Universidade de Évora

O Impacto da Rede Viária no Uso do Espaço da Geneta

(*Genetta genetta* L., 1758)

Dissertação apresentada para obtenção do grau de Mestre em Biologia da Conservação

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Orientação

Prof. Dr. António Mira

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Nota Introdutória

A tese de mestrado seguidamente apresentada encontra-se sob a forma de artigo. Este, destina-se a ser publicado numa revista científica cujos temas primordialmente abordados incidam sobre a conservação da biodiversidade. O formato de artigo apresentado não se encontra em total acordo com os parâmetros que normalmente caracterizam um artigo científico. No seu conjunto, é um artigo extenso que não poderá ser publicado com o formato que apresenta por razões de amostragem, uma vez que o número de genetas capturadas e efectivamente monitorizadas ao longo do estudo é reduzido. Os estudos de telemetria são normalmente exaustivos resultando numa grande quantidade de dados, no entanto estão dependentes de muitos factores externos, como por exemplo o sucesso de captura e intensidade de armadilhagem resultante da mão-de-obra disponível. Ainda assim, este estudo permitiu-nos obter dados reveladores, relativamente ao comportamento das genetas face às estradas, indicando-nos algumas tendências interessantes por parte destes carnívoros que serão posteriormente publicadas – padrões comportamentais de atracção/repulsa para com as estradas durante a noite e o dia respectivamente, a adopção de uma distância de segurança média de cerca de 1km das estradas principais, a não aleatoriedade no uso do espaço, concentrando-se maioritariamente num dos lados da estrada sugerindo talvez uma desconexão genética entre populações que residam em lados opostos da estrada e ainda o efeito condicionador que estas detêm nos movimentos desta espécie. No entanto se o artigo apresentado para conclusão de tese de mestrado abordasse apenas as tendências por este estudo apontadas, seria uma tese reduzida, não espelhando todos os dados e resultados obtidos ao longo de todo o estudo. Desta forma, a presente dissertação está dividida em três partes: enquadramento, artigo científico e considerações finais. O enquadramento reúne informação sobre a ecologia de estradas, biologia e ecologia da espécie alvo (*Genetta genetta*) bem como o porquê da importância do estudo realizado. O artigo descreve e demonstra todos os resultados provenientes do estudo, a discussão desses resultados bem como as devidas conclusões. As considerações finais resumem os principais resultados e conclusões bem como as limitações do estudo. Este último capítulo ainda abordará possíveis estudos futuros que possam provar ou comprovar as conclusões encontradas no presente estudo bem como medidas a aplicar para contornar ou minimizar o efeito que as estradas detêm nas genetas.

As referências bibliográficas apresentadas no final são o conjunto das citações referidas ao longo de toda a dissertação.

O impacto da rede viária no uso do espaço da geneta (*Genetta genetta* L., 1758)

Resumo

O presente estudo foi realizado numa área com 156,5 Km^2, localizada nos municípios de Évora e Montemor-o-Novo, a Sul de Portugal. Cinco genetas foram seguidas via telemetria durante seis meses visando o estudo do uso do espaço e comportamento relativamente às estradas. Estas, parecem funcionar como limites das áreas vitais da geneta actuando como barreira física e/ou social aos seus movimentos. Contudo, as genetas cruzaram diferentes tipos de estrada embora com frequência reduzida. Por outro lado, as genetas adoptaram uma distância de segurança média das estradas, de 1km, onde se verifica uma aproximação durante a noite e um distanciamento durante o dia. Todos os animais evidenciaram ter uma distribuição não aleatória relativamente às estradas concentrando-se maioritariamente apenas num dos lados da estrada, o que indica o efeito destas infra-estruturas como barreiras parciais ao movimento. A presença de galerias ripicolas parece promover o uso das bermas e durante o estudo todos os indivíduos seleccionaram positivamente estes habitats.

The Impact of Road Network on the Space Use of the European Genet (*Genetta genetta* L., 1758)

Abstract

The present study, was conducted in a 156,5 Km^2 area, located in the Évora and Montemor-o-Novo counties, southern Portugal. Five genets were radio-tracked for six months with the purpose of studying their space use and behavior towards roads. In this study, roads seem to be artificial boundaries to genets' home ranges acting as physical and social barrier to their movements. However, genets have crossed different types of roads, although in lower frequencies. They adopted, in average, a security distance of 1km from roads being further during the day and closer at night. All animals showed a not random distribution on their activity concerning roads presence and their localizations tend to concentrate on one side of the road which confirms that these infrastructures pose a significant barrier to genets' movements. The existence of riparian galleries seems to promote roadside usage and during the study genets have selected positively these habitats.

Enquadramento

O desenvolvimento notório das redes viárias por todo o Mundo é um dos temas que mais preocupa os cientistas devido ao carácter destrutivo e irreversível que incute nas populações faunísticas e florísticas, elementos que compõem as paisagens actuais. A perda artificial de habitats naturais bem como a sua divisão em parcelas de menores dimensões propicia o aumento da fragmentação dos habitats dividindo, consequentemente, as populações animais em populações de menores dimensões e/ou em sub-populações isoladas colocando em causa a estabilidade e viabilidade das mesmas (Forman and Alexander, 1998; Lodé, 2000; Iuell et al., 2003; Jaeger et al., 2005). Desta forma, os indivíduos de uma mesma população tendem a aumentar os casos de consanguinidade diminuindo, por sua vez a variabilidade genética do grupo (Jackson, 2000; Lodé, 2000; Ferreras, 2001). Esta redução vai aumentar o risco de extinção da população, ficando esta mais exposta a fenómenos de estocasticidade (Jackson, 2000).

Estas infra-estruturas actuam, para muitas espécies, como barreiras físicas intransponíveis, dificultando ou impedindo as deslocações naturais dos animais (Coffin, 2007) – os indivíduos não chegam ao outro lado da estrada e consequentemente não obtêm alimento, parceiro sexual e/ou local de reprodução (Jaeger et al., 2005). Este efeito barreira pode contribuir para o isolamento das populações resultando, posteriormente, na extinção das mesmas (Forman and Alexander, 1998; Jackson, 2000; Alexander et al., 2005). Muitos animais alteram as suas rotas de reprodução e migração devido a comportamentos de repulsa perante as estradas, enquanto outros morrem devido a colisões com veículos (Trombulak and Frissel, 2000; Alexander et al., 2005; Coffin, 2007).

A mortalidade resultante da colisão directa entre animal/automóvel é uma das consequências mais directas e consideráveis das estradas, em termos quantitativos, apresentando taxas bastante elevadas e expressivas (Clevenger et al., 2001; Coffin, 2007). A mortalidade por colisão reduz o número de efectivos de uma população o que pode comprometer a sua viabilidade se a taxa de nascimentos não for superior à taxa de atropelamentos (Jaeger et al., 2005). Ao privarem as espécies de executarem as suas funções vitais, estão a funcionar como barreira, propiciando o isolamento e a fragmentação destas populações. Assiste-se assim, a modificações de comportamento a vários níveis, entre eles os padrões de movimento, domínios vitais e sucesso reprodutor (Brown et al., 2001; Coffin, 2007).

Apesar de alguns cientistas terem demonstrado que as estradas nem sempre actuam como impenetráveis barreiras ao movimento dos animais (Kaczensky et al., 2003; Blanco et al., 2005; Riley et al., 2006, Grilo et al., 2008), estas podem representar barreiras sociais ao fluxo genético (Reh and Seitz, 1990; Riley et al., 2006; Strasburg, 2006), ficando as populações mais expostas a catástrofes naturais e artificiais.

A deturpação do ambiente físico é outra das consequências da implementação de estradas, alterando e degradando o meio envolvente e o comportamento das espécies (Forman and Alexander, 1998; Spellerberg, 1998; Iuell et al., 2003; Coffin, 2007). O ruído sonoro parece funcionar como sinal de aviso " área a evitar" para algumas espécies (Coffin, 2007) influenciando por outro lado, as vocalizações de várias espécies de aves (Forman and Alexander, 1998; Coffin, 2007). Este tipo de infra-estruturas tem o efeito oposto em muitas outras espécies, atraindo indivíduos para a vegetação inerente às bermas, habitats propícios à alimentação e/ou protecção (Coffin, 2007). As estradas são muitas vezes utilizadas como corredores ecológicos bem como fontes de termorregulação, sendo os anfíbios e répteis dois dos grupos mais afectados (Forman and Alexander, 1998).

A emissão de poluentes químicos também contribui para a deterioração dos habitas bem como das linhas de água, diminuindo assim a qualidade de vida destes animais (Forman and Alexander, 1998). Por outro lado, com a alteração de temperaturas, níveis de radiação solar e velocidade do vento os habitats adjacentes às estradas são susceptíveis de sofrer significativas alterações, podendo desenvolver-se um novo microclima propício à invasão de espécies exóticas (Forman and Alexander, 1998; Spellerberg, 1998; Trombulak and Frissel, 2000; Brown et al., 2001; Coffin, 2007). As bermas podem assim funcionar como refúgio para alguns animais, especialmente para pequenos mamíferos (Forman and Alexander, 1998; Spellerberg, 1998; Bellamy et al., 2000; Iuell et al., 2003; Coffin, 2007), como fontes de alimento e abrigo (Evink, 2002) e como corredores para actividades exploratórias, de dispersão e/ou de colonização (Spellerberg, 1998; Iuell et al., 2003; Coffin, 2007). Desta forma, as bermas e as estradas podem promover um de dois comportamentos – repulsa ou atracção, podendo atrair os animais para "armadilhas ecológicas" (Iuell et al., 2003; Coffin 2007).

As estradas conduzem a consequências complexas e variadas, beneficiando as espécies mais tolerantes a alterações nos ecossistemas e prejudicando muitas outras de forma gravosa. Os impactes causados por estas infra-estruturas actuam como entraves ao bom funcionamento de processos ecológicos, não só nas imediações das estradas como também em zonas relativamente afastadas (Brown et al., 2001).

É assim urgente, precisar os impactes ecológicos inerentes a estas infra-estruturas, de forma a dar resposta às necessidades das comunidades por elas afectadas.

Os carnívoros são particularmente vulneráveis à rede de estradas uma vez que possuem grandes áreas vitais, baixas taxas de reprodução, baixas densidades populacionais e pouca resiliência (Spellerberg , 1998; Trombulak and Frissel, 2000; Sunquist and Sunquist, 2001

; Ng, 2004). Nesta linha, são animais que percorrem grandes distâncias na procura de alimento, parceiro sexual e quando se encontram em dispersão (Spellerberg , 1998; Trombulak and Frissel, 2000; Sunquist and Sunquist, 2001 ; Ng, 2004). São espécies particularmente afectadas pelo efeito barreira e fragmentação do habitat, uma vez que precisam de um sistema contíguo de habitats naturais para alcançar as necessidades inerentes a cada um, sem as quais a sua existência é comprometida. No entanto, pouco se sabe sobre a resposta deste grupo relativamente à magnitude das estradas (Grilo, 2009).

