**Science** for Saving Species

Research findings factsheet

Project 1.1.5

Threatened Species Recovery Hub

National Environmental Science Programme

# Patterns of distribution, activity and interactions of foxes and cats in an arid landscape

## In brief

This study examined home ranges, movements and interactions of the red fox and feral cat over three years at the Australian Wildlife Conservancy's Scotia Wildlife Sanctuary in semi-arid south-western New South Wales.

We GPS collared and tracked 26 foxes for an average of 88 days and 28 cats for an average of 100 days. Both species are highly mobile, with cats moving up to 164 km from the point of capture and foxes up to 45km during the study.

Fewer cats (41%) than foxes (59%) occupied defined territories. The average home range size for cats with a home range was around 1,350 ha for the core home range and 5,000 ha for the extended range. This was more than 3 times larger than that observed for foxes at Scotia and 2-4 times larger than the estimated home range sizes of cats observed in other studies and regions.

High visitation sites used for breeding and shelter by both species included burrows dug into sandy soils, runs pushed under spinifex, and piles of timber and sand adjacent to roads.

While interactions were shown to occur in a few fox–cat pairs, overall, we found no strong evidence that the activity patterns or distribution of either species was influenced by the presence of the other.

*Camera trap image of fox carrying a GPS collar. Image: Australian Wildlife Conservancy*

*Camera trap image of a feral cat used to estimate predator activity. Image: Australian Wildlife Conservancy*

## Background

In Australia, the introduced European red fox (*Vulpes vulpes*) and feral cat (*Felis catus*) are major drivers of the decline and extinction of many small vertebrate animal species. The successful management and control of these species is dependent on some knowledge of space use and movements in order to target a population and monitor outcomes.

These tasks are made complex as landscapes are vast and the space use and individual-level interactions between these two predators are poorly studied. Understanding how these two species use and share space and interact is useful background information to inform programs that target either species.

## Main aim of the research

This research examined the concurrent space use, movements and interactions of the red fox and feral cat over three years.

australian wildlife conservancy

## What we did

The study was conducted at the Australian Wildlife Conservancy's Scotia Wildlife Sanctuary, a 64,659-ha private conservation reserve in south-western New South Wales containing an extensive area of arid woodlands and shrublands. This region contains no apex predators as the dingo has been removed via exclusion fencing and lethal control.

Foxes and cats were trapped across an area of approximately 19,000 ha, where no lethal control had occurred for more than six years prior to this study. No permanent free water is available within the study area, although during our study two artificial dams held water periodically.

Trapping months for foxes were chosen to facilitate the capture of adult foxes (over 1 year old) so that seasonal dispersal of juveniles did not bias the results.

Twenty-six adult foxes (10 female, 16 male) and were fitted with GPS collars, released and tracked, including four individuals that were captured and collared in two consecutive years (1 female, 3 male). On average, foxes were tracked for 88 days. In total, 93,969 GPS locations were obtained on foxes.

Twenty-eight adult cats were fitted with GPS collars, and tracked including two individuals that were captured and collared in two consecutive years (1 female, 1 male) and one male that was collared in three consecutive years. Cats were tracked for an average of 100 days. In total, 110,173 GPS locations were obtained on cats.

Most cats caught and collared in this study were male (20 of 28), which is consistent with other studies of feral cats in semi-arid and arid Australia, presumably because males are less risk averse and more likely to be trapped.

We also used data from 107 camera-traps placed across 14,000 ha within the study area. Camera traps operated 24 hours per day for more than 1000 days across four years between October 2015 – Sep 2019.

We used data from the GPS collars to examine the distribution and movement of individual animals and to identify sites of high visitation and used data from the camera traps to add to the analysis of activity patterns.

Genetic analysis was used to establish the relatedness of the animals.

We investigated the size of individual home ranges, if home ranges remain stable year to year, and the extent to which the home ranges of individuals overlap. We also examined their peak periods of activity, and importantly, whether the presence of one species modifies the behaviour of the other.

*Scotia Wildlife Sanctuary features extensive arid woodlands and shrublands. Image: Wayne Lawler / Australian Wildlife Conservancy*

*Camera trap image of feral cat carrying a GPS collar. Image: Australian Wildlife Conservancy*

## Key findings

In the absence of a larger apex predator, the two introduced mesopredators showed large differences in how they distribute themselves across the landscape and interact with each other and with other individuals of their own species.

### Fox movements

In this environment, 59% of foxes, had a defined home range or territory while the remaining foxes wandered through and between the territories of other foxes. Female foxes were more likely to have a defined home range than male foxes. Foxes with a defined home range had an average core home range size of 371 ha. More than one quarter (6) of the 22 foxes shifted their home ranges during the tracking period.

Home ranges of foxes could overlap. This was most likely to occur when the adjoining home ranges belonged to a female and a male, and sometimes occurred with adjoining females. Male foxes were never observed with adjoining or overlapping home ranges.

