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Source: Journal of Mammalogy, 83(2):608-613.

Published By: American Society of Mammalogists

DOI: [http://dx.doi.org/10.1644/1545-1542\(2002\)083<0608:NHALUO>2.0.CO;2](http://dx.doi.org/10.1644/1545-1542(2002)083<0608:NHALUO>2.0.CO;2)

URL: <http://www.bioone.org/doi/full/10.1644/1545-1542%282002%29083%3C0608%3ANHALUO%3E2.0.CO%3B2>

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NATURAL HISTORY AND LANDSCAPE-USE OF GUIGNAS (*ONCIFELIS GUIGNA*) ON ISLA GRANDE DE CHILOÉ, CHILE

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We studied the natural history and landscape-use patterns of the guigna, *Oncifelis guigna*, a small forest cat, on Isla Grande de Chiloé, Chile. We put radiocollars on 7 adult (5 males, 2 females) guignas to assess factors that affect persistence in a highly fragmented, human-dominated landscape and a contiguous forest with fewer human impacts. Conservation of guignas outside protected areas requires forested areas connected by corridors, containing free-ranging domestic fowl, and dispelling local myths that guignas are vampires.

Key words: corridor, fragmented forest, guigna, kodkod, *Oncifelis guigna*, predation, top carnivore

The diminutive guigna or kodkod (*Oncifelis guigna*) is one of the world's smallest and least known felids. Guignas have black-spotted gray pelage, black dorsal stripes on their necks, and bushy, banded tails. They are found in central and southern Chile, from Santiago to Parque Nacional Laguna San Rafael (Redford and Eisenberg 1992). Information about the ecology of guignas is largely anecdotal (Guggisberg 1975). Guignas have one of the smallest geographical distributions known for any felid, and therefore information that can improve their conservation is of high priority (Nowell and Jackson 1996).

Movement of mobile organisms across landscapes is receiving increased attention because populations in isolated fragments suffer higher risks of extinction (Merriam 1984). Maintaining movement corridors in human-dominated landscapes may be an effective way of protecting natural ecological functions (Harris et al. 1996). Field studies

involving movement corridors must consider that habitat is species-specific and depends upon the nature of the landscape (Bowers 1997; Bowers and Matter 1997; Bowne et al. 1999; Lima and Zollner 1996). Indeed, Bowne et al. (1999) stressed that greater emphasis must be placed on the behavioral aspects of movement across heterogeneous landscapes before effective conservation strategies can be implemented. To aid in developing an effective conservation strategy for guignas, we studied their natural history and movements in 2 landscapes on Isla Grande de Chiloé, Chile: a highly fragmented, human-dominated landscape of about 1,200 ha and a 6,000-ha contiguous forest with less human influence. Our objectives were to provide the 1st assessment of behavioral aspects of movement across these landscapes in relation to conservation needs and to increase understanding of the natural history of this poorly known cat.

MATERIALS AND METHODS

Study area.—We conducted our study from 1 November 1997 to 30 April 1998 on the north-

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western coast of Isla Grande de Chiloé (8,394 km²), Chile (42°S, 74°W) at Estación Biológica Senda Darwin (Armesto and Willson 1996). Average annual temperature and rainfall at Puerto Montt (41°28'S, 72°56'W) were 11.1°C and 1,996 mm, respectively (Veblen et al. 1983). The Valdivian rain forest has a west coast maritime climate of mild temperature range and high annual precipitation (Veblen et al. 1983). Remnants of natural forest are dominated by trees such as canelo (*Drimys winteri*), luma (*Amomyrtus luma*), chilco (*Fuchsia magellanica*), tepú (*Tepualia stipularia*), coique (*Nothofagus nitida*), melí (*Amomyrtus meli*), hazel nut (*Gevuina avellana*), arrayán (*Luma apiculata*), and quila (*Chusquea quila*), a bamboo (Hoffmann 1983; Veblen et al. 1983). Although the land is sparsely populated, northern Chiloé forests have largely been cleared to support domestic fowl, grazing, and farming (Lawford 1996). Woodcutters utilize remaining forests. The nearest city, Ancud (population 11,000), is 20 km W of our study area. The land rises abruptly from the sea, but elevation is <300 m. Rugged topography, high rainfall, and the Spanish system of land tenure have acted to keep pressure from human populations low in rural areas of northern Chiloé. Our study took place exclusively on human-dominated private lands at 2 sites 20 km apart. The nearest protected area is Chiloé National Park, 150 km SW of our study sites.