Este estudo tem como espécie alvo a geneta comum (*Genetta genetta* Linneus, 1758), o único exemplar representante do género Africano *Genetta*, na Europa (Rosalino and Santos-Reis, 2002). Esta espécie está classificada como "Pouco preocupante" de acordo com o Livro Vermelho de Portugal (Cabral et al., 2005), no entanto é uma vítima constante de armadilhas ilegais e práticas de caça. A sua área de distribuição está restringida a Portugal, Espanha, Ilhas Baleares e sudoeste de França (Bouchardy et al., 1986; Livet and Roeder, 1987). A geneta apresenta uma distribuição generalizada dado que é um dos carnívoros mais comuns em Portugal (Santos-Reis and Mathias, 1996), no entanto, os dados sobre a sua distribuição e abundância ainda são escassos (Gomes, 1998; Rosalino and Santos-Reis, 2002). Esta é uma espécie de hábitos nocturnos (Palomares and Delibes, 1994; Gomes, 1998) iniciando o período de actividade um pouco depois do pôr-do-sol e terminando esse mesmo período antes de o sol nascer (Palomares and Delibes, 1994; Lariviére and Calzada, 2001; Santos-Reis et al., 2004). É uma espécie convencionalmente classificada como generalista, consumindo os recursos mais disponíveis no tempo e no espaço (Lariviére and Calzada, 2001; Rosalino and Santos-Reis, 2002), no entanto, a sua presa principal, sempre que sobreposta à sua área vital, é o rato-do-campo (Apodemus sylvaticus) (Gomes, 1998; Virgós et al., 1999; Lariviére and Calzada, 2001). Apesar da existência de alguma bibliografia sobre a dieta deste animal, este é classificado pelos autores, de diferentes maneiras, variando essa classificação com a disponibilidade sazonal de alimentos e localização geográfica (Virgós et al., 1999; Rosalino and Santos-Reis, 2002; Carvalho and Gomes, 2004). É muitas vezes considerada uma espécie no intermédio de generalista e especialista sendo os grupos mais importantes para a sua dieta na Região Eurosiberiana no Norte e Centro da Europa os roedores e insectívoros (Virgós et al., 1999; Carvalho and Gomes, 2004) enquanto no Sul, apesar dos roedores ainda constituírem a fonte primordial de alimento, os coelhos e artrópodes adoptam posições igualmente importantes (Virgós et al., 1999; Rosalino and Santos-Reis, 2002).

A geneta europeia é uma espécie territorial que habita diversos tipos de habitats, sendo que a cobertura de vegetação terrestre e aérea é um factor essencial para a escolha das áreas vitais (Gomes, 1998; Barrientos and Virgós, 2006; Galantinho and Mira, 2008). A cobertura do solo é muito importante tanto nos períodos de actividade como nos períodos inactivos (Palomares and Delibes, 1988; Palomares and Delibes, 1994; Virgós and Casanovas, 1997), no entanto, estes animais podem usar zonas abertas para caçar ou quando se encontram em dispersão (Palomares and Delibes, 1988; Lariviére and Calzada, 2001). Os abrigos que usam durante o dia, para descansar, e a disponibilidade de presas são factores determinantes na selecção de habitat (Lariviére and Calzada, 2001; Galantinho and Mira, 2008). Muitos estudos têm sido realizados sobre a dieta das genetas (ex. Virgós et al., 1999; Rosalino and Santos-Reis, 2002) e apenas alguns nos factores que influenciam o uso do espaço (Virgós and Casanovas, 1997). No entanto, as estradas continuam a levantar algumas questões sobre o impacto que detêm na vida dos carnívoros, nomeadamente *como*, *quanto* e *quando* influenciam estes animais.

Para muitos ecologistas, perceber o comportamento animal na paisagem e determinar os principais factores que afectam o uso do espaço é uma questão crucial (Horne et al., 2008).
O uso do espaço de um animal é influenciado por uma combinação de características fisiológicas e adaptações comportamentais a diferentes ambientes (Giuggioli et al., 2006; Horne et al., 2008) podendo a selecção do habitat ser considerada uma peça chave para a compreensão das decisões comportamentais tomadas pelos animais (Orians and Wittenberger, 1991). A presença de outras espécies, a presença humana, a disponibilidade de habitat e a abundância e diversidade de presas são factores fundamentais, capazes de influenciar o comportamento das genetas. Infelizmente, estes não são os únicos factores capazes de alterar o uso do espaço desta espécie, o aumento da rede viária pode também desempenhar um papel importante no comportamento e movimento dos carnívoros apesar de ser ainda um assunto pouco conhecido. No entanto, saber como os animais respondem a todos estes factores pode ajudar os ecologistas a apresentar algumas medidas de conservação e/ou minimização.
Portugal, é um dos países da União Europeia com maior densidade de auto-estradas e vias rápidas (Farrall, 2000). Assim, torna-se urgente precisar a influência destas infra-estruturas na fauna e flora do nosso país, devido aos efeitos nefastos que incutem na natureza. É neste contexto que surge este trabalho, pretendendo dar resposta à influência das estradas no uso do espaço de mamíferos carnívoros. Compreender a organização dos animais no tempo e no espaço é uma questão fulcral na ecologia. A dinâmica populacional está directamente relacionada com a distribuição espacial e os movimentos individuais de cada espécie, inerentes a pressões internas ou externas que actuam sobre a população (Millspaugh, J. and Marzluff, J., 2001).

A resposta comportamental das genetas à presença de estradas é desconhecida. Serão as estradas barreiras efectivas ao movimento das genetas? Se sim, quão importantes são essas barreiras? As genetas evitam a proximidade das estradas ou podem usar o habitat adjacente a estas infra-estruturas para investidas exploratórias? Estas e outras questões são fulcrais para a gestão da fauna silvestre nos territórios adjacentes às estradas.

Este trabalho apresenta resultados sobre o comportamento espacial da geneta (*Genetta genetta*), obtidos via rádio-telemetria numa paisagem mediterrânica atravessada pelo maior corredor de transportes do sudoeste da Península Ibérica. O enfoque do estudo teve como principal objectivo saber como o uso do espaço é afectado pela rede viária e em determinar os principais factores que podem afectar o comportamento espacial das genetas. O número de atravessamentos e a distância das localizações dos indivíduos às estradas foi usado para analisar padrões de comportamento (atracção ou repulsa; efeito barreira). O tamanho das áreas vitais e a selecção de habitat foram conjuntamente determinados e os resultados tiverem sempre em consideração a distancia às estradas

The Impact of Road Network on the Space Use of the European Genet (*Genetta genetta* L., 1758)

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Abstract

The present study, was conducted in a 156,5 Km^2 area, located in the Évora and Montemor-o-Novo counties, southern Portugal. Five genets were radio-tracked for six months with the purpose of studying their space use and behavior towards roads. In this study, roads seem to be artificial boundaries to genets' home ranges acting as physical and social barrier to their movements. However, genets have crossed different types of roads, although in lower frequencies. They adopted, in average, a security distance of 1km from roads being further during the day and closer at night. All animals showed a not random distribution on their activity concerning roads presence and their localizations tend to concentrate on one side of the road which confirms that these infrastructures pose a significant barrier to genets' movements. The existence of riparian galleries seems to promote roadside usage and during the study genets have selected positively these habitats.

Keywords: European genet, road network, barrier effect, habitat selection, home ranges

Introduction

The continuous increase of linear infrastructures extension has radically changed landscapes and animal communities during the last decades (Lodé, 2000). This lead to the artificial loss of natural habitats and dissection of habitat patches, overall increasing habitat fragmentation. The sectioning of landscape divides animal populations into smaller and/or isolated sub-populations which is a serious threat to wildlife's stability and viability (Forman and Alexander, 1998; Lodé, 2000; Iuell, et al. 2003; Jaeger et al., 2005). In fact, animals tend to increase inbreeding consequently diminishing the variability between populations (Jackson, 2000; Lodé, 2000; Ferreras, 2001). Moreover, gene flow's reduction will increase the risk of extinction and the exposure of populations to stochasticity (Jackson, 2000).

Road network is commonly taken as part of modern landscapes (Clevenger, 1999). A barrier effect is originated by these paved corridors which increase resistance of movement (Coffin, 2007) - animals cannot reach the other side of the road and consequently do not reach resources like food, mates and/or breeding sites (Jaeger et al., 2005). Many animals modify their reproduction and displacement routes on account of road avoidance behavior while others perish due to collisions with vehicles (Trombulak and Frissel, 2000; Alexander et al., 2005; Coffin, 2007). Akin to habitat fragmentation, the barrier effect may instigate isolated populations leading them to extinction (Forman and Alexander, 1998; Jackson, 2000; Alexander et al., 2005).

Even though some researchers have demonstrated that roads may not always prevent animals to cross them (Kaczensky et al., 2003; Blanco et al., 2005; Riley et al., 2006, Grilo et al., 2008), acting as a physical barrier, they can represent a social barrier to gene flow (Reh and Seitz, 1990; Riley et al., 2006; Strasburg, 2006) leading populations to be more exposed to natural and artificial catastrophes.

Carnivores are particularly vulnerable to network road because they have relatively large home range requirements, low reproductive rates and low densities (Spellerberg ,1998; Trombulak and Frissel, 2000; Sunquist and Sunquist, 2001; Ng, 2004). For this reason, they usually move long distances searching for food, mates and also to disperse (Spellerberg ,1998; Trombulak and Frissel, 2000; Sunquist and Sunquist, 2001; Ng, 2004). These species are particularly affected by the barrier effect and by habitat fragmentation since they need a contiguous system of natural habitat to accommodate their special needs without which their existence is compromised. However, little is known about the carnivore response to the amount and magnitude of roads (Grilo et al., 2009)

This study is focused on the common genet (*Genetta genetta* Linneus, 1758), the single representative African genus, *Genetta*, in Europe (Rosalino and Santos-Reis, 2002). The species is classified as "Least Concern" according to the Portuguese Red Data Book (Cabral et al., 2005), it is a regular victim of illegal traps and hunt. Its distribution range is restricted to Portugal, Spain, The Balearic Islands and Southwestern France (Bouchardy et al., 1986; Livet and Roeder, 1987).

The common genet has a widespread distribution given that it is one of the most common carnivores in Portugal (Santos-Reis and Mathias, 1996), nevertheless, the data about its abundance and distribution is still scarce (Gomes, 1998; Rosalino and Santos-Reis, 2002). The genet is a nocturnal specie conventionally classified as a generalist animal, consuming the resources more available (Lariviére and Calzada, 2001; Rosalino and Santos-Reis, 2002), however, its main prey regardless of its range is the Wood mouse (*Apodemus sylvaticus*) (Virgós et al., 1999; Lariviére and Calzada, 2001). European genet is a territorial species which inhabits diverse types of habitats, being aerial and terrestrial vegetation coverage an essential factor to choose its home range (Gomes, 1998; Barrientos and Virgós, 2006; Galantinho and Mira, 2008). Shelters for resting and prey availability are determinant to habitat selection (Lariviére and Calzada, 2001; Galantinho and Mira, 2008). Many studies have been made about this species diet (see Virgós et al., 1999; Rosalino and Santos-Reis, 2002). On the other hand, other studies have focused on the factors that influence both space and temporal use of genets (Virgós and Casanovas, 1997). Nevertheless, roads continue to endorse some questions about their impact on carnivores' life namely *how*, *how much* and *when* they influence these animals.

