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Distribution, status and conservation problems of the wolf *Canis lupus* in Spain

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The distribution, status and conservation problems of the wolf *Canis lupus* in Spain were studied in 1987 and 1988. Wolves regularly occurred over 100,000 km², mainly in the northwest quarter of the country, with an estimated 294 breeding pairs, i.e. 1,500 and 2,000 wolves in early spring and autumn, respectively. For 1987, reports were received of 309 wolves killed in Spain (excluding Asturias) but the actual number could range from 550 to 750 every year, mostly illegal killings. Annual damage to livestock was estimated at nearly one million US \$, losses being disproportionately high in mountain areas due to the lack of protection of free-ranging livestock. The number of stray dogs is higher where wolves are absent and no extensive wolf-dog hybridization has been recorded. Problems related to wolf management are discussed.

INTRODUCTION

The wolf *Canis lupus* has been declining during this century throughout Europe (Bibikow, 1988). Today populations with more than 500 individuals are only found in the European USSR (Bibikow, 1988), Yugoslavia, Greece, and Rumania (Mech, 1982), Poland (Bobek *et al.*, 1987) and Spain (this paper). Small populations survive in Finland (Pulliainen, 1982), Norway–Sweden (Björvall, 1983), Czechoslovakia (Voskár, 1983), Bulgaria (Genov, 1989), Italy (Boitani, 1986), Portugal (Lyle, 1988) and Albania (Bibikow, 1988). Damage to livestock is the principal problem

caused by wolves in Europe (Zimen, 1978), and is the main reason for legal and illegal killing. The small populations are also threatened by hybridization with dogs (Boitani, 1983; Bibikow, 1988) and loss of genetic variability (Boitani, 1984).

In Spain the wolf was considered to be nearly extinct in the early 1970s (Valverde, 1971); however, the population appears to have increased during the last 15 years (Delibes, 1983; Reig *et al.*, 1987; Telleria & Sáez-Royuela, 1989). Until now no recent population surveys based on enough field data or studies on wolf problems have been carried out on a national level, so that information for management purposes is lacking.

This paper provides data on current wolf distribution, status, population trends, human-caused mortality, wolf predation on livestock, wolf–dog relationships and human attitudes towards wolves in Spain.

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METHODS

Work was undertaken during 1987 and 1988. More than 1,000 questionnaires were sent to gamekeepers, enquiring into the occurrence of stray dogs, human attitudes toward the wolf, and to plan field work. The field work provided evidence of pups, data on killed wolves and damage to livestock, and was carried out by 18 biologists divided into six teams. A total of 900 man-days was spent surveying 1,430 districts, covering the whole wolf range in Spain.

In order to estimate population size, breeding pairs were recognized by the presence of pups in spring and summer. Pups are rather conspicuous and are often seen, trapped or hunted by country people. Most of the field work consisted of interviews with naturalists, wardens, shepherds and other people in rural areas regarding the presence of pups. Data were checked by interviewing independent informants, and when possible footprints were examined at dens and rendezvous sites. In large areas where wolves were permanently seen but the presence of pups was not confirmed (mainly in rough mountain areas), the existence of a minimum number of breeding pairs was estimated. In total, the presence of pups was confirmed in 233 (79.3%) breeding pairs from the 294 estimated.

The number of wolves was obtained by multiplying the number of breeding pairs by 5 and 7, the first total giving the population size in early spring, before births, and the second the number of wolves in the middle of the annual cycle, in autumn. These figures, based on casual observations, agree with estimates of other Spanish (García, 1979; Bárcena & Varela, 1984; González *et al.*, 1987) and European (Voskár, 1983) authors. Obviously this method provides approximate numbers only.

Estimates of wolf damage to livestock were derived from statistics from regions where compensation is paid, and elsewhere on interviews with shepherds and livestock owners. Every damage claim was examined by wardens. Where interviews were carried out data on extensive damage were carefully checked and the tendency of people to exaggerate was always taken into account. No damage was considered to be caused by wolves if stray dogs were noticed in the area. When possible, damage was examined by ourselves in the field. However, owing to the difficulty of obtaining reliable data, the accuracy of the results cannot be

checked. For currency exchange calculation, 1 US\$ has been taken to equal 120 Spanish pesetas.

