

Activity pattern of the red fox *Vulpes vulpes* in Doñana, SW Spain

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Radio tracking data from six red foxes *Vulpes vulpes* (Linnaeus, 1758) in Coto Doñana (SW Spain) were used to obtain the activity pattern throughout the day and night. Results suggested that females travelled longer distances during the night than during the day ($p < 0.001$). Males travelled distances similar during both day and night ($p > 0.15$) but they travelled farther than females throughout 24 h periods ($p < 0.05$).

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Introduction

Studies of travelling distances and daily activity patterns of certain carnivores are difficult, due to their extensive home ranges, secretive behaviour, fast movements and low population densities. However, studies on wild animals through indirect methods try to establish the hours of the day when these species are more active (Kruuk 1972, Schaller 1972, Ables 1975, Alvarez *et al.* 1983, Andelt 1985, Tester 1987, Schaller *et al.* 1989).

In certain biotopes, the mammal community expends its activities from a temporal point of view (Valverde 1967). Carnivores present three basic activity patterns: (1) Nocturnal activity; moving and feeding during the night, as foxes and hyenas do (Kruuk 1972, Maurel 1980, 1983; (2) Crepuscular activity, like the coyote and giant panda, when their major movements and activities coincide with sunset and sunrise (Andelt 1985, Schaller *et al.* 1989); (3) Diurnal activity, like the coati, African wild dog and mongoose, where moving and feeding activities occur only during daytime (Delibes and Beltran 1986, Gittleman 1989). There also exist seasonal variations in activity patterns, in accordance with female breeding periods (Andelt and Gipson 1979).

Preliminary results of the red fox *Vulpes vulpes* (Linnaeus, 1758) activity patterns from Doñana National Park, Spain, are reported in this paper. Travelling distances in cycles of 24 hours are also given.

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Study area and methods

This research was conducted at the Doñana National Park, in a Mediterranean shrub area, where a variety of dominant plants exists, for example: *Halimium halimifolium*, *H. conmutatum*, *Cistus libanotis*, *Erica scoparia* and *Calluna vulgaris*, among others (Allier *et al.* 1974). The weather in this zone is Mediterranean-Atlantic with hot and dry summers, while winters are wet and cold (Allier *et al.* 1974, Delibes 1980). The fox movements were on the shrub area and on an ecotone between a floodable area or marisma and a wet zone of rush and grassland of *Cynodon* sp. and *Paspalum* sp.

Foxes were captured with snares, steel foothold traps (No. 2) and two door box traps similar to the Tomahawk type. Steel foothold traps were covered with soft material to avoid injuries when an animal was caught. Traps were baited with synthetic urine (Cronck Co.), and a mix of chicken with fish was also used.

Two females and four males were captured and anaesthetised with a mixture of ketamine and xylazine (Delibes and Beltran 1986). Foxes were weighed and radiocollars (Biotrack) of the frequency 150 – 152 MHz were attached. Males were radio-tracked from November 1984 to February 1985; and females from February to June 1985 (Table 1).

Table 1. Radiotracking time, intensive 24 h periods, and number of locations of six red foxes in Doñana National Park, SW Spain.

Fox Number	Sex	Weight (kg)	Date of capture	Total days monitored	Tracking 24 h	Number of locations
210	M	6.0	Nov. 84	73	1	59
213	M	4.5	Dec. 84	72	2	91
284	M	5.9	Dec. 84	84	3	97
211*	M	6.5	Jan. 85	31	2	44
112**	F	6.0	Jan. 85	159	8	225
214	F	5.1	Feb. 85	142	6	250

* Dead on February 18th, 1985. ** Breeding female with pups (spring 1985).

Table 2. Mean distances (km) travelled by red foxes during day and night in Doñana National Park.

	Day	Night	24 h	N
Females	1.35	4.58	5.93	14
Males	4.45	5.37	9.82	8
Average	2.90	4.97	7.88	22

Radio locations of foxes were determined by compass bearings from 2 of 75 tracking stations. An "all terrain" vehicle was necessary in order to move faster from one station to the other, and thus enabled the triangulation method to be used (Mech 1983). Radio signals were monitored with a receiver model LA-12 (AVM Instrument Co.), connected to a portable three element "yagi" antenna. For visual recognition of the animal, each collar was covered with a reflective plastic of different colors.

We assumed the distance travelled per hour was a measurement of activity, due to the fact that Canids are considered cursorial pursuers of prey. Hence we obtained distances travelled in a straight line between locations as an index of activity.

From 766 radiofixes accumulated during intensive 24 h radiotracking periods with a one-hour interval, a $\pm 5^\circ$ error was calculated from the bearing lectures (Table 1). The diurnal period is considered from 18:01 to 06:00 h, while the nocturnal period is from 06:01 to 18:00 h, and the crepuscular time considered from 05:45 to 06:45 h (sunrise) and 17:45 to 18:45 h (sunset). Paired comparisons were made using the Student *t*-test in order to determine activity relationships between males and females, and also travelling distances during night and day. The $p < 0.05$ calculation was required for the statistical significance (Sokal and Rohlf 1981).

