

# Ecology of the Iberian lynx in Donana, southwestern Spain

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Beltran, J.F., J.I. Aldama, and M. Delibes. 1992. Ecology of the Iberian lynx in Donana, southwestern Spain. In: Global trends in wildlife management. B. Bobek, K. Perzanowski, and W. Regelin (eds). Trans. 18th IUGB Congress, Krakow 1987. Swiat Press, Krakow-Warszawa. 1992.

**Abstract.** Studied are physical characteristics, food habits, space and time use, energetics and mortality patterns of lynxes inhabiting the Donana National Park, at the right bank of the mouth of the River Guadalquivir, in southwestern Spain. Iberian lynxes weigh about one half of what European lynxes do, males being on the average 35% heavier than females. Mediterranean scrubland is the main habitat of the species. Monthly home range sizes average 10 km<sup>2</sup> for an adult male and 8 km<sup>2</sup> for a female. Home ranges tend to be intrasexually exclusive, with complete intersexual overlap. Daily distances travelled average 7.6 km for an adult males and 5 km for adult females. Most of the displacements occur during the night and twilights. Lynxes mainly eat rabbits, with trophic diversity increasing in autumn-winter when deer and ducks are included in the diet. Adult and young mortality seems to be very high and mainly due to human-related causes.

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## Introduction

Although considered for some authors (e.g., Tumlison, 1987) only a subspecies of the European lynx, at present the Iberian lynx *Lynx pardina* trends to be recognized as an independent species (Matjuschkin, 1978) phylogenetically separated from other lynxes from the Pliocene (Werdelin, 1980). For Mallinson (1978) it would be the most endangered carnivore in Europe.

Since 1983 we have been capturing, immobilizing and radio-tagging lynxes at the Donana National Park, in SW Spain. Some years before we conducted analysis of faeces to assess the species diet. Also,

studies on haematology, feeding metabolism and energy requirements have been carried out. In this communication we summarize our main preliminary results.

## Study area and Methods

The Donana area, flat and low, is placed on the right bank of the Guadalquivir mouth, in southwestern Spain. Mediterranean maquis and pine forests grow on sandy soils by the border of the marsh, where thousands of birds, (mainly ducks and geese) winter every year. We estimate the number of lynxes living in all the region (approximately 2000 square kilometres for the Park and its surrounding) to be 40-50 animals, including juveniles but not kittens (Palomares et al., in prep.).

Information used for this report come from three main sources. Dietary studies by means of analyses of faeces and remains of large prey have been made since 1973. More than two thousand droppings have been analyzed, mostly corresponding to the periods 1973-1976 and 1983-1984 (Delibes, 1980; Beltran et al., 1985; unpubl. data). A field study using radio-tracking was started in 1983. Up to date 18 different animals have been radio tagged and four (three females and one male) are being tracked at present. Some details on the equipment and techniques employed can be found in Delibes and Beltran (1986). Finally, we developed an energetics model from the radio-tracking data to estimate energy requirements of free-living non-reproductive lynxes. Nutritional experiences with a captive individual allowed us to estimate energy use by lynxes from a rabbit diet.

## Results and Discussion

### 1. Physical characteristic and haematology

There are very few data in the literature about body weight and dimensions of Iberian lynxes. In our area adult males average 12.9 kg of body weight ( $n=10$ ) and adult females 9.4 kg ( $n=6$ ). This means about one half of the weight of European lynxes. An evident sexual dimorphism in size begins to appear from the second year of life.

Two types of coat design can be recognized: one with small and poorly defined black spots and other with large and distinct black lines and spots. All the individuals captured in the Donana area during the study belonged to the second group.

A sample of blood and serum (less than 1 cc per kg of animal weight) was obtained from each captured lynx, and more than 30 variables analyzed in. Average number of white blood cells was  $17.2 (10^3/\mu\text{l})$  and red blood cells  $7.3 (10^6/\mu\text{l})$ . In our knowledge this is one of the first attempts to establish haematological and serum chemical values from a free-living lynx population.

### 2. Habitat and home range

In Donana lynxes utilize dense maquis as protective shelters from weather and disturbances. More than 90% of the diurnal resting places were in humid and dense heather scrubs *Erica spp.*, probably, at least in summer, as a result of high temperatures and lack of surface drinkable water. Also, in winter these biotopes are more protected from cold. Dense maquis made up of *Erica* and *Rubus* are also the usual places for dens.

Adult resident lynxes have nearly exclusive intrasex areas with little or no home range overlap, at least where food is abundant (Delibes and Beltran, 1984). Monthly home range size of resident males changes with individuals, prey availability and season, and it averages about 10

square kilometres. Home ranges of resident females are smaller and overlap those of males. A strong intrasexual competition for the highest quality habitats seems to exist. Probably scent-marking has an important role signalling to neighbouring resident and transient lynxes that the area is occupied. Nevertheless, two males and one female were known to settle in area already occupied by residents, all of which left their home ranges starting dispersive movements similar to those of subadults. At least for both males, the replacing of a home range owner was preceded by hard fighting, as shown by the severe injuries detected on the defeated animal.