RESULTS AND DISCUSSION

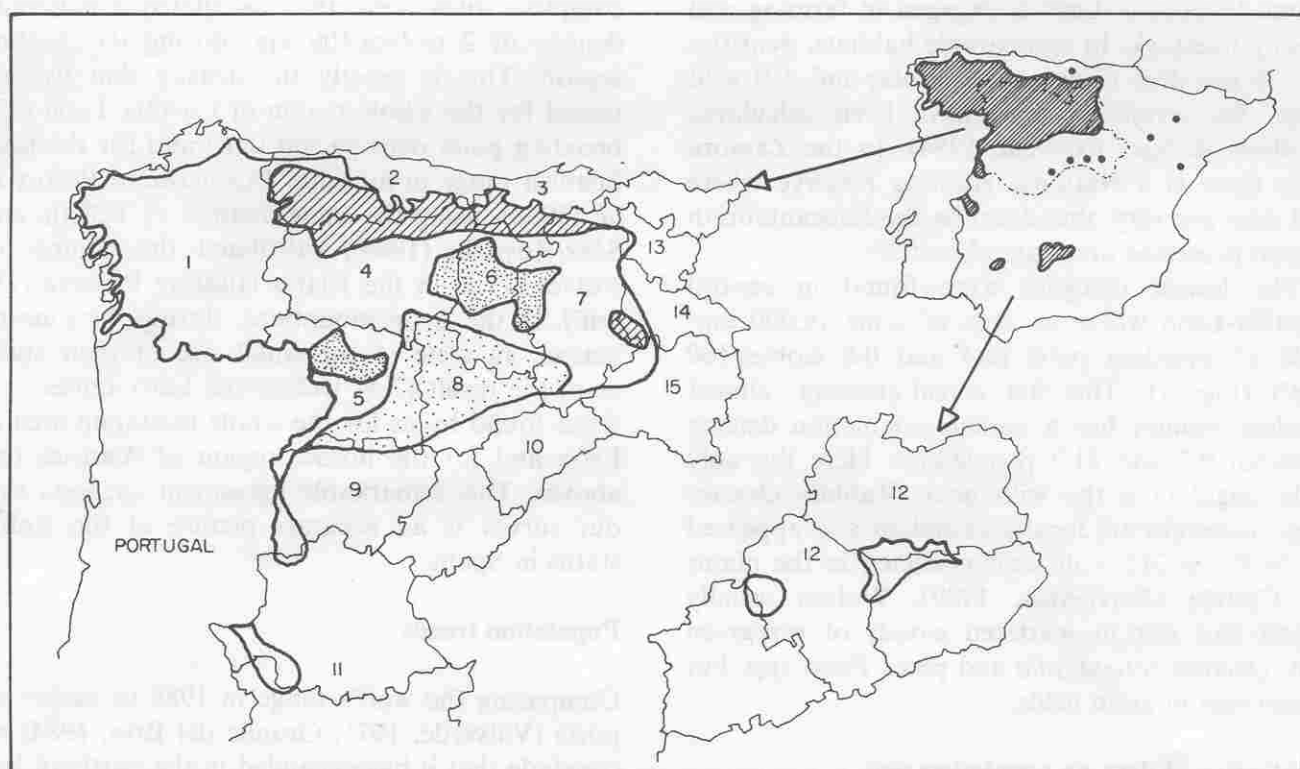
Distribution, status and densities

In 1988 wolves occurred regularly over some 100,000 km², principally in the northwest quarter of Spain, where the distribution was continuous. In the southern half of the country there were two small populations in Extremadura and Sierra Morena. The wolves of Extremadura may be able to keep in occasional communication with those of the northern half of the country along the length of the frontier with Portugal, but the population of Sierra Morena seems to be completely isolated (Fig. 1).

Sometimes wolves are killed distant from their usual distribution area. Most of these records appear to correspond to young dispersing males older than one year. For example, in December 1987 a male was shot in the Province of Castellón, 250 km outside the area of stable distribution and 50 km from the Mediterranean Sea (Fig. 1).