For many ecologists, understanding animal behavior in the landscape determining the main factors affecting space use is one of the most crucial issues (Horne et al., 2008). Animal space use is influenced by a combination of physiological characteristics and behavioral adaptations to different environments (Giuggioli et al., 2006; Horne et al., 2008) and habitat selection can be considered a key to reveal behavioral decisions (Orians and Wittenberger, 1991). The presence of other animals, human presence, available habitat and prey abundance and diversity are all fundamental factors capable of influencing genets' behavior. Unfortunately, these are not the only features capable of altering animals' space use. The increasing of road network may also to play a major role in carnivore behavior and movements although this is still a poorly known issue. However, knowing how animals respond to all these factors may help ecologists to put forward some safety and conservational measures.

Radio-telemetry is a very useful method to investigate this issue because it gives us precious information about animals' space use and their behavior towards landscape units

(Harris et al., 1990; Ministry of environment, 1998; Kauhala and Tiilikainen, 2002; Wauters et al., 2007).

The behavioral response of genets to the presence of roads is unknown. Are roads barriers to the genet movements? If yes, how important are these barriers? Do genets avoid the proximity to roads or they can use road vicinity as, for instance foraging grounds? This and other questions are key issues that can help to manage wildlife populations in road surroundings.

The present paper provides results on the spatial behavior of genets (*Genetta genetta*) obtained via radio tracking in a Mediterranean landscape crossed by biggest transportation corridor in the southwest of the Iberian Peninsula. Interest has been centered on how space is affected by the road network and in determining the main factors that might affect the spatial behavior of genets. The number of road crosses and the distance of the animals locations to roads were used to evaluate and analyzed the behavior pattern (attraction or avoidance; barrier effect). The home range size and habitat selection were also determined and the results are discussed taking into account distance to roads.

Study area

This research was conducted in a 156,5 Km^2 area located in Évora and Montemor-o-Novo counties, southern Portugal. The study area is partially included in Serra de Monfurado, Natura 2000 Site (ICN, 2006), where most lands are private property. The climate is Mediterranean with Atlantic influences - dry hot summers and cold rainy winters where the highest main annual temperature is 21^0C and the lowest 11^0C, being the average annual precipitation 665mm/year (Weather station Évora-Mitra, 1951-1980). The landscape is dominated by cork and holm oak woodland, sometimes with an undercanopy of scrubs - commonly described as *montado*. The study area also includes pastures and fallow lands, olive and pine groves, vineyards, and a few patches of exotic tree species (*Eucalyptus globulus*). The well represented Riparian vegetation is composed of black poplar (*Populus nigra*), ash (*Fraxinus angustifolia*), white willow (*Salix alba*), blackberry (Rubus ulmifolius) thickets and black alder (*Alnus glutinosa*). The area is crossed by several roads with different traffic density. There is a two-side fenced highway (A6) with an annual average of daily traffic between 330 and 2494 vehicles/night, several sections of national roads (N114, N4 and N370) reaching values between 500 and 2161 vehicles/night (Grilo et al., 2009) and a secondary paved road (Guadalupe road) with lowest traffic intensity. In some locations the highway runs parallel to a national road (N114). Although human presence is scarce and dispersed, it promotes visible human impacts such as cork extraction, livestock and hunting activities. Genets are sometimes seen as pests mainly by hunters because they prey on game species and their eggs, so they are commonly victims of human practices as illegal predator control.

Methods

Capture and Radio-tracking

The animals, were captured with box traps (Tomahawk Deluxe Single door live trap, Model 108.2) measuring 91,44cm of length, 25,4 cm of width and 30,48 cm of height (Tomahawk Live Trap Co., Wisconsin, USA) between February and May 2008. The box traps were placed near the N114 road between Évora and Montemor-o-Novo. Trap location was chosen according to the tree cover density, human accessibility and other suitable conditions for genets' presence. Whenever the weather conditions were unacceptable, trapping were interrupted. At the beginning, sardines were used as bait. Later they were replaced by eggs because the fish was a strong attractor to rats making the traps unavailable for capturing the genets; droppings of other carnivores were placed near traps to increase trapping success. Traps were checked in the early morning. When captured, the animals were immobilized and anaesthetized with a combination of ketamine and xylazine, under veterinary supervision. Each animal was fitted with a radio collar and marked with a TAG, for individual recognition. All animals were weighted, measured, sexed, and aged as young, sub-adults or adults (according tooth wearing and development and body dimensions). After animals' total recovery, they were released in the same place of the capture.

Radio collars (Wildlife Materials, Inc., mod.lpm2700A) weighed approximately 25g, never outnumbering 5% of the animals' weight and their signal was received by TRX-1000S receiver (Wildlife Materials, Inc.) with a three element Yagi, directional antenna (Wildlife Materials, Inc.) and a hand-held GPS (Garmin GPS- eTrex H). Necklace transmitters were transformed with neoprene to minimize the impact on animals.

Radio tracking was carried out between April and November 2008 when one or two locations were made during the day and/or night for each animal wherever they were found (for each location a characterization of the microhabitat vegetation and surrounding areas was made.) The time interval between two successive locations was controlled to ensure the independence of data locations - daily locations were made by means of homing technique where animals were inactive (wherever possible) and nocturnal locations via triangulation when they were active (Mech, 1983 *in* Palomares and Delibes, 1994). In order to evaluate activity patterns, a rotational scheme with periods of four hours, covering all the 24 hours, was used to radio-track every animal. The accuracy of locations obtained through triangulation was evaluated with tests done with animals for which the exact location was known (e.g. when animals were inactive) and then compared with the exact location of the animal (homing). Results differ on average 360m. The radio telemetry locations were obtained by one observer hence the bearings were recorded within a 5 min interval and differences in azimuths between 45 and 120^0. The activity status of the animals was evaluated on the basis of the frequency of the radio signal.

Data analyses

Before estimating the home range size, we have previously evaluated the number of points needed to get a stabilized estimation of it (Harris et al., 1990; Aebischer at al., 1993; Munuera and Llobet, 2004). The plot of estimated home range size with minimum convex polygon (MCP) against the number of fixes was used to define the minimum number of locations needed to get an accurate estimate of the home range. This number corresponds to the value for which a home range size reaches an asymptote (Kernohan et al., 2001). For all animals, except one, a minimum of 80 locations are needed to make estimations of the home range. For one animal, which only have 30 points, the asymptote was never reached. Hence, all the analyses in this study refer to animals for which the minimum number of locations was gathered.

Estimates for home-range size were carried out with the Animal Movement Extension (SA v2.04 beta) of ArcView Gis 3.3 (ESRI, 1999). Two methods were used: the minimum convex polygon (100%) (Mohr, 1947) - the most used method for home range calculation because of its usefulness to compare with other studies (Harris et al. 1990; Junior and Chiarello, 2005; Farrimond et al., 2006; Franzreb, 2006) - and the fixed kernel estimator (95%)(Worton, 1989; Seaman and Powell, 1996; Millspaugh and Marzluff, 2001). Whenever possible, we also estimated the core areas of each animal which corresponds to the 50% fixed kernel - using LSCV (Farrimond et al., 2006; Franzreb, 2006). For both 95 and 50% fixed kernel, smoothing parameters were determined by the least squares cross-validation,(LSCV) being the grid size defined automatically by the software (Franzreb, 2006). The overlap of home ranges between each pair of animals was expressed as the total percentage of home range overlap for the kernel 95% home ranges. Daily resting sites were described according to several biophysical characteristics including tree and scrub cover and the dominant species of each stratum. For each animal, the re-use rate of each resting site was evaluated by dividing the total number of resting periods by the different resting sites detected (Palomares and Delibes, 1994).

Genets space use is intrinsically linked with habitat selection not only because home range definition depends on habitat composition but also because the surrounding matrix may/may not favor the proximity with road network.

Habitat selection was analyzed in two ways. Firstly, we have compared the proportion of each habitat type within home ranges with the proportion of use (number of locations) made by each animal within its home range; secondly we have compared the available habitat in the area of study (defined by the minimum convex polygon including all locations of all studied animals) with the habitat within each genet home range (Johnson, 1980; Aebischer, 1993; Cavallini and Lovari, 1994). Five different habitats were considered: riparian gallery (RG), cork oak woodland (CO_wood), dense cork oak woodland (D_CO_wood), open field (OF) and others (which included habitats poorly represented in the study area, less than 2 % of the area; such as olive and pine groves, vineyards, and a few patches of exotic tree species).

In this study the analyses were made at an individual level because it is believed by several authors that pooling data of all individuals turns more difficult to draw conclusions (Cavallini and Lovari, 1994). All radio-locations (due to the few location data of each individual 4 hour), were used for the analysis of habitat selection (the activity and resting points), despite the recommendations of several authors for an independent analysis (Palomares and Delibes, 1994).

Preference or avoidance towards habitats was evaluated through a qui-square test (with K-1 degrees of freedom where k is the number of habitat categories (Neu et al., 1974). When significant differences were found, the Bailey's confidence intervals were used to determine the direction of selection of each habitat class (Cherry, 1996). Habitat types used more or less frequently than availably were respectively considered as preferred or avoided (Cherry, 1996; Martins and Borralho, 1998). When habitat types are used in proportion of their availability, a selection by the animals does not exist.

In order to evaluate behavioral patterns of genets in relation to road network, we measured the distance to the nearest road for every location of each animal. The analysis was done considering separately active and inactive locations, in that order to test attraction/avoidance behavior and with all data points for each animal. Distances were gathered in arcview GIS (ESRI, 2006) and then tested through the Mann Withney nonparametic test (Maroco, 2003). We also analyzed the distances to riparian galleries because during the study this habitat revealed to be an important resting places for some of the animals and this may help us to understand better the genet's space use.

In order to evaluate the possible role of roads as barriers for movements and their influence on space use, for each animal (except G5) we generated a circular plot, having a similar area of its MCP home range and centered at capture point. These were located close to the N114 so all plots were crossed by this road. Inside each circle, 100 random points were generated, corresponding to simulated fixes that were used as predicted values for a qui-square tests aiming to evaluate if observed fixes were randomly located on each roadside. We also looked for crosses by mapping the daily locations of each monitored animals on a road map.

