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GPS-tracking of two domestic cats in Sierra Nevada, southeastern Spain

Seguimiento GPS de dos gatos domésticos en Sierra Nevada, sureste de España

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Abstract

Domestic cats are widespread companion animals that pose significant risks to biodiversity when they roam freely. We GPS-tracked two domestic cats during the rutting period, living in country houses within the Sierra Nevada Natural Space (southeastern Spain), to assess their movement patterns. The adult female displayed very restricted movements, with a home range less than 20 ha and most fixes concentrated near her residence. In contrast, the young male exhibited significantly larger movements, with a home range exceeding 300 ha, excursions of up to 2.7 km, and repeated visits to his residence of origin, located 2.5 km away, consistent with mate-seeking behaviour during the breeding season. These contrasting strategies highlight sex- and behaviour-related variation in domestic cat mobility, especially during the mating period, and demonstrate their ability to penetrate natural habitats within a highly protected area. Our findings highlight potential risks of overlap with wildcats and reinforce the need for management actions, including responsible ownership, sterilisation, and restrictions on cat access to natural areas, to mitigate threats to biodiversity-rich Mediterranean landscapes.

Key words: *Felis catus*, *Felis silvestris*, home range, mate-seeking behaviour, movements, protected area.

Resumen

Los gatos domésticos son animales de compañía muy comunes que representan riesgos significativos para la biodiversidad cuando deambulan libremente. Rastreamos mediante GPS a dos gatos domésticos durante el período de celo, que vivían en casas rurales dentro del Espacio Natural de Sierra Nevada (sureste de España), para evaluar sus patrones de movimiento. La hembra adulta mostró movimientos muy restringidos, con un área de distribución inferior a 20 ha y la mayoría de los puntos de referencia concentrados cerca de su residencia. Por el contrario, el macho joven exhibió movimientos significativamente más amplios, con un área de distribución superior a 300 ha, excursiones medias de hasta 1,7 km y visitas repetidas a su residencia de origen, ubicada a 2,5 km de distancia, en consonancia con el comportamiento de búsqueda de pareja durante la época de cría. Estas estrategias diferentes resaltan la variación relacionada con el sexo y el comportamiento en la movilidad del gato doméstico, especialmente durante el período de celo, y demuestran su capacidad para penetrar en hábitats naturales dentro de un área altamente protegida. Nuestros hallazgos resaltan los riesgos potenciales de superposición con gatos monteses y refuerzan la necesidad de acciones de gestión, incluidas la propiedad responsable, la esterilización y las restricciones al acceso de los gatos a las áreas naturales, para mitigar las amenazas a los paisajes mediterráneos ricos en biodiversidad.

Palabras clave: Área de campeo, área protegida, comportamiento de búsqueda de pareja, *Felis catus*, *Felis silvestris,* movimientos.

Introduction

Domestic cats *Felis catus* Linnaeus, 1758, are among the most widespread companion animals worldwide. When allowed to roam freely, they can pose serious threats to biodiversity through predation, disease transmission, and hybridisation with closely related species such as the European wildcat *Felis silvestris* Schreber, 1777 (Carrete *et al.* 2022). These risks are of particular concern in areas where free-ranging cats may overlap with wildcat populations, increasing the potential for ecological and genetic interactions. Despite their relevance, information on the detailed movements of domestic cats in areas of the Iberian Peninsula remains limited (Palomares & Delibes 1993, Ferreira *et al.* 2011, Lázaro *et al.* 2024, Palomares & Sanglas 2025, Gil-Sánchez *et al.* 2025). Such knowledge is essential to understand the potential risks that domestic cats pose to wildcat populations (Gil-Sánchez *et al.* 2025).

Here, we describe the detailed movements of two GPS-collared domestic cats living in country houses within the Sierra Nevada Natural Space (southeastern Spain), a protected area with presence of wildcats (Gil-Sánchez *et al.* 2015, Sanglas & Palomares 2023). By documenting their home ranges and movement patterns, we provide insights into the potential for spatial overlap and interaction between domestic and wild cats in Mediterranean landscapes.

Material and methods

Study area

The domestic cats were GPS-tracked in a country house (Cortijo Lotrines, Abrucena municipality, Almería province) in the eastern part of the Sierra Nevada Natural Space, southeastern Spain (Fig. 1), situated at an altitude of 1,350 m above sea level. The landscape was typical of the mid-mountain habitat in Sierra Nevada, composed of oaks (*Quercus* sp.) and pine plantations (mainly *Pinus pinaster*) intercalated with riverside forests and agricultural areas. The wild carnivore community in the region is formed by the wildcats, the red fox *Vulpes vulpes* (Linnaeus, 1758), the stone marten *Martes foina* (Erxleben, 1777), the common genet *Genetta genetta* (Linnaeus, 1758), the European badger *Meles meles* (Linnaeus, 1758), and the least weasel *Mustela nivalis* Linnaeus, 1766. Several small mammal, bird, reptile and insect species can be hunted by both cat species in the area (Sanglas *et al.* 2023, Palomares *et al.* 2025).