We estimate that in Spain there were some 294 breeding pairs in 1988 and thus some 1,500 wolves in early spring and 2,000 in autumn. To estimate the total Iberian population we must add 90–120 from Portugal, where wolves are mainly in the north, on the border with Galicia and Zamora (Lyle, 1988). In Spain, more than 95% of the population was found in the northern half of the country, mainly in the regions of Castilla-León and Galicia (Table 1). The average density of wolves within their Spanish distribution area is 1.5 and 2.0 individuals/100 km², before birth and in autumn, respectively.

Very different habitats are occupied by wolves. In most of Galicia the habitat is very disturbed, the human population is dense (over 50 people/km² in rural areas) and wild ungulates are scarce. Average wolf density is 1.9 and 2.6 individuals/100 km², and they feed mainly on refuse and livestock (Bárcena, 1979). At the other extreme, in Extremadura and Sierra Morena, the wolf lives in undisturbed, practically uninhabited areas where average red deer *Cervus elaphus* density is 1,000–2,000/100 km². Wolf densities are 1.0 and 1.4/100 km² in Sierra Morena, and 1.7 and 2.5/100 km² in Extremadura; in these areas the diet is basically composed of wild ungulates (unpublished data).



Numbers refer to the provinces/regions named in Table 1.

2,000 km² (5.0 and 7.0 wolves/100 km²), and in the Subcantabrian area there were 31 breeding pairs in 5,200 km² (3.0 and 4.2 wolves/100 km²). In both areas the relief is uneven and the vegetation consists of oak *Quercus pyrenaica* woods, with scrub and cereal cultivation. The human population

Table 1. Estimated wolf population size, 1988, records of wolves killed by man in 1987, and annual damage to livestock, 1987/88

Province/ region	Population size			Killed by man	Damage to livestock			
	Breeding pairs	Estimated number	Percentage of total population		US\$	Sheep/ goats	Cattle	Horses/ donkeys
(1) ^a Galicia	100	500–700	34.0%	108	250,000	615	246	396
(2) Asturias	18	90–126	6.1%	?	364,440	522	74	702
(3) Cantabria	3	15–21	1.0%	16	54,167	548	22	31
(4) León	50	250–350	17.0%	49	149,350	1,436	44	47
(5) Zamora	45	225–315	15.3%	50	64,500	760	12	4
(6) Palencia	26	130–182	8.9%	18	34,375	300	23	1
(7) Burgos ^b	30	150–210	10.2%	44	60,625	700	5	15
(8) Valladolid	4	20–28	1.4%	10	22,625	215	13	0
(9) Salamanca	5	25–35	1.7%	3	4,025	27	4	0
(10) Segovia	0	0	0%	1	0	0	0	0
(11) Extremadura	5	25–35	1.7%	3	950	6	1	0
(12) Sierra Morena	8	40–56	2.7%	7	3,750	49	0	0
Total	294	1,470–2,058	100	309	1,008,807	5,174	448	1,196

^a Numbers in parenthesis refer to location of provinces and regions (see Fig. 1).

^b Including small border areas in Alava (13), La Rioja (14) and Soria (15).

(some 10 people /km²) is engaged in farming and raising livestock. In comparable habitats, densities of 170 roe deer *Capreolus capreolus* and 210 wild boar *Sus scrofa*/100 km² have been calculated (Tellería & Sáez-Royuela, 1984). In the Zamora area there is a National Hunting Reserve where red deer are very abundant. In the Subcantabrian region protected areas are absent.

The lowest densities were found in central Castilla-León where an area of some 19,000 km² held 15 breeding pairs (0.4 and 0.6 wolves/100 km²) (Fig. 1). This flat cereal-growing, almost treeless country has a human population density between 9.2 and 21.7 people/km². Here the only wild ungulate is the wild boar. Rabbits *Oryctolagus cuniculus* are locally abundant and appeared in 26.4% of 212 wolf scats collected in the plains of Castilla (Barrientos, 1989). Wolves usually breed and rest in scattered woods of evergreen oak *Quercus rotundifolia* and pines *Pinus* spp. but sometimes in grain fields.

Evaluation of data on population size

To evaluate the accuracy of our population estimates, we compared the densities obtained by our different teams in areas with similar ecological and social characteristics. In Asturias (18 breeding pairs over 5,100 km²) and in the border mountain area of León (10 breeding pairs over 2,969 km²) groups working independently obtained densities of 2.47 and 2.36 wolves/100 km², respectively. The main habitats occurred in similar proportions in the provinces of León (50 breeding pairs over 15,468 km²) and Palencia (26 breeding pairs over 8,028 km²), and the two teams working there obtained exactly the same result: 2.26 wolves/100 km² in autumn. This agreement suggests that this method used by different field observers provides reasonably consistent results.