Results

Captures and genet locations

Ninety tree animals were captured in 960 night-traps, including 69 rodents, the more frequently caught group; seventeen carnivores (seven european genets, five egyptian mongoose, two beech marten and tree domestic cats); four birds (three passerines and one owl) and tree hedgehogs. Seven genets were captured with a capture success of 1,3%. The first two captures (G8 and G9) were released without collar necks due to their small weight. The other five captured genets (see table one - G1,G2,G3,G4,G6) were monitorized between four and six months except G6, who was lost after one week of monitorizing. However, two other genets (G5 and G7) were captured by local farmers and were part of the study. Unfortunately the female G7, outside captured, was lost after being released due to collar failure, being G5 the only outsider monitorized with the other four captured animals, for at least forty days before his death .During the whole study, seven males and two females were captured, five of which were sub-adults and four adults. In average the genets weighted 1.461kg (SD = 0.326, range =0.98-1.870, n=9).

Table 1- General characteristics of captured genets (*genets captured by locals).

Genets	sex	weight	age	destination	restings	Total fixes
Serena (G1)	female	1630g	Sub-adult	Radio-tracked	60	155
Xe (G2)	male	1590g	Sub-adult	Radio-tracked	45	98
Neptuno (G3)	male	1470g	Sub-adult	Radio-tracked	44	100
Hercules (G4)	male	1220g	adult	Radio-tracked	29	138
Vasco (G5) *	male	1720g	Sub-adult	Radio-tracked	1	27
Cavalinni (G6)	male	1870g	adult	missing	-	-
Naide (G7) *	female	1690g	adult	Battery failure	-	-
G8	male	980g	Sub-adult	released	-	-
G9	male	980	adult	released	-	-

A total of 518 locations (339 triangulations and 179 homings) were obtained for the 5 studied genets. More than 20% of fixes were missing, i.e., the animal was not found when searched.

As illustrated by figure 1, roads seem to play an important role in spatial organization of the animals since most of their locations are bounded by roads. The highway A6 presents a stretch parallel to N114 which turns more difficult for animals to cross it, since they have to cross the national road first. Only one genet (G3), which has also crossed N114 and N370 once, has crossed the highway, this happened at least 13 times, meaning that he crossed the national road, N114, also 13 times. Twenty eight percent of the locations were on the opposite side of the road from the capture location of G3. Despite the small monitoring time, genet G5 crossed a national road (N4) eleven times (40,7% of locations). Other genets (G1, G2, G4) had a lower crossing rate: of the 155 locations, the female crossed roads 5 times (3,2%) (The Guadalupe road -the road with less traffic - on three 3 occasions - and the N114 twice); G2 only crossed the Guadalupe road twice (2%) and G4 only crossed the N114 once (0,7%) .

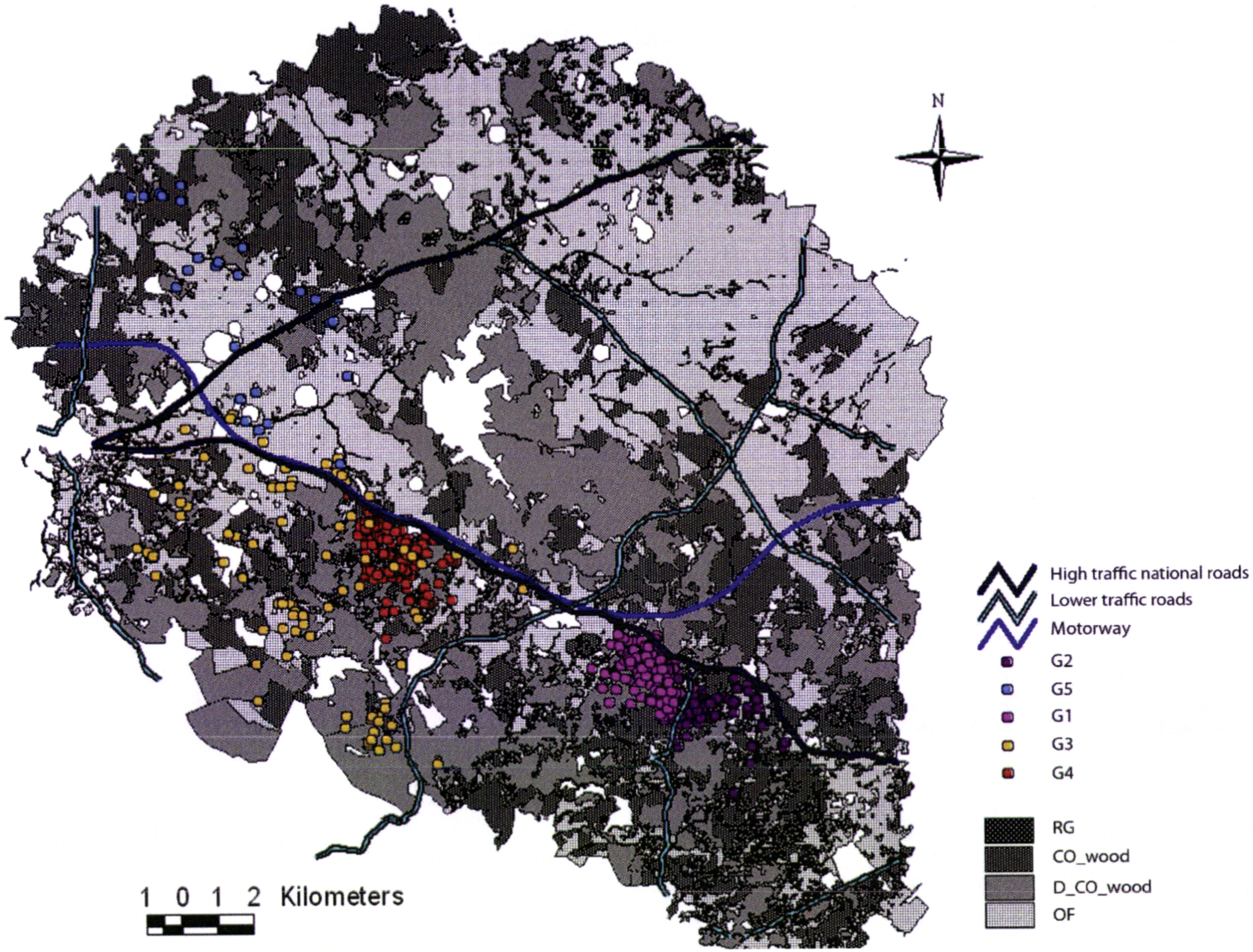


Figure 1 – Locations of genets (G1,G2,G3,G4,G5) according to land uses (riparian gallery (RG), cork oak woodland (CO_wood), dense cork oak woodland (D_CO_wood), open field (OF)) and presence of roads.

Home ranges and core areas

The mean home range area of studied genets was 20,2 Km^2 using the minimum convex polygon (SD=28.2, n=4)) being slightly smaller when obtained by kernel method, 18,63 Km^2 (95%, SD=28.2, n=4) .

The larger home range area was 62 km^2 (mpc), a value corresponding to a sub-adult male probably a disperser (G3). The female G1 has the smallest home range (4,68km^2) (see table 2). Nevertheless, the three among four animals showed some similar values. Home ranges areas present similar values for both methods except for genet G2, which presents a smaller size for the kernel method (Table2). This difference may be explained by the use of the mcp which leads to overestimation of the animals´ home range (Harris et al., 1990) In some cases, home ranges are bordered by two roads delimitating the north, the east and sometimes even west borders.

Some overlap may be observed between G3 and G4 (figure 2). The first genet is a sub-adult clearly in dispersion, whose home range includes almost all (98,21%) the home range of G4. On the contrary, G4 home range only includes 10,7% of G3 home range. The home ranges of G2 and G1 present an overlapped, less than 6%.

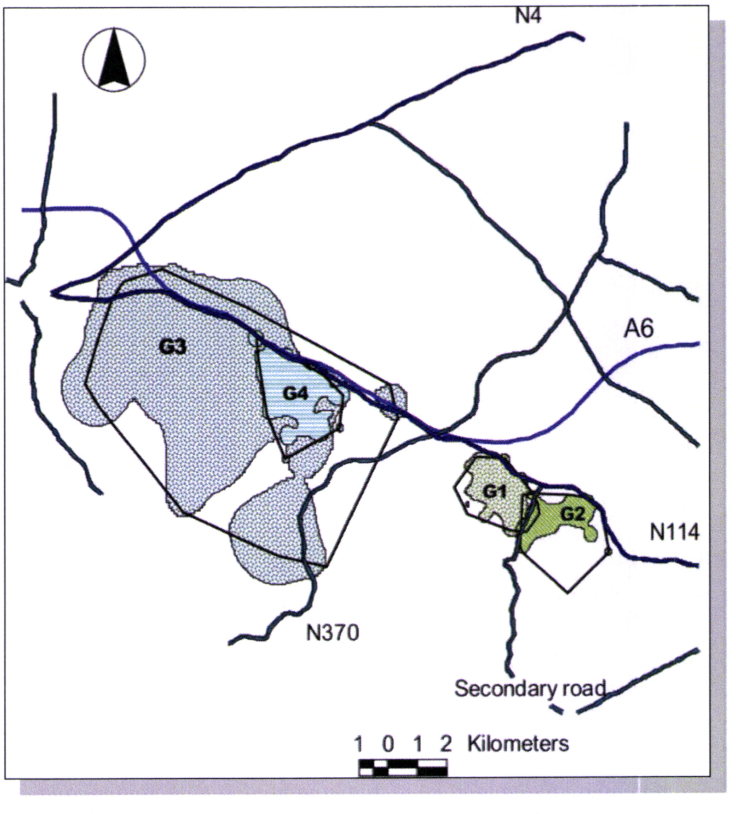


Figure 2 – Genets home ranges obtained by minimum convex polygon (showed by outer straight lines) and fixed kernel method (95%) (showed by contour lines, filled and colored areas). There were three male genets (G2, G3, G4) and one female (G1)

The mean core areas of studied genets was 1,46 Km^2 using the kernel method, (50%, SD=1.83, n=4).The core areas of the animals occupied in average 7,8 % of the total home range area being almost thirteen times smaller (1,46 Km^2) than home ranges, however if we exclude genet G3 of the analyses the three animals occupied in average 12,4% of the total home range area being just eight times smaller (0,56 Km^2) than home ranges. All genets had more than one core area, except for G2; G1 had four, G4 three, and G3 two; the single female had more core areas than males (figure 3).

