 made many forays outside its normal home range during this period. At four instances the individual M3 has moved about 60 kilometers or more in one single day. Such long distances are not uncommon and in case of arctic fox the maximum distance travelled in a day is reported to be 154 kilometers (Fuglei & Tarroux, 2019).

The daily average movement in case of wolves showed a great variation, ranging from 17 to 38 km/day (Ciucci et al., 1997). It is reported that the daily average movement travelled during the mating season for wolves may go as high as 34 km/day (Jedrzejewski et al., 2001). During the breeding season, it is observed that males in *Lynx* frequently move at longer distances and at greater speeds to increase their chances of mating with females (Schmidt, 1999). Since our collaring sessions coincides with the breeding time of red fox, we suspect M3 and M4 to have made these long forays.

This study explores the spatial ecology of red fox in the Trans-Himalayan cold desert. In addition to home-ranges we provide insights on the daily movements and directionality in red fox. The red fox avoided higher elevations and rugged terrains. Although, we did not find any significant directionality in the movement of red fox this is the first study that explores this possibility. The daily movements are crucial not only for understanding the individuals, but also for understanding species requirements at the population level. The daily movements further aids to comprehend the daily energetics and nutritional requirements of species (Miller et al., 2014). Despite the red fox being one of the most extensively studied carnivore, there is no literature available for the daily movement of red fox. Further studies regarding movements of the red fox are warranted to understand the impact of dynamic anthropogenic landscapes coupled with climate change and how these animals adapt their behaviour and movement for survival.

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Conflicts of interest

The authors declare that they have no competing interests.

Author Contributions

HSR did the fieldwork, procured data, analyzed, and wrote the first draft. SK, ZH and PR helped in the analysis and writing of the manuscript. BH and PR procured the funding. BH conceptuslised the study. BH and RD supervised the project and discussed the results to improvise and produce the final manuscript.

Animal Ethics

All red foxes were captured following standard and approved protocols after due permission from the Ministry of Environment, Forests and Climate Change, Government of India, and Department of Wildlife Protection, Ladakh, Jammu and Kashmir. The permit details are as follows: CCFWL\Permission\2016\575-76

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List of Figures and Tables

Table 1 (on next page)

Home range of red fox calculated by different methods

Table. 1 Home range of red fox calculated by different methods

HR Method	MCP	Kernel	LoCoH	BBMM	MCP	Kernel	LoCoH	BBMM
	Percent Contour							
Individual	50	50	50	50	95	95	95	95
F1	0.14	0.22	0.05	0.55	1.95	1.62	1.17	3.81
F2	0.36	1.27	0.32	2.33	45.99	41.59	37.57	29.75
F3	18.86	16.84	0.59	2.31	672.19	269.15	78.42	49.23
M1	1.74	1.50	0.18	1.93	118.77	18.49	8.97	31.02
M2	24.47	4.02	0.26	2.62	39.36	26.65	10.63	26.19
M3	1.15	1.57	0.43	2.69	39.99	38.83	35.57	32.93
M4	0.44	0.77	0.36	1.15	11.00	12.07	10.11	10.75

Figure 1

Study area and GPS fixes of radio-collared red foxes in the Trans-Himalayan cold desert, Ladakh, India

