

LYNX IMPACT UPON RABBIT POPULATIONS

The Iberian lynx, *Lynx pardinus*, endemic of the Iberian Peninsula, is a specialist predator on the European rabbit, *Oryctolagus cuniculus*. Unfortunately it is the most threatened felid in the world. One of its main conservation problems comes from hunters who blame lynx for the decline of rabbit density. Knowing the real impact of lynx upon rabbit populations will provide us an excellent tool for conservation policies. It involves knowing how lynx is using rabbit-resource. In a three-year study, lynx and rabbit densities were recorded in an area of Doñana National Park, SW Spain. Simultaneously, lynx diet was analyzed.

METHODS

Lynx density

The minimum number of lynx inside the study area was estimated considering information from:

- Trapping and radio-tracking
- Locating and counting kittens in litters
- Lynx sightings

Data are presented by seasons. I used the proportion of time spent by each individual within the study area (estimated as the proportion of independent radio-locations within the area) as an index of the area use by each lynx.

Lynx diet

Lynx diet was determined by scats analysis (Reynolds, 1991). Scats were collected on the monthly base. Correction factors in feeding trials with captive lynx (Aldama 1993) allowed to determine the percentage of rabbit biomass consumed by lynx from the proportion of rabbit found in scats.

Lynx energetic requirements

I used the additive model to estimate seasonal energy expenditure of free-ranging lynx, developed by Aldama (1991, 1993). Costs of resting, locomotion, hunting, eating, gestation, lactating, raising young and playing activities were considered. Daily rabbit mass required by lynx was obtained (Table 1).

Rabbit size selection

Body mass of predated rabbits was estimated from the measurements of rabbit teeth found in lynx scats (Calzada et al. 1999). Rabbits were classified in four classes (Table 2).

Rabbit density and distribution

Density was seasonally estimated by line transect censuses and warren mapping. A geographic information system (GIS) was used to calculate the total number of rabbits in the study area (Palomares et al. 1999).

Rabbit population structure

Reproductive index, mean litter size and sex ratio were obtained by trapping rabbits every season during 1996 and 1997. Survival probabilities were obtained from a previous study on the same rabbit population (Villaflorida 1994).

Rabbit population was modeled in a stage-classified model (Caswell 1989) with four stage classes (Table 2).

Total number of rabbits eaten by the lynx population

Seasonal rabbit biomass consumed by lynx was estimated as:

g: daily mass required by each lynx in equivalent of rabbit mass

d: time spent in the study area per season (in days)

u: area use

p: proportion of rabbits in lynx diet

n: number of lynx present

$$Pg = \sum_{i=1}^n g \times d \times u \times p$$

Number of rabbits of each class predated by lynx was estimated as:

Pg: seasonal rabbit biomass consumed by lynx

c: percentage of each rabbit stage class found in the scat analysis

w: mean body mass of the stage rabbit class

$$Nc = (Pg \times c) / w$$

RESULTS

Lynx density

As many as 37 different lynx were recorded along all the study period in Coto del Rey. They were three lynx pairs and their offspring. Seasonally, the number of lynx present in the study area ranged between 10 and 19. Lynx density averaged 0.75 ind/km² for the whole study.

Lynx diet

Diet of lynx was almost exclusively based on rabbits. From the 1552 lynx scats collected, rabbit was present in 99% of the scats, and constituted 96% of the ingested biomass.

Rabbit size selection

Baby rabbits were never more than 15% of the rabbits ingested per season. Their importance in the lynx diet was related with their presence in the field. Young rabbits formed the main part of the lynx diet. The lightest class of young rabbits (young_a) was mainly consumed in winter and spring. Their decrease in importance was accompanied by an increase in the percentage of the heaviest class of young rabbits (young_b). Adult rabbits had low importance, except in winter and autumn when they were the 32-40% of the lynx diet (Fig. 2).

Rabbit densities, distribution and population structure

Rabbit densities showed intra and inter annual fluctuations. Mean rabbit density for all the study was 28±21 ind/ha, with a maximum of 68 ind/ha in spring 1995 and a minimum of 7 ind/ha in summer 1996. Total rabbit numbers and stage class structure along the three years for each season is showed in Fig. 3.