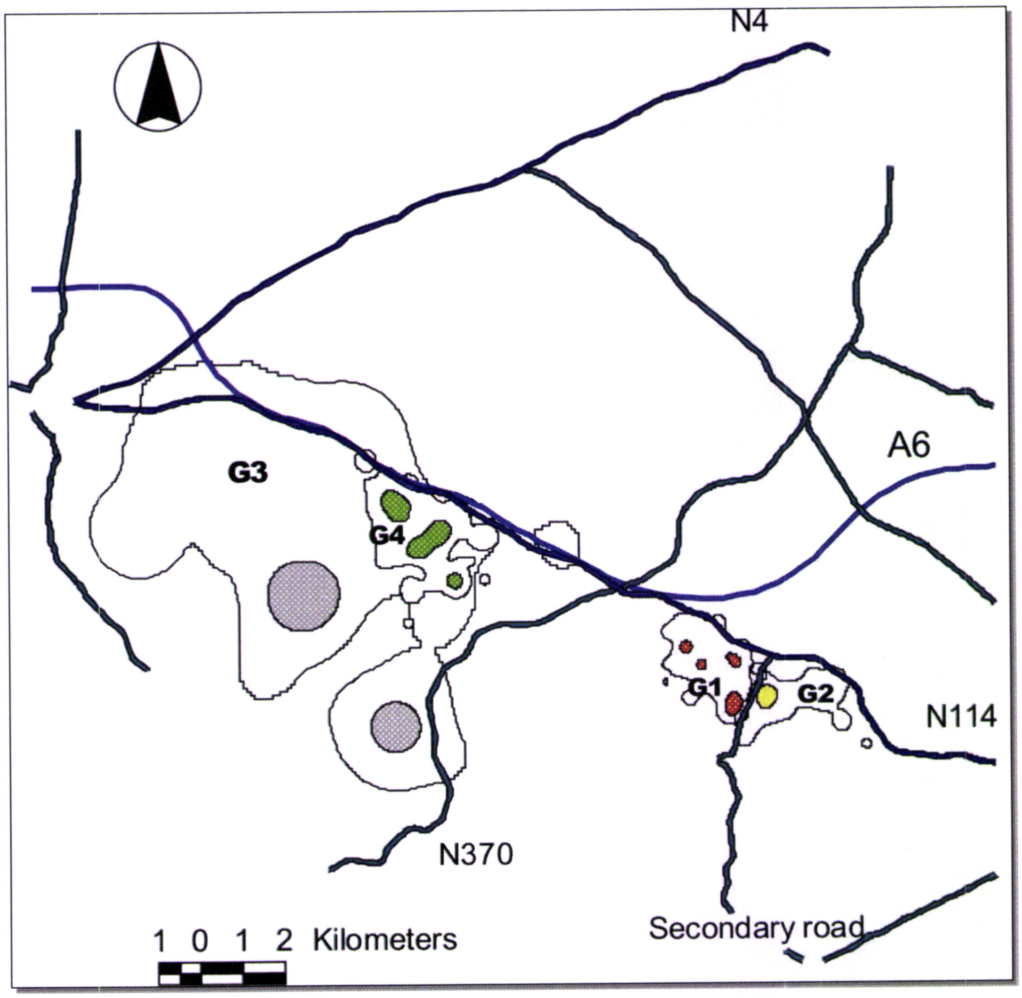


Figure 3 – Home ranges (showed by contour lines) and core areas (filled and colored areas) of genets (95% and 50% fixed kernel) with principal roads of study area.

Table 2- Home ranges of the genets estimated, using the minimum convex polygon and fixed kernel (95%) and core areas (kernel-50%).

Genets	Mpc Km^2	Kernel Km^2 (95%)	Kernel Km^2 (50%)
G1	4,68	4,0497	0,375
G2	6,98	3,526	0,3294
G3	62,43	60,926	4,179
G4	6,65	6,025	0,98

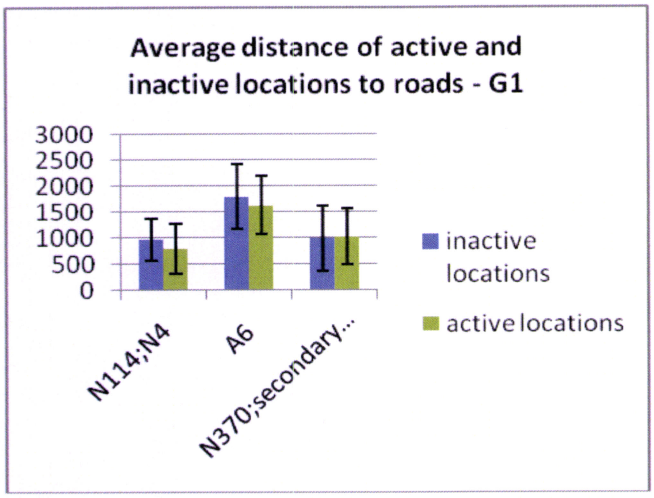
Roads

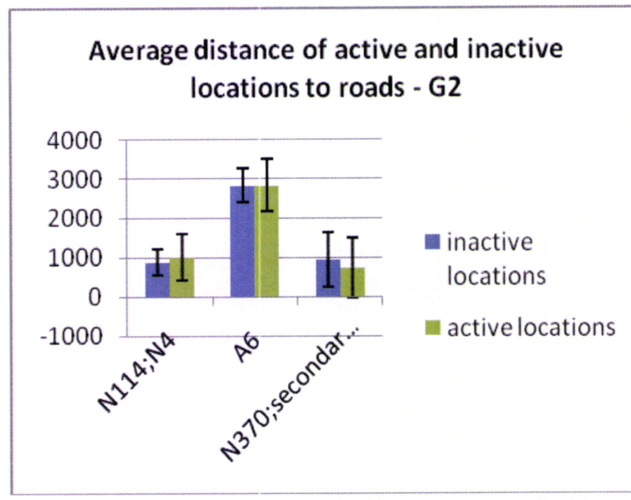
Table 3 presents the average distance of each genet to main roads, classified according to the traffic intensity and to water courses.

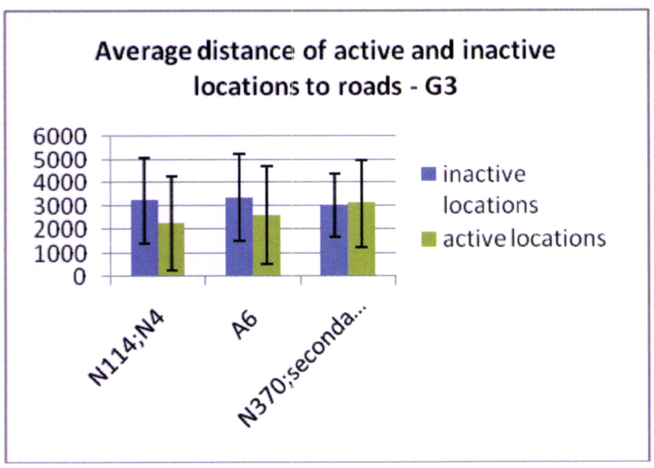
Table 3- Average distance of genets' locations of three different types of roads, classified according to the traffic volume: highway (A6), high traffic national roads (N114, N4) and lower traffic roads (N370, Guadalupe road). The average distance to watercourses was shown as the standard deviation (S.D.)

Average Dist. (m)	N114,N4	S.D.	A6	S.D	N370, Guadalupe road	S.D.	Watercourses	S.D
G1	**911,35**	451,13	1759,84	603,59	**994,19**	577,41	325,64	228,43
G2	**978,71**	465,96	2814,6	536,52	**759,98**	709,36	178,41	210,39
G3	2714,77	1888,97	2928,43	1916,85	3094,93	1587	391,33	339,01
G4	**973,78**	570,09	1087,73	591,07	2827,46	837,49	239,91	219,26
G5	2065,31	1737,85	2657,01	1473,26	3705,05	1391,2	368,53	339,05

In average, genets are 1500m away from national roads, 2250m from the highway A6, 2275m from secondary roads and 300m from watercourses. Three genets (G1, G2 and G4) were found at an average distance of about 1 km to some road and in general all animals are close to watercourses. Figure 4 presents the average distance of roads to active and inactive genets' location. We also present the results of the Mann Whitney Test comparing, for each animal the mean distance of active and inactive locations (table 4):







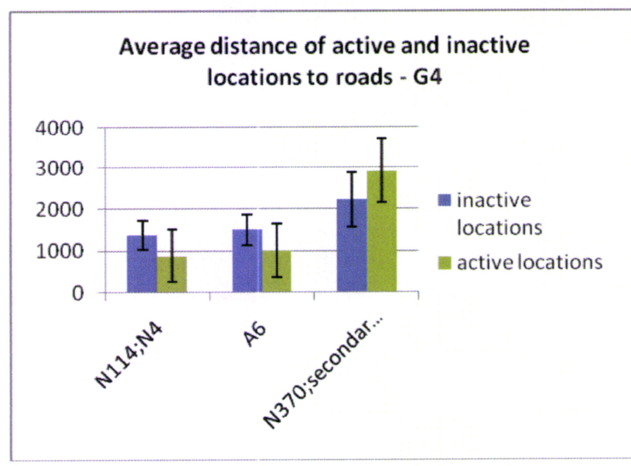


Figure 4 - Average distance of active and inactive genet's locations to different types of roads. Results of the Mann Whitney Test (* significant differences with p <0,05) are shown for each individual.

Table 4 - Results of the Mann Whitney Test (* significant differences with p <0,05) are shown for each individual (comparisons of mean distance of active and inactive locations) and for each road .

Mann-Whitney	Motorway (A6)	High traffic national roads (N114;N4)	Lower traffics roads (N370; secondary road)
G1 (p)	0,132	**0,011***	0,89
G2 (p)	0,885	0,267	0,174
G3 (p)	**0,097 (almost sig.)**	**0,012***	0,822
G4 (p)	0,00 *	0,00*	0,00*

All animals, except for one (G2), seem to have a pattern influenced by the roads. In general the animals are closer to roads when they are active (at night) and tend to be further away from roads during the day, when they are resting. This pattern is only witnessed in high intensity traffic roads (N114;N4 and A6) excluding the national road N370 and secondary road of Guadalupe. Despite genet G4 differ significantly on all tested roads, the lower traffic roads presented an opposite result, compared to the other analyzed roads. The genet G2 did not presented any significant differences between active and inactive locations, for any road.

The circular plots created to test the genets' randomness of habitat use have shown that animals do not normally have a random behavior concerning the presence of the roads (figure 5).