Kinship group appears to influence the subsequent range occupied by fox offspring and siblings, depending on sex. Related females sometimes had overlapping home ranges, but kinship groups which contained males did not.

The maximum displacement from the point of capture for a fox was 45 km. Two male foxes wondered back and forth through an area of 100s of $km^2$, that crossed the ranges of other foxes.

Individual foxes typically had one or two dens or shelter sites that were used frequently, and the duration of stay at these sites was notably longer than at any other location within the animals' home range. The location and number of sites that were used changed over time, although some individuals had a single high visitation site that they visited more than 100 times during the course of the study, while others had none. All foxes had one or many preferred sites that were revisited but not all individuals had a site that could be characterised as high-use.

Most interactions between individual foxes were neutral, that is, neither attraction nor avoidance. Although examples of strong attraction were also observed, such as a pair of female foxes with overlapping home ranges that had many occasions of apparent contact with each other during the study and were recorded to occur within 4 m of each other. And cases where attraction was one way, such as a pair where one female fox displayed attraction to another female fox, but the latter neither sought out nor avoided the former.

### Cat movements

We observed long distance movements in feral cats. One male cat travelled 164 km from its point of release in 16 days before settling in an area of farmland covering approximately 1100 ha for at least three months before the collar batteries ran out, then eight months later it was recorded only 11km from where it was first captured and released the previous year. Two cats (one male, one female) travelled 150km to the only large river in the region and the female returned to the vicinity of the capture point 16 weeks later.

Compared to foxes, a much smaller proportion of cats (41%) occupied defined home range. Most feral cats roam apparently independent of each other with occasional periods of frequent interaction with other cats of either sex.

For the cats that remained within a home-range core areas averaged ~1350 ha and extended areas averaged ~5000 ha. This range size was more than 3 times larger than that observed for foxes. Cases of home range overlap were observed for male-female and male-male cat pairs. All individuals that shared a portion of their range had frequent contact with the other, regardless of sex, being recorded with 1 m of each other on numerous occasions.

For resident feral cats, the observed extended home range was about double the size of home ranges estimated for feral cats in another arid region of Western Australia, and about three times that estimated for arid South Australia and four-times that estimated for subtropical savannas in northern Australia. This suggests that prey resources are more limiting in the semi-arid woodland environments of the study area compared to regions with greater rainfall and/or more diverse reptile and small mammal faunas.

As for foxes, among the feral cats tracked for more than 60 days, approximately half had individual lairs (shelter sites) that were used more than 20 times during the study. Similarly, when lairs were used repeatedly, cats typically used one or two such sites only during the three to nine months that they were observed. In two males with defined home ranges this was a single high visitation site that in each case was a vacant rabbit burrows adjacent to a road. The one exception was a male feral cat that

*Arid shrublands at Scotia Wildlife Sanctuary. Image: Wayne Lawler / Australian Wildlife Conservancy*

## Key findings (continued)

had three to four high visitation sites in each of the summer months of 2016–17. Some sites were visited by this cat >60 times during the period of observation and >30 times in a single month, as occurred in December 2016. The following summer this individual maintained the same approximate home range but, in contrast to the previous year, had no individual sites of high visitation.

### Comparisons

There was no obvious difference between foxes and cats in usage of high visitation sites. In this study, sites of high visitation are shelter sites (dens or lairs) – used during breeding or as refuge from extreme weather conditions.

A similar portion of both species used such sites; 43% for foxes and 45% for cats. High visitation sites were of three broad types: burrows dug into sandy soils, runs pushed under spinifex, and piles of timber and sand adjacent to roads. In addition, foxes utilised rest sites under shrubs and feral cats used dense *Callitris* spp. stands—both of which provide effective shade.

Overall, the temporal activity patterns of foxes and cats in this study are similar; both species being predominantly nocturnal. In the hottest months (Jan–Feb.) most activity of both species was in the pre-dawn, while in the cooler months (May–Sep.) most activity was in the early evening.

However, some activity was observed during daylight hours for feral cats in winter.

Attraction to animals of the same species was stronger for cats than foxes, though both cats and foxes were also observed avoiding animals of their same species.

Unlike fox-fox and cat-cat interactions we detected significant avoidance behaviours in both directions in the interactions of foxes and cats with overlapping ranges. While interactions were shown to occur in a few fox–cat pairs, overall, we found no strong evidence that the activity patterns or distribution of either species was influenced by the presence of the other.

## Implications

This study is the most complete analysis for any environment of the spatial distribution, movement patterns and interactions of two co-occurring mesopredators—the red fox and feral cat—providing new insight into the long-distance movements of cats in Australia, and the interactions within and between these species.

This information is relevant to land managers that seek to monitor the abundance of either introduced predator species and/or to deploy control measures and evaluate their success.

As a greater portion of the feral cat population were mobile and did not remain within a stable home range, and cats travelled larger distances, local control efforts are likely to be less effective for cats than for foxes. However, the findings of this study highlight that for both species, the likelihood is high of new animals moving into areas that have had localised control effort.

## Cited material

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## Further Information

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