Results and discussion

The fox mean home range size was 116 ha, like in studies by Macdonald (1977), Maurel (1980), Boitani *et al.* (1984) and Blanco (1986). Foxes usually visit all boundary areas of their home range, and usually the pattern of movement is done in a rather erratic way.

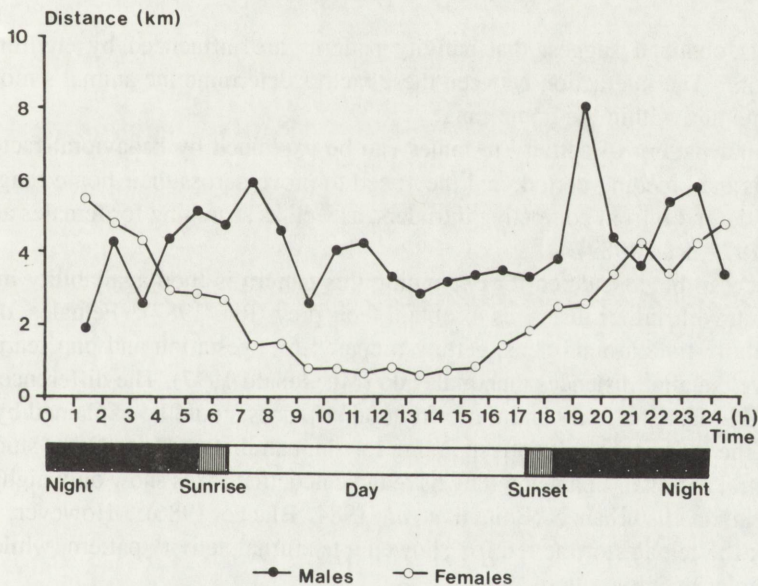


Fig. 1. Activity pattern of red fox (*Vulpes vulpes*) in Doñana, SW Spain; (○) females; (●) males.

The female fox activity had its maximum mean of distance travelled of 0.55 km, between 00:00 and 01:00 hours; while minimum travelling distance of 0.05 km during daytime was between 12:00 and 13:00 hours (Fig. 1). Throughout all the nocturnal periods from 18:00 to 06:00 hours, females travelled, within their home range, a mean distance of 4.58 km, while during daytime, a mean distance of 1.35 km was travelled. Therefore, during the study time period females showed a nocturnal activity and were more active at night than on daytime ($t = 7.78$; d.f. = 23; $p < 0.001$). The total mean of travelling distances of vixens was 5.93 km in the 24 hour cycles (Table 2).

Male foxes displayed both night and day activity, having maximum mean travelling distances during sunset between 18:00 and 19:00 hours ($\bar{x} = 0.81$ km; $n = 7$) and sunrise from

06:00 to 07:00 hours (\bar{x} = 0.59 km; n = 5). They showed a crepuscular activity rhythm. At night foxes moved 5.37 km, slightly more than during the daytime figure of 4.45 km. However, there were no significant differences between daytime and night movements (t = 1.42; d.f. = 23; p > 0.15) (Table 2).

Comparing distances travelled by males and females in 24 hours, we found that male foxes had a mean travelling distance of 9.82 km, and female foxes 5.93 km, the difference being significant (t = 2.29; d.f. = 21; p < 0.05) (Table 2).

Total mean travelling distances for the red fox in Doñana National Park was 7.87 km in 24 hour cycles (n = 22). The daytime mean distance covered was 2.90 km, while in the night foxes moved 4.97 km, suggesting that nocturnal movements were larger than diurnal ones (t = 85.89; d.f. = 23; p < 0.001).

Conclusions

The results obtained suggest that activity patterns are influenced by environmental and endogenous factors. The interaction between these factors determines the animal's movements in relation to time and within the home range.

The irregular pattern of activity in males can be explained by behavioral factors. In late winter there is the breeding period, and they need to move across their home range for scent marking, and defend it from competing intruders, as well as searching for females and for food (Macdonald 1977, Rau 1987).

Other aspect to be considered for explaining this pattern is food availability in winter, as foxes need to travel further distances to obtain their prey (Rau 1987). Females, on the other hand, spend more time around dens, getting prepared for gestation and pup rearing. This is why they travel smaller distances than males do (Macdonald 1977). The difference of activity patterns found in Doñana foxes and those from other places, could be explained by the actual protection of the study area and corresponding low human disturbance. Other studies carried out in the central region of Spain and Italy have indicated, that foxes show only nightly activity, because of human disturbance (Boitani *et al.* 1984, Blanco 1986). However, in Doñana National Park the females of the red fox showed a nocturnal activity pattern, while the males had a crepuscular activity pattern.

There is the need to continue our studies on adult foxes in order to determine the differences between males and females in daily and seasonal activity patterns in areas of varying human intervention.

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