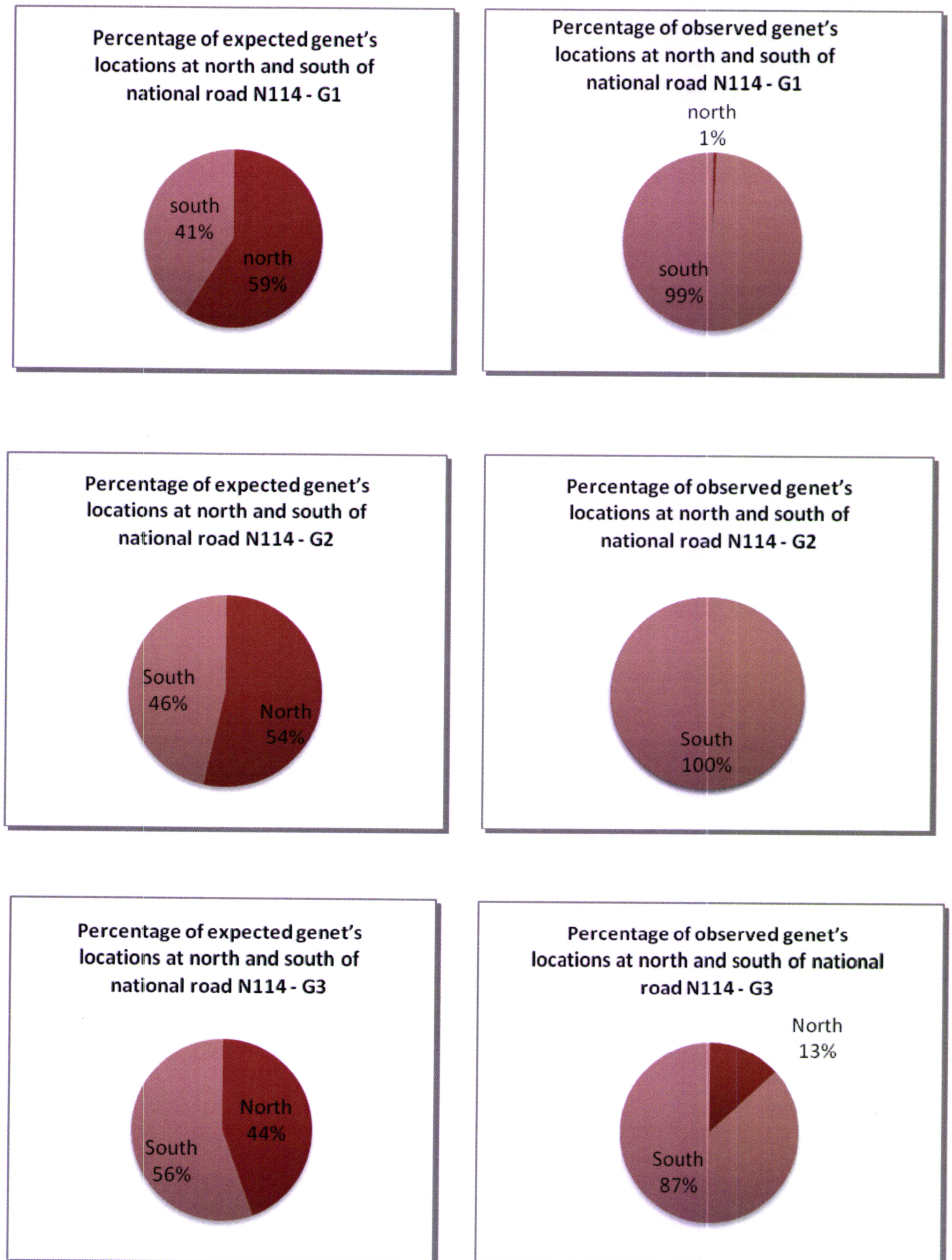
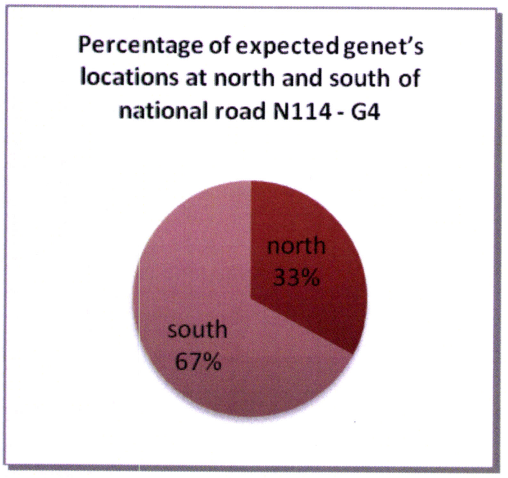
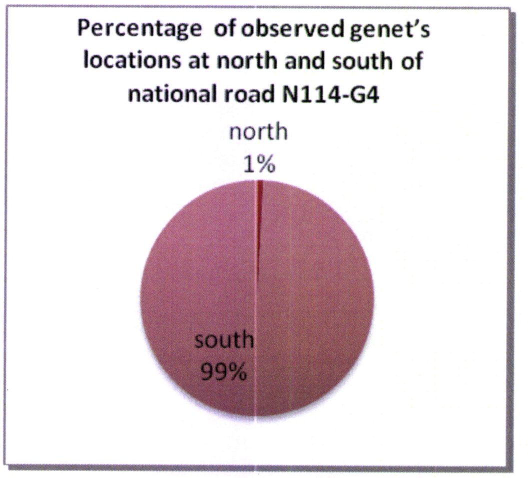


Figure 5 - Percentage of observed and expected genet's locations north and south of national road N114.

Figure 5 – (Cont.)





As it can be perceived, the observed percentage of locations north of N114 is very low, almost insignificant when compared with the expected one. Two genets (G4 and G1) have only presented 1% of the north-side road locations when, if they behave randomly, they should have presented 33% and 59%, respectively. One animal (G2) did not show any location north of the road and the sub-adult male, probably a disperser (G3) was the genet that presented a higher percentage of points in the north side. All the animals showed significant differences between the expected (Ei) and the observed (Oi) number of locations meaning that all genets present a non-random behavior (see table 5).

Table 5- Qui-square test between the observed and the expected number of locations on both sides of the national road (N114); (* significant differences with p <0,05).

Genets		Oi	Ei	χ^2
G1	North	1	91	89
	South	153	63	128,57
Total		154	154	**217,57***
G2	North	0	52	52
	South	97	45	60
Total		97	97	**112***
G3	North	13	44	21,8
	South	86	55	17,47
Total		99	99	**39,27***
G4	North	1	45	43
	South	136	92	21
Total		137	137	**64***

Habitat Selection

Both habitat selection analyses (first order: genets' locations *vs.* mpc; second order mpc *vs.* area of study) have presented significant differences for all animals, except G3 which did not show any differences between the observed frequencies within mpc and the expected frequencies within the area of study. Results of qui-squared and Bailey tests for first and second order of selection are shown in tables 6 and 7.

Habitat composition inside home ranges consisted on average of 35% of dense cork oak and holm oak woodland, 33,6% of open field, 22,4% of cork oak and holm oak woodland, only 6,4% of other vegetation (olive and pine groves, vineyards and a few patches of exotic tree species such as the *Eucalyptus globulus*) and 1,8% of riparian vegetation.

Genets spent, in average, more time exploring the dense cork oak and the holm oak woodland (30,2%) followed by the open field (23,4%), the riparian vegetation (21,6%) and the cork oak and the holm oak woodland (20,4%).

Each genet presented significant differences in habitat use and availability within home ranges. After the qui-square test, the Bailey confidence intervals have shown a generalized preference for riparian galleries, both for resting and foraging, despite their low extension within home-ranges. In every genet's core areas, at least one riparian gallery associated with watercourses was presented. For one of the males (G3) the *montado* was disproportionately less used when compared to its availability and the same is true for G2 yet in this case only the dense *montado*. Every other habitat types were used according to their availability

Two genets (G3 and G2) had used all habitats within mpc according with their availability in the area of study. Genets G1 and G4 had positively chosen dense *montado* and negatively chosen open fields. For these animals, all other types of habitats were used according with their availability.

Table 6- Results of qui-squared and Bailey's confidence intervals for the first order habitat selection analysis:

Genets	Habitat categories	χ^2	Availability of categories (proportion)	Bailey Confidence intervals	Type of selection
G1	RG	88,2	0,030153	[0,096;0,255]	Selection+
	CO_ wood	0,86	0,185339	[0,086;0,24]	H_0
	D_CO_wood	0,0125	0,51626	[0,4;0,61]	H_0
	OF	2,86	0,224837	[0,091;0,248]	H_0
	Others	4,166	0,030467	[0,0008;0,0445]	H_0
	Total	96,09*			

Table 6 – (Cont.)

G2	RG	420,5	0,017811	[0,197;0,444]	Selection+
	CO_ wood	12,5	0,342477	[0,18;0,423]	H_0
	D_CO_wood	12	0,273624	[0,029;0,188]	Selection –
	OF	0,5	0,32719	[0,17;0,4]	H_0
	Others	1,33	0,003347	-	-
	Total	446,83*			
G3	RG	289	0,00898	[0,089;0,294]	Selection+
	CO_ wood	2,9	0,219539	[0,061;0,247]	H_0
	D_CO_wood	0,026	0,383094	[0,245;0,498]	H_0
	OF	0,13	0,303551	[0,168;0,4]	H_0
	Others	4	0,047858	[0,0016;0,1]	H_0
	Total	296,056*			
G4	RG	176,3	0,019983	[0,108;0,285]	Selection +
	CO_ wood	5,83	0,207738	[0,054;0,2]	Selection –
	D_CO_wood	0,125	0,523219	[0,384;0,608]	H_0
	OF	3,11	0,183312	[0,059;0,209]	H_0
	Others	0,5	0,054397	[0,021;0,136]	H_0
	Total	185,86*			

Table 7 – Results of qui-squared and Bailey's confidence intervals for the second order habitat selection analysis:

Genets	Habitat categories	χ^2	Availability of categories (proportion)	Bailey's Confidence intervals	Type of selection
G1	RG	3,43	0,010	[0,0016;0,1016]	H_0
	CO_ wood	0,118	0,20558	[0,097;0,3056]	H_0
	D_CO_wood	10,89	0,33	[0,38;0,64]	Selection +
	OF	4,68	0,3598	[0,127;0,350]	Selection –
	Others	4,3	0,033	[0,0016;0,10]	H_0
	Total	23,44			
G2	RG	0,85	0,01	[6,49x10^{-5};0,0856]	H_0
	CO_ wood	10,14	0,2	[0,18;0,42]	H_0
	D_CO_wood	0,76	0,33	[0,18;0,42]	H_0
	OF	0,2468	0,3598	[0,2449;0,498]	H_0
	Others	5,78	0,033	[0,00124;0,068]	H_0
	Total	17,77*			
G4	RG	0,79	0,01077	[6,49 x 10^{-5};0,0856]	H_0
	CO_ wood	0,0095	0,205584	[0,1124;0,328]	H_0
	D_CO _wood	10,896	0,33	[0,382667;0,6454]	Selection +
	OF	8	0,359	[0,097;0,30]	Selection –
	Others	1,2	0,033	[0,013;0,1452]	H_0
	Total	20,89*			

Resting sites

From the 177 diurnal locations taken during the inactive genets' period, we identified 134 different resting sites. The results suggest that the re-used rate is very low. In fact, despite being generally perceived as animals that frequently re-use the same resting sites (Palomares and Delibes, 1994), in this study, however, genets have mostly used resting sites only once.