Capture and radiotracking.—Guignas were captured in Tomahawk No. 207 live traps (Tomahawk Live Trap Company, Tomahawk, Wisconsin) baited with chicken scraps. Captured animals were anesthetized with ketamine hydrochloride at dosages of 20 mg/kg body mass. No information on morphometrics of guignas has been available since the work of Allen (1919). Therefore, we also recorded measurements of head and neck circumference; tail, body, hind foot, and ear length; canine tooth length; and body mass. Males of 1.7 kg or more with adult dentition and well-developed testes were classified as adults. Females of 1.5 kg or more with adult dentition and that were lactating or had large, pigmented teats were classified as adults. Guignas that did not meet these criteria were classified as juveniles. A similar classification scheme was used for ocelots (*Leopardus pardalis*) by Ludlow and Sunquist (1987).

Radio transmitters with internal antennas and mortality switches (Advanced Telemetry Sys-

tems, Inc., Isanti, Minnesota) weighing <2% of the cat's body weight were fitted as collars. Telemetry locations were obtained on foot using portable receiving equipment (Wildlife Materials, Inc., Carbondale, Illinois; AF Antronics, Inc., Urbana, Illinois) and recorded as UTM units with a Garmin 12XL global positioning unit (GARMIN International Inc., Olathe, Kansas). Attempts were made to locate radiocollared guignas at least twice daily, and occasionally each cat was monitored for 24 h. Visual locations were obtained once every other week for each radiocollared guigna. Home range size did not increase more than 5% after 90 locations for males and 67 for females.

Audible qualities of radio signals were used to interpret activity, and a guigna was considered active if its signal changed in tone or strength during the 3–5 min before a location was obtained (Sunquist 1981). Movement was determined from changes in the guigna's location. Habitat types were assigned to each location. There were 722 radio locations of cats that were classified as inactive. Actual locations of inactive animals were determined by walking around or near the cats (within 5.7 m \pm 1.7 SE, $n = 54$). Location data were plotted on aerial photos. Vegetation type and structure were also recorded. We used Ranges V software to estimate home ranges by the concave polygon method (Kenward and Hodder 1995; Seamen and Powell 1996; White and Garrott 1990).

RESULTS

Natural history.—We captured and put radiocollars on 3 adult male and 2 adult female guignas in the fragmented landscape and 2 males in the contiguous landscape. Additionally, we captured, weighed, and released 1 female in the contiguous landscape on the last day of our study. One male and 1 female were melanistic, with spots and banded tails discernible only in bright sunlight. Measurements (mean \pm SE, range) for 5 males and 2 females (in mm, except for mass in kg): head circumference 196.3 \pm 5.1 (188.5–202.0), 170.0 \pm 2.7 (168.1–171.9); neck circumference 158.8 \pm 7.2 (150.0–168.2), 157.5 \pm 5.8 (153.4–161.6); upper canine 9.6 \pm 0.27 (9.2–9.9), 9.0 \pm 0.14 (8.9–9.1); lower canine 9.5 \pm 0.23

(9.1–9.8), 8.2 ± 0.13 (8.1–8.3); body 467.4 ± 16.5 (456.7–489.2), 440.0 ± 15.1 (429.3–450.7); tail 233.3 ± 4.7 (227.0–239.2), 217.5 ± 7.4 (212.3–222.7); hind foot 100.8 ± 3.6 (95.3–104.5), 89.0 ± 3.1 (87.3–90.7); ear 39.3 ± 0.7 (38.4–40.2), 41.0 ± 1.7 (39.8–42.2), mass 2.2 ± 0.25 (1.9–2.5), 1.7 ± 0.05 (1.64–1.76; $n = 3$).

Guignas preyed on birds, lizards, and rodents in ravines and other forested areas and also preyed on domestic fowl. Prey remains collected or observations of prey items carried by guignas included 1 austral thrush (*Turdus falklandii*), 2 Southern lapwing (*Vanellus chilensis*), 1 chucao tapaculo (*Scelorchilus rubecula*), 1 huet-huet (*Pteroptochos tarnii*), 1 domestic goose, 16 domestic chickens, and 1 Chiloé lizard (*Liolaemus pictus chiloensis*). All guignas spent most of their time in forested ravines with running water (49%), along near-vertical coastal forest strips (4%), or in mixed forest (43%; $n = 880$ locations on all individuals).