Since we cannot show that the average number of individuals assigned to each breeding pair is correct, we have compared our results with those of local censuses carried out by other authors using a different method. Tellería and Sáez-Royuela (1989), using hunting statistics, calculated the wolf proportion in an 8,000 km² area in Castilla-León, including representative habitats for the whole region. They related the number of wolves shot ($n = 34$) to the number seen (i.e. number present, $n = 179$) in 52 hunting drives. Applying this percentage to the known number of wolves shot in drives during one year over their

complete study area, they calculated a minimum density of 2 wolves/100 km² during the hunting season. This is exactly the density that we obtained for the whole region of Castilla-León (159 breeding pairs over 55,500 km²) and for the total Spanish range in autumn. Furthermore Purroy *et al.* (1988), using the same method as Tellería and Sáez-Royuela (1989), calculated the number of wolves (17.5) in the Riaño Hunting Reserve (715 km²), in the León mountains, during the hunting season. In spite of the small size of their study area, the result (2.44 wolves/100 km²) agrees with those found by us for the whole mountain area of León and for the border region of Asturias (see above). This remarkable agreement suggests that our survey is an accurate picture of the wolf's status in Spain.

Population trends

Comparing the wolf's range in 1988 to earlier reports (Valverde, 1971; Grande del Brío, 1984) we conclude that it has expanded in the northern half of Spain and has been reduced in the southern half. Besides extending its range, the number of wolves killed in the northern half of Spain has also increased, as has been shown in several areas where the population has been accurately monitored. In Cantabria an annual average of 4.7 wolves were killed between 1973 and 1981, and this number increased to 14.3 between 1985 and 1987 (Fernández *et al.*, 1988). In the Province of Valladolid only two wolves were killed between 1946 and 1977, but at least 76 between 1980 and April 1989 (Barrientos, 1989, pers. comm.) In an 8,000 km² area of the Province of Burgos the number of wolves hunted increased exponentially ($r = 0.20$) between the 1981/82 and 1984/85 hunting seasons (Tellería & Sáez-Royuela, 1989). These data and much other evidence revealed by our field work allow us to conclude that in the northern half of Spain the population size has increased considerably in the last 10 or 15 years. Nevertheless in the south of the country, mainly in Sierra Morena, it still appears to be declining.

The wolf's increase in most of its Spanish range seems to have two main causes. First, in 1970 it was considered to be a legal game species rather than vermin; moreover, since 1984 poisoned baits, possibly the main cause of wolf mortality in the past, have been strictly forbidden. Secondly, rural depopulation, regeneration of natural vegetation, and a great increase in wild boar and roe deer

have been recorded for inland regions in the north of Spain (Tellería & Sáez-Royuela, 1984, 1985). These factors appear to have allowed wolf numbers to grow without a proportionate increase in damage to livestock. In this connection, a strong correlation ($r = 0.999$, $p < 0.001$) has been found between increasing records of roe deer and wolves hunted in recent years (Tellería & Sáez-Royuela, 1989).

In the south of Spain wolves occupy large private estates where red deer hunting is the main income, the profits of which have been rising in recent years. Although wolves are strictly protected in Extremadura and Andalusia, they are killed to prevent damage to game species. Since most of these estates are wild and isolated, illegal killing can rarely be controlled, and the wolf is becoming increasingly scarce.

Human-caused mortality

The wolf in Spain is heavily persecuted. For 1987, we have reports of 309 killed by people in the whole country (excluding Asturias) but the true number may have been much higher. Considering that 19% of the population is shot during the hunting season (Tellería & Sáez-Royuela, 1989) and that shooting accounts for 60% of identified human-caused mortality (Table 1), at least 550 wolves could be killed annually. On the other hand, Reig *et al.* (1987), from data collected in a small area in Burgos, calculated that 25% of the population (considered in late spring, after births) was killed each year. Extrapolating from this, 750 wolves would be killed every year in Spain. This rate of killing would allow the wolf population to keep increasing, since as far as we know no population decline has been reported to be caused by rates of exploitation lower than 25% (Mech, 1970; Peterson *et al.*, 1984; Ballard *et al.*, 1987; Fuller, 1989). In addition, exploitation by humans seems to stimulate both reproduction and survival of pups, enabling the population to attain its potential maximum productivity (Mech, 1970; Pulliam, 1980).