Individual G1 had a re-use rate of 1,46 (N= 60; 41 different resting sites), G2 of 1,36 (N= 45; 33 different resting sites), G3 of 1,16 (N=43; 37 different resting sites)and G4 of 1,26 (N=29 ; 23 different resting sites), being the average re-use rate of 1,32 (N=177, 134 different resting sites). Genets were mostly found on two kinds of resting sites: thickets (25,4%), chiefly comprised of *rubus ulmifolius, cistus sp*. and climbing plants such as *hedera helix* and *smilax aspera;* and wood plots of different tree species (43,8%) . The preferred trees to rest were cork oaks (22,8%) followed by riparian trees (16%) (including the black poplar -*Populus nigra*-, the ash -*Fraxinus angustifolia*-, the white willow -*Salix alba*- and the black alder -*Alnus glutinosa*), holm oaks (3,7%) and olives (1,2%). The category others (3,62%) refers to rocky places (3%) and old abandoned houses (0,62%). We cannot say whether genets prefer trees rather than thickets in the sense that 27,1% of the resting sites (not included in the analyses) were detected in dense patches of trees and scrubs. In these cases, we have not obtained the exact location of the animals because of the dense and impenetrable vegetation.

Discussion

Captures and genets locations

The capture results showed a low density of genets in the study area (0,057/Km^2), a small value compared with other studies (Palomares and Delibes, 1994; Munuera and Llobet, 2004; Santos-Reis et al., 2004; Rosalino et al., 2005), which can be due to the low trapping intensity (sixty four days; 15 traps), and some to problems with bait that in the begging of the study attracted also rats to the traps, inactivating them. Twenty percent of locations were missing (the animals were not found when searched) probably due to topographic constrained. Most of the locations can be found south of highway and national road 114 and the animals seem to have some intrinsic relation with these infrastructures, once they have their territory boundaries really close to the roads that cross the study area.

Home ranges and core areas

The mean home range area (MCP = 20,2 Km^2; 95% Kernel= 18,63 Km^2,) reaches a larger value compared to the results of other studies (Palomares and Delibes, 1994; Munuera and Llobet, 2004; Santos-Reis et al., 2004) due to the presence of a probable disperser (G3). This animal has a home range area of approximately 62 Km^2 similar to a dispersal genet in Doñana National Park which covered an area of about 50 Km^2 (Palomares and Delibes, 1988). If genet G3 is removed from this analysis, the mean home range size of the other three genets decreases a lot (MCP= 6,10Km^2, SD=1.24, N=3; 95% Kernel = 4,53 Km^2, SD=1.32, n=3) and is similar to the average home size in Doñana National Park, Spain (MCP=7,8 Km^2) (Palomares and Delibes, 1994) and bigger than in a similar mediterranean habitat in southern Portugal (MCP= 3,29 Km^2) (Santos-Reis et al., 2004).The only female of this study had a minor home range size than the males when calculated by the minimum convex polygon, nevertheless, when we used the kernel method the home range size of the female G1 and male G2 were similar. The core areas found on our study (excluding G3) are eight times smaller than home ranges and slightly bigger than the eight genets radio-tracked in Grândola, southwestern cost of Portugal (Santos-Reis et al., 2004).The core areas did not overlap among individuals and were used for both foraging and resting. The sub-adult disperser (G3) had also a large core area reaching 6 Km^2 divided in two smaller areas. Only one genet had a single core area (G2) probably due to the richness of the habitat in this area. This 0,33 Km^2 of landscape area is located in a riparian gallery extremely used by this animal where the main conditions for its survival (shelter, food and water) are fulfilled. The single female of the study shows a core area size similar to this last animal (0,38 Km^2) yet she has more core areas than the other genets (four), genet G4 had three core areas and G3 had two. For all genets, at least, one core area was traversed by a very important riparian gallery.

Genets are normally described as territorial animals mostly with adults of the same sex; however it is reported some complacency when dealing with animals of opposite sexes (Palomares and Delibes, 1994). In this study we have found 0,174 Km^2 of common home range area both to G1 and G2. On the other hand, G3 shares his home range area with G4 (6 Km^2). In this case there is an almost total overlap since this 6 Km^2 covered all home range size of G4. Despite this overlap we believe that these animals have a reduced number of encounters given that the disperser has a vast area to explore.

Roads

The radio tracking data analysis has shown that roads vicinity was not totally avoided by genets. All individuals were found, several times, quite close to roads, as shown by the distribution map. In all studied animals, roads were part of home range boundary. Except for the disperser's (G3) home range, genet's home range approached roads despite seldom crossing them, suggesting that these infrastructures may act as artificial territorial boundaries (Riley, 2006). This last role as a territorial boundary had already been witnessed by other authors in brown bears in Slovenia (Kaczensky, 2003), and bobcats and coyotes in Southern California (Riley, 2006).

It is clear that roads are acting as barriers to genet's movements and also as traps that kill them (personal observations during the study), despite the positive crossing rate already shown. Genet G3 was the only one that crossed often the main road - the highway A6 which seems to be less permeable to genets than other roads. This animal's crossing rate was moderate (28%). This may be explained by the fact that it is a disperser animal and thus more willing to find territory. In periods of mating, dispersion or even in atypical conditions of drought or scarcity of food, roads not only act as a harmful barrier forbidding normal ecological stages of animals but also increase kills rate. The highway runs parallel to the national road N114 in some stretches and in contrast to A6, the national road N114 was crossed by three of the five studied animals. If animals cross the N114, parallel to A6, why not crossing the highway as well? It seems that the highway can be a major problem for these animals probably because of the physical characteristics, larger pavement, better fences, and high noise and speed. Excepting genet G3, and despite the low crossing rate, low traffic roads were crossed by genets G1 and G2 more often than other roads. Besides having less traffic, these roads are well integrated in the landscape, making it easier for the animals to cross them. The existence of riparian galleries may also encourage the roadside usage and crossings. For instance, genet G2 was very often near national road n114 and/or the secondary road (Guadalupe road) because in this area exists a large riparian gallery near the roads. The N4, a national road similar to N114 in traffic and noise, was crossed several times by G5, who does not seem to have a defined home range. It was impossible to draw any conclusions about this animal because only few locations were taken before his death caused by humans (we found him buried near a stream). Genet G4 was the animal with a lower crossing rate since only one road, N114, was crossed and only once. None of the genets that crossed a road stayed on the other side and as showed by Riley et al. (2006) the territories near roads may be acting as effective social and behavioral barriers to a genetically successful dispersal.

Additionally, genets seem to keep on average 1km of distance from roads suggesting that this may be a comfortable distance for the animals, softening human disturbance when they are resting but being sufficiently close and available at night, for hunting near the verges where many small fauna tend to concentrate (Forman and Alexander, 1998; Bellamy et al. 2000; Iuell et al. 2003; Coffin, 2007). A detailed analysis made concerning road distances of locations distinguishing between active and inactive data corroborates the previous statement.

Our results have shown that animals were not found randomly, but occurred in specific areas of the mediterranean landscape. All animals showed a not random distribution concerning roads presence and tend to concentrate their activity on one side of the road. This fact may difficult young disperser's movements' who try to find territory and mates, having more difficulty to establish and defend territories near roads and/or crossing these areas to mating (Riley et al., 2006).

Moreover, Riley et al. (2006), have showed how highway can genetically differentiate populations of the same species which means that genets in the north side of national road (N114) tend to be genetically different, due to the lower probability of breeding between populations of both sides of the road.

Habitat selection

European genets inhabit various sorts of habitats with a special preference for Quercus forests as revealed in our study. *Montado* with a dense shrub cover was positively selected by two genets and the opposite occurred in open areas. These results are in accordance with the ones of Lariviére and Calzada (2001) and Palomares and Delibes (1988).

Our study has also confirmed the importance of the vegetation patches with a high proportion of dense shrub cover (Galantinho and Mira, 2008; Mangas et. al., 2008) for resting and foraging (Palomares and Delibes 1988; Palomares and Delibes, 1994). Another important result was the selection of riparian vegetation by all genets even when other suitable habitat types were presented in the proximities. There have been some controversial results related to the importance of the riparian vegetation for genets - on the one hand there are some authors (Palomares and Delibes, 1994; Santos-Reis, 1994) who argue on its importance for genets for resting and feeding; on the other hand there are some authors that didn´t found such a strong relationship (Galantinho and Mira, 2008). Another interesting issue is the avoidance/non-avoidance of roads. Roads are normally very disturbed areas and so they should be avoided by these mammals. Yet this study has demonstrated that genets' home ranges are very close to these areas perhaps because they offer good conditions for the presence of prey (mainly small mammals, on verges) (Forman and Alexander, 1998; Bellamy et al., 2000; Iuell et al., 2003; Coffin, 2007). In resting sites, riparian vegetation had also a remarkable place. Indeed, the preferred habitat to rest is the riparian vegetation. The majority of the shelters thickets were placed in the riparian galleries so the riparian shelterbelts frequently composed of bushy and high trees were frequently used by genets. Despite the re-use rate of particular resting places is low, we commonly found the re-use of same patches to rest, being different resting places very close to each other.

Diverse communities of carnivores are supported by the riparian woodlands in the Iberian Peninsula. This fact has been sustained by some intrinsic characteristics of this special habitat namely the microclimate, thee offer: shelter (shrub cover, hollow trees) and food (small mammals, insectivores, fruits), imperative facts that favor genets' occurrence (Virgós, 2001). It has been pointed out that the microclimate effect was probably the most important factor for genets mostly in cold regions of central and northern Spain (Virgós, 2001). Alentejo is a region with high temperatures during the summer and cold winters; therefore this explanation may possibly be applied as well.

Notwithstanding an evident preference for riparian vegetation, these animals also clearly depend on holm and cork oak woodlands, typical Mediterranean landscapes habitats. These patches are commonly found with scrubland patches and our results show that both are very important for genets as resting sites.

The decision to address the habitat selection to this study has to do with the fact that roads cannot be seen as isolated and closed elements since they are part of our landscape and can encourage or discourage an animal to live near roads or to cross them. If the surrounding landscape was dominated by open fields, our results could be different. On the other hand this analysis has exposed the extraordinary importance of the riparian galleries. These peculiar habitats acting like shelters to many animals, particularly for monitored genets, may pacify and minimize the deleterious effects of roads.

Conclusion

In this study, we have witnessed that genets are able to cross different types of roads, although in lower frequencies. The highway can be the major problem for some of them since only one genet, the disperser, have crossed it.

Our results besides allowing us to understand genets' space use as well as their spatial organization also provide information to adopt conservation and/or minimization measures.

Genets have adopted a safety distance concerning roads, keeping in average, 1km distance from roads. Moreover, genets have showed a particular behavior pattern towards roads, being away from main roads during the day and closer to them at night. The results have also shown that they do not move randomly and have some reluctance to cross main roads. The huge percentage of locations on the south side of road suggest that although roads are acting as semi-permeable barrier they may function as effective barriers to gene flow, which may contribute to threatening genets populations in the future, in landscapes with high density of roads.

The surrounding habitat of roads is also very important for animals. As we could witness, all genets have shown locations close to roads mostly when road surroundings were particularly suitable for genets as is the case of riparian galleries for which the genets have presented a strong positive selection.