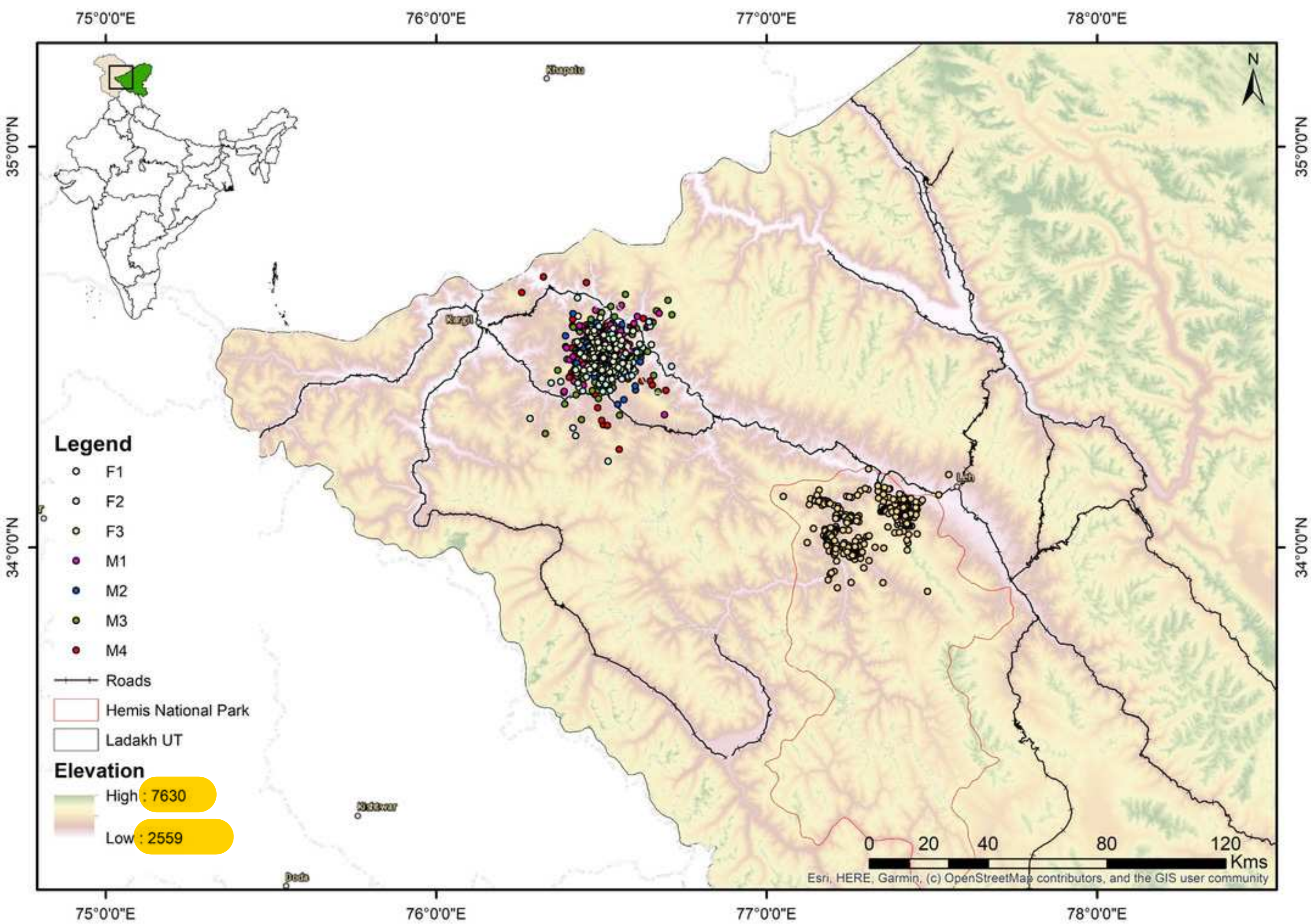

Figure 2

Average daily movement of red fox in the trans-Himalayan cold desert, Ladakh, India