Guignas climbed trees >8 cm diameter at breast height with ease ($n = 7$ observations on 4 individuals). Guignas found on tree branches were resting or escaping from perceived danger such as domestic dogs ($n = 13$ observations on 3 individuals). Guignas were also located resting on stumps of fallen trees ($n = 5$ observations on 7 individuals). Tree branches on the steep sides of ravines were used by guignas to stalk prey such as lizards ($n = 11$ observations on 2 individuals). Guignas resting on branches in relatively open forests during the day were mobbed by birds, including pairs of Chimango caracaras (*Milvago chimango*; $n = 3$ observations on 2 individuals) and Southern lapwings ($n = 2$ observations on 1 individual). Guignas also rested during the day along streams in thick vegetation ($n = 134$ observations on 7 individuals), under live and dead gorse (*Ulex europa*; $n = 67$ observations on 2 individuals), an exotic shrub, and in heavily disturbed, logged forest brush piles ($n = 46$ observations on 3

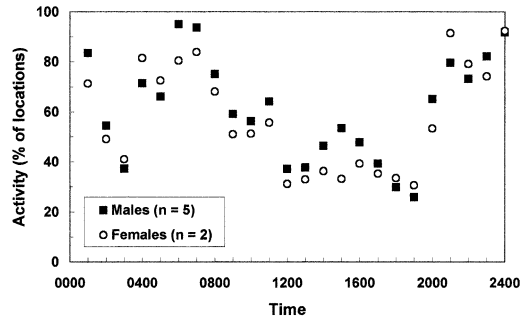


FIG. 1.—Activity patterns of individual guignas, Isla Grande de Chiloé, Chile. Guignas were active at all times of the day but exhibited dips in activity from 0100 to 0400 h, from 0800 to 1200 h, and from 1500 to 1900 h. Open squares and open circles represent 2 adult females. All other symbols represent adult males.

individuals). Night resting sites were thick piles of live or dead vegetation, often dense quila ($n = 35$ observations on 5 individuals). Guignas were active at all times of the day but exhibited dips in activity from 0100 to 0400 h, from 0800 to 1200 h, and from 1500 to 1900 h (Fig. 1).

Humans killed 2 radiocollared male guignas when they attacked domestic fowl in the fragmented landscape. For 7 days, we documented a male guigna occupying a forest adjacent to a pasture of free-ranging chickens. He killed 6 of them. Home ranges of the females did not overlap with human dwellings, whereas home range of 1 male contained more than 20 occupied human homes. Resident subsistence farmers held negative attitudes about guignas and believed them to be vampires that killed their prey by a bite to the neck and then sucked their prey's blood.

Home range and movements.—In the fragmented forest, home-range size of 2 males was 357.5 ha ($n = 126$ locations over 144 days, range 341.6–373.4, maximum range width 3,717 m). An additional male tracked at 31 locations had a home range of 160.0 ha. Home-range size of 2 females in the fragmented landscape was 126.1 ha ($n = 176$ locations over 178 days, range 84.8–167.3, maximum range width 2,459

m). In both landscapes, home ranges of males were exclusive of other males. Home ranges of females were exclusive of those of other females, but 2 females were within the range of a single male. Home-range size of 2 males we radiocollared in the contiguous landscape was 178.6 ha ($n = 145$ locations over 142 days, maximum range width 1,964 m) and 2,241.5 ha ($n = 122$ locations over 137 days, maximum range width 13,989 m). Habitats within home ranges in the fragmented landscape occupied by guignas included varying amounts of forested ravines with flowing water and steep coastal forest strips. Male guignas avoided agricultural fields, pastures, and other cleared areas within their home ranges. Home ranges of the 2 females did not contain these features. In the contiguous landscape, guignas avoided human-altered boundary areas. No guignas spent more than a few hours in isolated forest fragments ($n = 31$ observations on 5 individuals).

One male in the fragmented landscape exclusively used the steep coastal forest to move between boundaries with 2 adjacent males. Within 2 weeks of the killing of the northern male by a landowner during a depredation incident in a henhouse, the boundary of the adjacent male expanded northward. This male was killed 15 days later, also raiding a henhouse. Within 13 days, the southernmost radiocollared male was exploring northward along the coast and was located subsequently in ravine systems previously occupied by the deceased male and used by 2 females. Female home-range size did not change during this event.

Movements between forest tracts and ravines took place exclusively in vegetated depressions or vegetated corridors, some as small as 3 m wide. Guignas were not observed using or crossing grazed pasture with vegetation <0.4 m high. Male guignas sometimes moved across their home ranges in a single day ($n = 7$ observations on 2 individuals). Roads did not prevent movements; on 2 occasions, a male was seen

crossing a road during the daytime, but only late in the afternoon when the shadows of trees extended across the road. Male guignas were observed crossing unpaved roads without cover during the day, and such crossings occurred from heavily vegetated road shoulders. Female guignas were not observed to cross roads in the open. Guignas used culverts to cross roads ($n = 17$ observations on 3 individuals).