Methods

The two domestic cats (female FCHA21_AL and male FCMA22_AL) were monitored using GPS collars (1A, e-obs GmbH). Both domestic cat location fixes and home range estimations were deposited in public repositories (Movebank; Palomares & Sanglas (2023a) for location fixes, and Digital CSIC, Palomares & Sanglas (2023b), for home range estimations and individual cat characteristics. We inspected location fixes for home range estimation to detect and remove possible errors typical for some devices used (see Palomares & Sanglas 2023b for details). Both domestic cats were handled to equip them with GPS collars. GPS collars were programmed to take fixes every 4 hours. The study was undertaken with the corresponding permissions (including the bioethics one) of the Consejería de Agricultura, Ganadería, Pesca y Desarrollo Sostenible of the Junta de Andalucía, the Sierra Nevada Natural Space, and the Dirección General de la Producción Agrícola y Ganadera of the Junta de Andalucía.

Results

We first located the two domestic cats in October 2022, when we conducted a census of domestic cats in the study area. FCHA21_AL was an adult female (4 years, 3.5 kg, not spayed), and the only cat in the Cortijo Lotrines (thereafter house 1). FCMA22_AL was a young male (1 year, 3.1 kg, not neutered) and shared a country house (Cortijos Mendoza, thereafter house 2) with five other domestic cats (three adult males and two adult females, all non-neutered or spayed). Both cats were fed by the house owners. The female had been living in house 1 since cubhood. We fitted a GPS collar to this female from 21 December 2022 (just before the mating period began) until 12 March 2023. Male, however, had been living in house 2 since he was a cub, situated 2.65 km from the first one (Fig. 1). Soon after the female was GPS tagged in December 2022, this male began visiting the female in house 1 and started spending more time there. We equipped this male with a GPS collar from January 23, 2023, to March 12, 2023. The female and male continued to stay in house 1 for several months after the GPS tracking period ended. The female gave birth to two cubs in April 2023.

We got 391 GPS fixes for the female. Mean daily distance from residence was 36 m (SD= 20 m; range= 5-209 m). Her estimated home range

size was 0.28-18.21 ha, depending on estimation methods, with a core area (50% kernel) of 0.08 ha (Table 1; Fig. 1c). 83% of the 95% MCP home range was in agricultural areas surrounded or intermixed with natural vegetation, and the remaining 17% in natural vegetation.

We got 410 fixes for the male. His movements were much broader, with a mean distance from residence of 1,772 m (SD= 1,110 m; range= 10-2,664 m). His estimated home range size was 71-328 ha, depending on estimation methods, with a core area (50% kernel) of 63 ha (Table 1; Fig. 1c). Similar to the female, 83% of 95% MCP home range was in agricultural areas surrounded or intermixed with natural vegetation, and the remaining 17% in natural vegetation. During the time this male was GPS-tracked, we detected three trips between the two country houses, resulting in a total of six journeys (Fig. 1d). Except for one, all were completed in less than 4 hours, and all occurred between dusk and dawn (16:00-08:00). While a total of 23 days elapsed between the first and the second journey, the remaining ones were all carried out at intervals of 2-8 days. (Figure 1d).