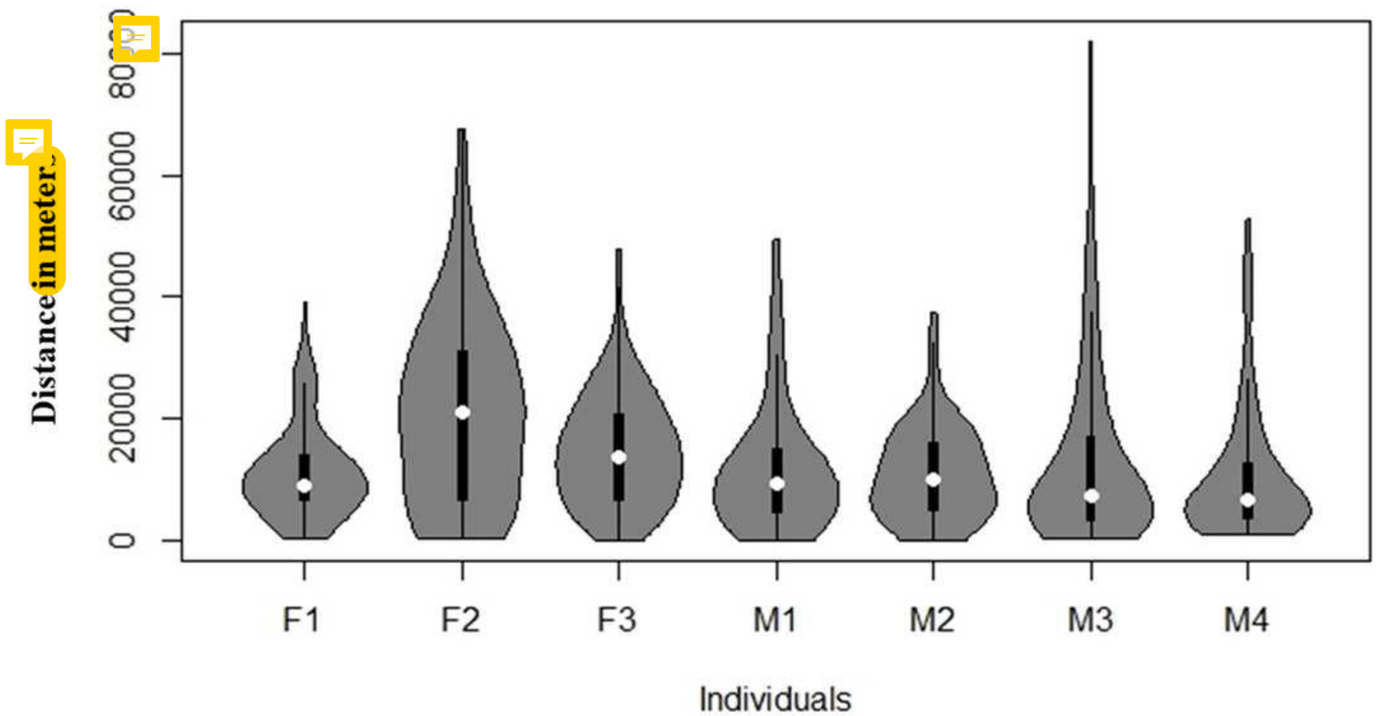

Figure 3

Land-use land cover categories utilized by different red fox individuals in the trans-Himalayan cold desert, Ladakh, India (case; True = true steps, False = random steps)

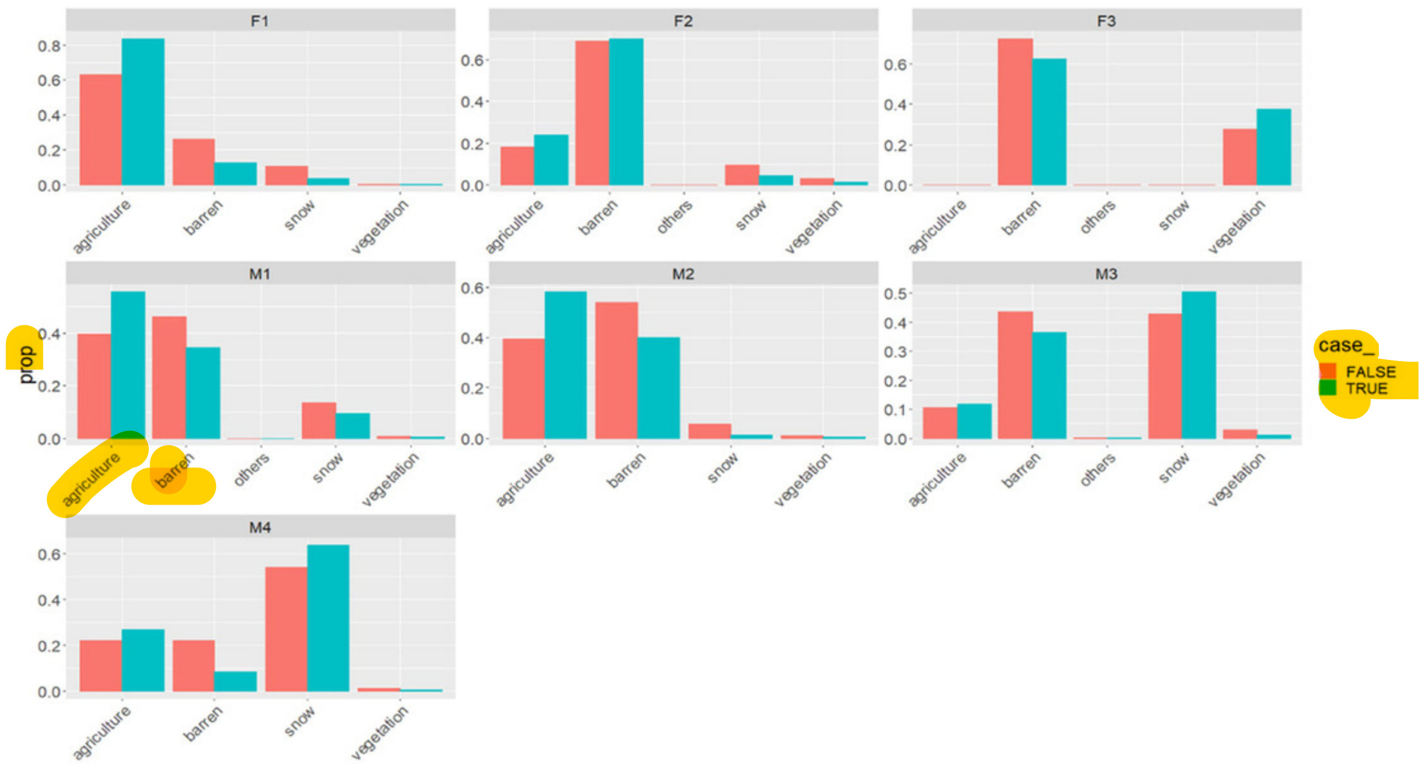

Figure 4

Step-Selection function beta coefficients of different red fox individuals