Rabbit numbers taken by the lynx population

The amount of rabbits consumed by lynx remained constant along the seasons with small increments in spring, coinciding with lynx reproduction (Fig. 4). Number of rabbits eaten by lynx was more variable, with peaks in spring, when predation focused on the smallest rabbit size classes (Fig. 5).

The percentage of rabbits extracted by lynx from the rabbit population did not show any significant change among seasons during 1995 (3-6%), when rabbit densities were high. But in the following two years, after the decline in rabbit numbers, rabbit percentage taken by lynx increased drastically especially in summer and autumn (13-30%), (Fig. 3).

CONCLUSIONS

Total number of rabbits consumed by lynx depended on the size of the rabbits eaten in a given season (because the total weight of rabbit consumed remained rather unchanged among seasons). During 1995 the percentage of rabbit extracted by lynx from the field per season was never above 10%, independently of the rabbit density.

At the end of 1995 rabbit population suffered a strong decline. Changes were not recorded either in lynx density, or in the rabbit proportion in lynx diet. So, the total weight of rabbit consumed did not change. However, the percentage of rabbits extracted only grew noticeably during the annual low-density minimums of 1996 and 1997 (summer and autumn).

Mainly rabbits under the adult body mass formed the lynx diet. Furthermore in half of the seasons more than 50% of the diet was based on baby rabbits and the lighter class of young rabbits (young type a) (Fig. 2). Those rabbit classes constituted the 35% of the total weight eaten (Fig. 4), and the 65% of the total number of rabbits preyed during all the years (Fig. 5), and those are the rabbit classes which have the lowest reproductive values.

STUDY AREA

The study area is formed by 8 km² of Mediterranean scrubland called Coto del Rey, situated in the north of Doñana National Park (37°09'N 6°26'W), south-western Spain. The area is flat with sandy soils and is covered with large shrubs (mainly *Pistacia lentiscus*), scrubs (*Halimium halimifolium*), pulse pastures and scattered cork oaks (*Quercus suber*). The climate is Mediterranean sub-humid, with wet winters and hot, dry summers. Average annual rainfall is between 500 and 600 mm (Fig. 1).

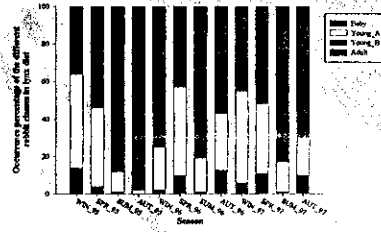


Fig. 2. Rabbit class across percentage to lynx diet.

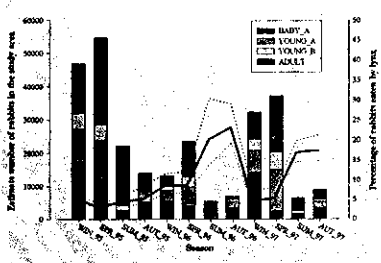


Fig. 3. Estimated number of rabbits in the study area through the years. Dotted red line is the percentage of rabbits extracted by the lynx from the population. Dashed lines are the 95% confidence intervals.

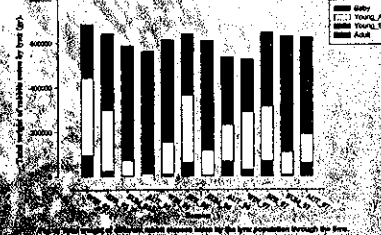


Fig. 4. Total number of rabbits taken by lynx population through the years.

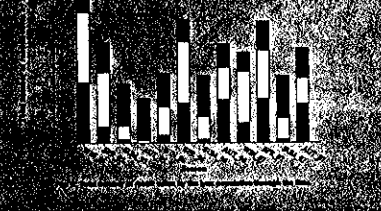


Fig. 5. Percentage of rabbits taken by lynx population through the years.

Table 1. Daily rabbit mass required by lynx (100g of rabbit=920 calories).

Status	Rabbit mass Required
Adult male	941 g/day
Adult female	804 g/day
Lactating	978 g/day
Young	785 g/day

Table 2. Rabbit stage classes considered.

Age	Body mass (g)
Baby rabbits	46-215 g
Young type A	216-450 g
Young type B	450-850 g
Adult	850 g

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