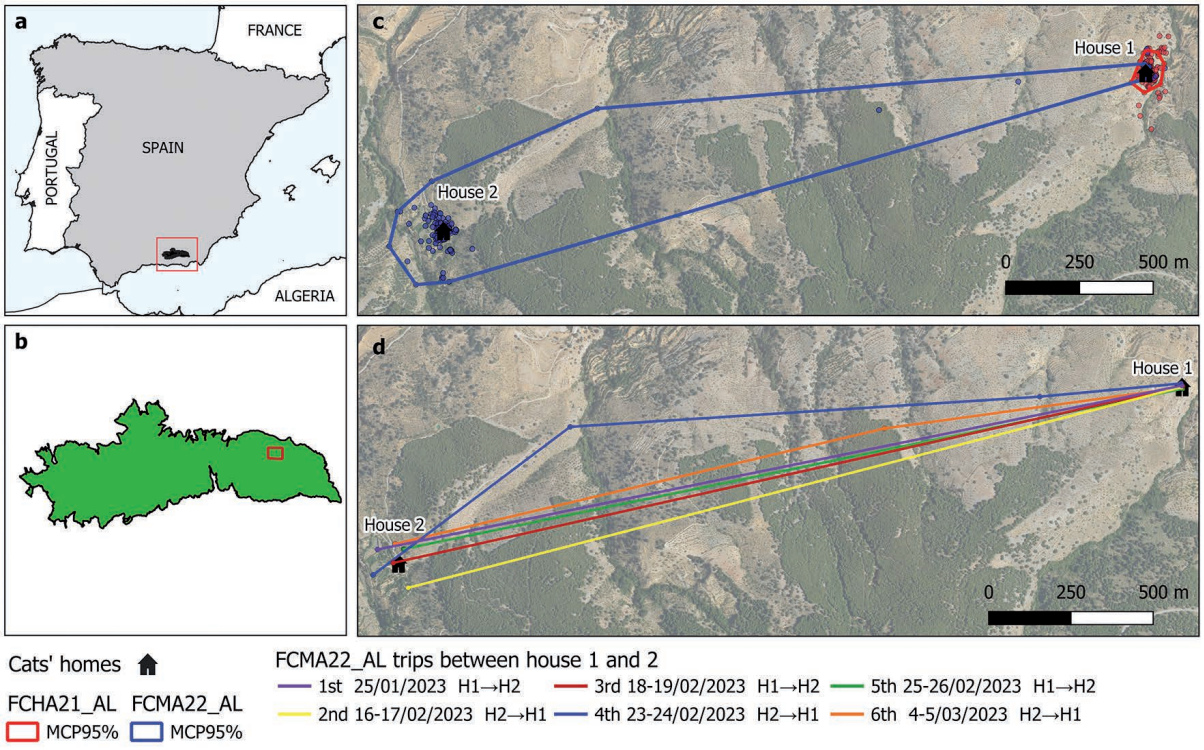

Figure 1. Map of the study area in the eastern part of Sierra Nevada Natural Space showing: a) the location in Spain, b) the location within the Sierra Nevada Natural Space, c) the country houses where both domestic cats were equipped with GPS collars (House 1), the other country house where the male domestic cat come from (House 2), and the fixes and 95% MCP home ranges of both domestic cats (in red the female, blue the male), and d) detailed movements of male between the two houses.

Table 1. Home range estimated (ha) for the two domestic cats GPS-tracked in Sierra Nevada. MPC100: minimum convex polygon using 100% valid fixes, MPC95: minimum convex polygon using 95% valid fixes, Kernel95: Kernel method using 95% valid fixes, Kernel method using 50% valid fixes (between brackets the number of core areas).

Cat	Nº fixes	Nº tracking days	MPC100	MPC95	Kernel95	Kernel50
FCHA21_AL	391	82	18.21	1.05	0.28	0.08 (1)
FCMA22_AL	410	49	76.83	71.36	327.92	62.92 (2)

Discussion

Our study provides novel information on the movements of two free-ranging domestic cats living inside the Sierra Nevada Natural Space, a protected area that still harbours European wildcats. The marked differences observed between male and female cats are consistent with previous findings indicating that males typically exhibit larger home ranges and travel longer distances, particularly during the mating season (Ferreira *et al.* 2011, Nottingham *et al.* 2022, Philippe-Lesaffre *et al.* 2023, but see Palomares & Sanglas 2025).

The pronounced excursions of the male (moving between two country houses approximately 2.5 km apart during the mating season) are consistent with mate-seeking behaviour described in free-ranging domestic cats. Previous studies have documented that males often expand their home ranges, repeatedly visit oestrous females, and undertake extraterritorial forays to increase mating opportunities (Liberg 1980, Yamane *et al.* 1996, Say *et al.* 2002, Finka & Buesching 2023, Gil-Sánchez *et al.* 2025). Such behaviour highlights the role of reproductive strategies in shaping male movement patterns and underscores the potential for increased overlap with wildcats during the breeding season. In fact, we could document the presence of wildcats in the area where both domestic cats moved (Sanglas & Palomares 2023).

The female, in contrast, exhibited a very restricted home range, remaining close to her residence, a pattern documented in other studies of domestic cats with access to human resources (Lázaro *et al.* 2024). These contrasting strategies illustrate how individual variation, associated with sex and reproductive condition, can shape the potential risk that domestic cats pose to wildlife in natural areas. Nevertheless, this female was also exposed to contact with wildcats as previously mentioned (Sanglas & Palomares 2023).

Our results show that domestic cats residing in protected areas can penetrate natural habitats and display movement patterns comparable to those reported for other Mediterranean landscapes (Palomares & Delibes 1993, Palomares & Sanglas 2025). The presence of free-ranging domestic cats within highly protected areas may exacerbate the risks of hybridisation, disease transmission, and competition for prey, although these risks appear to depend strongly on wildcat demographic structure and interspecific spatial segregation (Gil-Sánchez *et al.* 2025).

Overall, our findings underscore the importance of regulating the presence and movements of domestic cats in sensitive habitats. Preventive measures, such as sterilization, responsible ownership, and restricting cat access to natural areas, should be prioritized to reduce risks to wildcat populations.

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