Young lynxes are reared by the female until they become self-sufficient, remaining for a variable time (from some months to more than two years) within the female home range. Males seem to disperse earlier and farther than females. Risks of accidental death increase greatly by dispersion, both for subadults and old individuals.

### 3. Activity and daily movements

From the analysis of 115 periods of 24-h of radio-tracking, corresponding to 12 individuals, can be deduced that lynxes are mainly nocturnal in the study area. Higher locomotion activity corresponds to twilights and it is related to movements from resting to hunting places. Average number of daily resting periods (hours) is 10.4 (range 3-18), from which about 6 correspond to the day and 4 to the night. Average daily distance travelled by the lynx was a close to 7 km, being longer for males. Percent of rabbits in the diet is negatively correlated to daily distance travelled, and activity patterns of lynxes and rabbits trend to be synchronized.

Individual and seasonal changes are the main sources of variation in the daily pattern of lynx activity. From November to February diurnal activity is at its maximum (36% of the distance travelled occurs during light hours) and from July to October

at a minimum (only 27% at light hours). Juveniles are more irregular than adults in their activity patterns.

#### 4. Food and interactions with prey

Rabbits *Oryctolagus cuniculus* are the staple prey for lynxes in Donana all around the year. Importance of this prey reaches 93% in biomass in the summer, decreasing to 75% in winter. Trophic diversity and the rabbit's role in the diet are negatively correlated (Delibes, 1980). These results are practically the same for the two studied periods, suggesting a strong specialization. However, lynxes seem to account only for a small percentage of predation upon rabbits, as the number and diversity of generalist predators eating rabbits are very high (Kufner, 1986).

The variety of prey increases in autumn-winter, when deer and ducks are often captured (Delibes, 1980). Fallow deer *Dama dama* are selected over red deer *Cervus elaphus*, juveniles over to adults and females over to males (Beltran et al., 1985). Lynx predation seems to have an important role on fallow deer population numbers, but it could be a type of starvation-related mortality.

#### 5. Energetics and prey requirements

We have built a model for the energy expenditure of free-living non-reproductive lynxes following that of Powell (1979) for the fisher *Martes pennanti*. As mutually exclusive sources of energy expenditure (activities) we have considered resting, running, hunting and eating, also adding a cost for thermoregulation (considered insignificant in our area). The different costs for each activity have been modelled using linear relationship for mammals or carnivores obtained from the literature and introducing the data obtained throughout radio-tracking. In this way, the energy expenditure of lynxes in Donana, excluding reproduction, has been estimated to be 120 Kcal/kg<sup>0.75</sup>/day. This represents about

947 Kcal/day for an adult male and 700 Kcal/day for a female (Aldama, 1986).

On the other hand, a captive lynx was fed on wild rabbits just to know its trophic efficiency. The lynx metabolized 76.6% of the consumed energy and wasted 13% of the biomass of killed rabbits. A male lynx eating rabbits only would need 368 individuals/year and a non-reproductive female 260.

#### 6. Mortality and management

Since 1983 we have known of at least 14 dead lynxes, 7 of them radio-tagged. Accidental death seems to be very common. Two of the radio-collared lynxes were killed by road-traffic, one drowned in a irrigation well, and at least three more were captured in traps set for rabbits. Another individual was certainly killed by men, but we do not know how. Besides this, since 1982 we have known of six more lynxes killed (or severely injured) by human actions in the area, three with traps, and the rest drowned, overrun and poisoned.

Two adult females died from apparently natural causes. One of them had a broken rib piercing a lung. Death was estimated to occur one month after the injury, that could have resulted while attacking a deer. The second female was known to limp and post mortem revealed an arthrosis on the femur head. Both were very thin when found dead (weighting less than 5 and 6 kg, respectively).

Moreover, two closely related general problems do affect the lynx population of the Donana area: namely inbreeding and the insularization of suitable habitats. The National Park and its surroundings may be a too small surface to contain always a genetically stable population of the predator (Frankel and Soule, 1981), this risk being increased by the trend of fragmentation of its small and isolated range (Harris, 1984). At present, we have found some indirect evidence of a genetic depauperation of this population.

Concerned by the survival of the Donana lynxes, we have proposed a management plan to the authorities of the National Park. The main lines of this plan are: habitat improvement in the Park, mitigation of the detrimental impact of various activities (including the road) on the surroundings, increasing forage supply for lynxes (rabbit populations), prohibition of the use of non selective traps for rabbits and foxes, and carrying out of educational programs.

### Acknowledgements

We wish to acknowledge Mr. R. Laffitte for the capture of the animals for the radio-tracking project. Mr. F. Palomares allowed us to use some of his unpublished data. Mr. E. Collado and Miss N. Bustamante improved previous versions of the manuscript. The study was supported by CSIC-CAICYT (project 944) and FONDE-NA-ADENA WWF Spain. Financial support to attend the Congress was provided by the Consejería de Educación of the Junta de Andalucía.

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