Our results showed that there are many factors that influence genets' behavior and their behavior towards roads and that is difficult to isolate the single effect of roads on genets' behavior and movements. We highlight also de fact the small sample size prevented us to perform some statistical analyses. Furthermore, the number of crossings only refers to the tracking days and, therefore, it might not totally correspond to an accurate frequency of crossings.

However, the facts that (1) home ranges limits often correspond to roads suggesting that these infrastructures may be acting as artificial territorial boundaries and (2) the animals seldom cross main roads and tend to concentrate their activity only on one side of the road shows that these infrastructures pose a significant barrier to genets' movements. The fundamental question now seems to be "How many successful crossings are needed to maintain habitat connectivity and long term genet population persistence?" (Seiler *in* Jaarsma, 2006).

Further studies including larger samples sizes and new technologies (e.g. GPS satellite telemetry) are needed to answer this question.

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Considerações finais

As estradas, são comummente vistas como barreiras físicas impenetráveis para muitos grupos faunísticos, no entanto, apresentam-se como barreiras semi-permeáveis para todos aqueles que conseguem atravessar estas infra-estruturas sem colidirem com o tráfego inerente às mesmas.

Os resultados obtidos no presente estudo revelam a capacidade das genetas para atravessar diferentes tipos de estradas, apesar de o fazerem em frequências reduzidas. A auto-estrada, por sua vez, parece constituir o maior problema para estes animais, sendo que apenas foi atravessada por um dos indivíduos, a geneta que se encontrava em dispersão. Estas rodovias podem constituir uma ameaça a estas espécies quando inseridas no meio de habitats favoráveis à sua presença ou quando se localizam no meio de populações que necessitam de manter a conectividade para subsistirem a longo prazo. As auto-estradas são infra-estruturas de maiores proporções, normalmente vedadas de ambos os lados e apresentam maior tráfego automóvel. A geneta G4, alvo de estudo, demonstrou alguma relutância em atravessar estradas, efectuando apenas um atravessamento ao longo de todo o estudo. Os indivíduos G1 e G2 estavam cercados pela estada nacional N114 e pela estrada secundária (estrada de Guadalupe), demonstrando clara preferência em atravessar a estrada com menor tráfego. Por outro lado, devemos ter em consideração que o efeito barreira produzido pelas estradas pode actuar a um nível individual quando combinado com outros factores externos.

Outro resultado importante foi a distância de segurança adoptada pelas genetas relativamente às estradas, distando em média cerca de um quilómetro das mesmas. Esta distância não parece aleatória mas sim uma distância que possibilita um afastamento destas infra-estruturas durante o dia e uma aproximação durante a noite. De facto, este foi um padrão de comportamento verificado ao longo do estudo, demonstrando que as estradas tal como inicialmente relatado, podem ter vantagens e desvantagens para os animais. São locais propícios à caça durante a noite e zonas com ruído sonoro durante o dia o que poderá explicar este tipo de comportamento adoptado pelas genetas. Estes resultados, podem assim contribuir para uma melhor compreensão da organização espacial da espécie, proporcionando-nos ferramentas essenciais para promover estratégias de conservação e/ou minimização referente a danos resultantes das estradas.

Desta forma, os resultados obtidos provam assim, que estes indivíduos não se movem de forma aleatória, o que confirma a relutância dos mesmos perante as estradas.

A grande percentagem de localizações no lado sul da estrada N114 sugere que apesar destas infra-estruturas actuarem como barreiras semi-permeáveis à espécie, podem funcionar como efectivas barreiras ao fluxo genético, o que pode contribuir para o declínio das populações. Os animais que estabelecem territórios nas parcelas de vegetação envolventes às estradas constituem um obstáculo a todos os indivíduos aquando da procura de parceiro sexual, local de reprodução e ou alimentos, sendo que os mais afectados são os dispersantes juvenis. Estes animais para além de se depararem com a barreira física imposta pelas estradas têm de conseguir atravessar os territórios previamente estabelecidos em ambos os lados da estrada.

O habitat adjacente às estradas é muito importante para os animais. Como mostraram os resultados, todas as genetas apresentaram localizações muito próximas às estradas mas em muitos casos o habitat envolvente era propício a essa proximidade. A presença de galerias ripícolas parece favorecer o uso das bermas das estradas e durante o estudo, as genetas seleccionaram positivamente estes habitats. O indivíduo G2 foi muitas vezes encontrado em locais próximos da estrada nacional N114 bem como da estrada secundária de Guadalupe. Estas presenças foram influenciadas pela existência de uma galeria ripícola, paralela a esta última estrada e perpendicular à estrada N114. Esta galeria ripícola foi constantemente requisitada por este indivíduo, ao longo de todo o estudo.

Os resultados apresentados, demonstraram assim, que existem muitos factores que influenciam o comportamento das genetas bem como o seu comportamento perante as estradas, sendo difícil isolar os efeitos exclusivos das estradas no comportamento e movimento da geneta.

Muitos outros factores têm de ser tidos em consideração tendo em conta os nossos resultados, nomeadamente o tamanho reduzido da amostra de estudo o que nos impediu de considerar e realizar outras análises estatísticas. Por outro lado, o número de atravessamentos apenas se refere aos dias de monitorização das genetas, podendo este número não corresponder totalmente à frequência exacta de atravessamentos durante o período do estudo. No entanto, o facto de (1) os limites das áreas vitais quase sempre corresponderem às estradas sugerindo que estas infra-estruturas podem estar a actuar como delimitadores artificiais de territórios e (2) os animais raramente atravessarem as estradas principais e concentrarem a sua actividade apenas num dos lados da estrada, demonstra que as estradas são significativas barreiras ao movimento das genetas. A questão fundamental é "Quantos atravessamentos de sucesso são necessários para manter a conectividade do habitat e a persistência da população a longo prazo? " (Seiler *in* jaarsma, 2006).

Implicações na conservação da espécie

A maioria dos carnívoros, independentemente do estatuto de conservação atribuído, é um grupo naturalmente sensível às alterações artificialmente incutidas na paisagem pelo Homem uma vez que apresentam baixas densidades populacionais, baixa taxa de reprodução e grandes áreas vitais (Spellerberg, 1998; Trombulak and Frissel, 2000; Sunquist and Sunquist, 2001; Ng, 2004). Antes de se propor qualquer medida de conservação ou minimização, deverão ser reunidos esforços para se realizarem acções de esclarecimento sobre a biologia, ecologia e comportamento da geneta junto da população local. Estes animais, como muitos outros, fazem de herdades privadas as suas "casas" e por esse motivo qualquer medida de conservação e/ou minimização deverá envolver os habitantes locais.

Existem já algumas medidas propostas por vários autores de forma a melhorar as condições favoráveis à presença desta espécie como por exemplo incentivar os agricultores para manter as parcelas com vegetação arbustiva (Galantinho and Mira, 2008; Mangas et al., 2008). A importância da vegetação arbustiva como cobertura do solo foi um resultado também observado ao longo do presente estudo. São locais favoráveis ao refúgio da espécie albergando muitas vezes a sua presa favorita, o ratinho-do campo (Palomares and Delibes, 1988; Palomares and Delibes, 1994; Virgós and Casanovas, 1997).

A manutenção e conservação das galerias ripícolas devem também ser acções prioritárias para a conservação da espécie uma vez que são habitats preferencialmente escolhidos pela geneta tanto para descansar como durante o período activo (Palomares and Delibes, 1994; Santos-Reis, 1994), podendo constituir uma ajuda na minimização dos efeitos negativos das estradas.

A caça desregrada e o controlo de predadores são duas acções humanas que podem pôr em causa a subsistência da espécie e como tal deveremos abordar e fiscalizar todas e quaisquer acções tomadas no sentido de reverter esta situação (Galantinho and Mira, 2008).

A mortalidade nas estradas é uma ameaça real e constante e por estes motivos tem sido alvo de alguns estudos (Lodé, 2000; Taylor and Goldingay, 2004; Kaczensky et al., 2003; Saeki and Macdonald, 2004; Orlowski and Nowak, 2006; Ramp et al., 2006; Grilo et al., 2009). É assim possível pôr em prática, algumas medidas minimizadoras como a construção de passagens para fauna ou adaptação de passagens já existentes para outros fins. A construção de passagens inferiores ou superiores para a fauna deve ser acompanhada de outras medidas propícias à presença da espécie como a construção de corredores de flora até á entrada das passagens (Clevenger and Waltho, 2005), a colocação de alguma vegetação e pedras dentro das passagens ou valas condutoras que indiquem o caminho da passagem à fauna existente no local (Yanes et al., 1995; Iuell et al., 2003; Grilo et al., 2008). As passagens hidráulicas têm sido alvo de alguns estudos uma vez que são usadas por muitas espécies de carnívoros (Yanes et al., 1995; Ng. et al., 2004; Mata et al. 2005; Ascensão and Mira, 2007; Varela, 2007; Grilo et al. 2008). Há evidências do uso destas passagens por parte das genetas (Yanes et al., 1995; Mata et al., 2005; Ascensão and Mira, 2007; Varela, 2007; Grilo et al. 2008), de forma que seria uma mais valia ajustar e alterar estas estruturas tendo em conta o comportamento desta espécie.

Estudos futuros

A dispersão dos indivíduos, principalmente em populações pequenas, é imprescindível na manutenção da variabilidade genética e como tal seria importante perceber se a estrada N114 está realmente a funcionar como barreira efectiva ao fluxo genético, sendo necessário para o efeito capturar e marcar as genetas para posteriores testes genéticos.

A densidade populacional de micromamíferos na área de estudo deveria também ser alvo de estudo, tanto nas bermas como fora das bermas para se comprovar a teoria de que as genetas utilizam as bermas à noite como zona de caça.

Estudos futuros devem incluir uma amostra de maiores dimensões e utilizar novas tecnologias, mais eficazes como por exemplo a telemetria por satélite de forma a confirmar as tendências apresentadas nesta tese.

Factores condicionantes ao estudo

As condicionantes impostas ao presente estudo resultaram de alguns factores não controláveis como o número de capturas, que por sua vez depende da intensidade de armadilhagem, número de pessoas envolvidas no projecto, tempo disponível para toda a parte prática e questões monetárias, tendo resultado numa amostra pequena para a realização de várias análises estatísticas. Por outro lado os dados resultantes da telemetria foram quantitativamente menores do que o esperado. Os animais não foram localizados variadas vezes quer por razões de interferência resultante da presença de postos de electricidade quer por razões topográficas. Alguns dados foram também cortados das análises devido a más triangulações. Existem análises que permitem a existência de dependência entre os dados se estes tiverem em conta o factor tempo, no entanto, pelas razões acima mencionadas, os animais muitas vezes, além de não serem encontrados, apenas eram identificados sonoramente após horas de procura, o que dificultou a localização dos indivíduos sempre à mesma hora.

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