Males made use of landscape features such as an abrupt coastline and heavily vegetated cliff faces to move about their home ranges. Deep east–west ravines with running water and lush vegetation bisected the landscape and acted as natural property boundaries for humans and linear corridors for guigna movement. In the fragmented landscape, these natural corridors allowed guignas to avoid agricultural fields, pastures, orchards, and other open areas. Movement rates of 4 males were 61.5 ± 16.8 m/h ($n = 101$ locations over 178 days, range 37.0–75.0 m/h). Movement rates for 2 females were 36.0 ± 0.56 m/h ($n = 160$ locations over 172 days, range 35.6–36.4 m/h).

DISCUSSION

The geographic range of guignas is restricted to remnant temperate Valdivian rainforest of south-central Chile and a small part of Argentina. These forests are under pressure from logging and other development (Armesto et al. 1998). Agricultural encroachment into habitat of guignas, however, had immediate effects relevant to conservation. Males and females moved in forests, forested, inaccessible ravines, and vegetated corridors and did not use or cross agricultural fields or pastures. Male guignas visited females and crossed their territories through a hazardous, fragmented landscape. Most encountered free-ranging domestic chickens and geese, and some males were killed preying on domestic fowl. Our results suggest that sex-dependent movement behavior through a heterogeneous anthropo-

centric landscape was an important factor influencing the mortality of male guignas.

Our results also suggest that habitat fragmentation and loss may affect male and female guignas differently. Females were sedentary and rarely explored areas beyond their established home ranges. In contrast, males constantly moved about their territories, presumably marking their boundaries and visiting females. Range expansions occurred when competitors disappeared. Such behavior is typical of solitary carnivores (Nowell and Jackson 1996). Males were therefore more likely to come into contact with humans, their pets, and domestic fowl.

In a study of cougars (*Puma concolor*), Cunningham et al. (1995) reported a higher mortality rate from predator control of livestock killers for males than for females (16 males versus 6 females killed). In areas almost uninhabited by humans, Logan and Sweaner (2001) found that juvenile male cougars had lower survival rates than juvenile females. They attributed this to males facing more risks as they dispersed farther than females from natal areas. Knowledge of spatial configuration and species-specific movement behavior is required to make effective conservation plans (Fahrig and Merriam 1994; Hobbs 1992). Conservation of guignas outside national parks and preserves requires corridors linking habitat, restricting access to free-ranging domestic fowl, and education to dispel myths that guignas are vampires.

RESUMEN

Estudiamos los patrones de uso del paisaje y la historia natural de la guiña, *Oncifelis guigna*, un pequeño gato que vive en el bosque en la Isla Grande de Chiloé, Chile. Pusimos 7 collares con radio a guiñas adultos (5 machos y 2 hembras) para determinar los factores que afectan la persistencia en paisajes con un alto grado de fragmentación, dominados por la presencia humana, y en un bosque contiguo con bajo impacto humano. La conservación de las guiñas fuera de las áreas de protección re-

quiere de áreas conectadas por corredores que estén sin aves domésticas libres, y por otro lado disipar el mito local de que las guiñas son vampiros.

ACKNOWLEDGMENTS

We thank Servicio Agrícola y Ganadero, Chile, for granting us permission to study guigna. J. Eisenberg provided encouragement and equipment. J. Armesto made Senda Darwin Research Station, Isla Grande de Chiloé, available. J. Arnett, M. Busca, A. Jennings, L. McDonnell, S. McGehee, and L. Phillips provided field assistance. I. Diaz and E. Elgueta spoke to many landowners on behalf of our project and greatly aided gaining access to properties. We are grateful to the families of Delgado, Ulloa, Varas, Zuniga, Mondiola, Carcamo, and Duran, and many other landowners for providing unlimited access to their private property so that we could conduct our study. Reviews by J. Seidensticker, R. Ims, D. Maehr, and 2 anonymous reviewers improved our manuscript. This work was funded by the Bosack and Kruger Charitable Foundation, Seattle, Washington, through K. Nowell's Cat Action Treasury. We gratefully acknowledge their support, encouragement, and continued interest.

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Submitted 29 January 2001. Accepted 24 August 2001.

Associate Editor was Thomas J. O'Shea.