The main factors of identified human-caused mortality recorded from 1984 to 1988 ($n = 503$) were shooting (60.0%) and removal of litters (19.7%). Snaring and trapping (11.5%), vehicle collision (4.6), poisoning (3.0%) and other factors (1.2%) were of lesser importance.

In Castilla-León 26.4% of wolves known to be shot between 1984 and 1988 ($n = 277$) were killed

outside the hunting season (i.e. illegally hunted). Extrapolating this result and adding the remaining illegal causes of mortality (all but vehicle collision) we conclude that at least 51.2% of wolves killed by humans were killed illegally, but the true percentage may have been higher.

Damage to livestock

Wolves prey mainly on sheep and goats (79.5%) and to a lesser extent horses (17.6%) and cows (6.5%). We estimate annual damage caused by wolves at nearly 1 million US\$ (Table 1).

From these figures, and taking the autumn population size, an average wolf in Spain inflicts damage of 500 US\$ a year, i.e. approximately six sheep or one calf. However, the distribution of damage is uneven and does not correspond in magnitude to wolf numbers. Where most of the livestock was free-ranging, in mountain areas, notably in the Cantabrian Mountains, we found greater damage (Fig. 1). These areas suffer 77.0% of the losses of the whole country but support only 20.6% of Spain's wolves. Considering data from smaller areas, a similar pattern exists. In the whole region of Castilla-León and in the Province of León 49.5% and 71.7% of losses were in the mountains, where only 12.5% and 20.0%, respectively, of the wolves were found. In the area of greatest damage each wolf would have caused annual average losses of 2,083 US\$, but an average of 359\$ in the rest of the country, where shepherds usually guard livestock. In the areas of higher wolf density (Fig. 1) annual damage per wolf was only 129 US\$ in Zamora and 83 US\$ in the Subcantabrian area. Differences between the damage caused by wolves in different areas was thus very high, even allowing for some error in estimates.

The main cause of the disproportionately high losses in mountains seems to be the unprotected state of livestock. To a large extent the area of greatest damage is within National Hunting Reserves where wild ungulates are abundant (for example, in Riaño Hunting Reserve, 46.6 red deer, 316.1 roe deer, 167.8 chamois *Rupicapra rupicapra*, and 85.3 wild boar/100 km²; Purroy *et al.*, 1988), but widespread losses and frequent surplus killing of unguarded livestock were not eliminated by the high availability of natural prey.

Livestock loss statistics from comparable European countries are only available for Italy. The estimated annual damage caused by some 22

wolves living in Abruzzo averaged 61,000 US\$ between 1974 and 1978, i.e. about 2,773 US\$ per wolf (Boitani, 1982). L. Boitani (pers. comm.) estimates that annual losses claimed by livestock owners throughout Italy are 1–2 million US\$, but only 30–40% is attributable to wolves. Thus some 250 Italian wolves would cause annual damage of 800,000–300,000 US\$ (3,200–1,200 US\$ per wolf). Although these figures are very variable, it is obvious that average damage per wolf is several times lower in Spain than is claimed in Italy. Nevertheless the annual livestock loss caused by the 50,000 North American wolves has been evaluated at some 280,000–320,000 US\$ (Carbyn, 1988). These data can help to highlight the social problems caused by European wolves.

Impact of wolf predation on red deer in Sierra Morena

An approximate estimate has been made of predation on red deer in Sierra Morena, where an area of 4,400 km² is occupied by about 56 wolves, with minimum densities of 1,000–2,000 red deer/100 km². Assuming that an average wolf consumes 6% of its body weight/day (Fuller, 1989) and that average wolf and deer weights are 20 and 80 kg (Tellería & Sáez-Royuela, 1984), even if wolves only fed on deer, the wolf population would every year consume 0.7–0.3% of the total deer biomass. These figures indicate the extent to which wolf persecution in order to protect big game in this region is unjustified.

Stray dogs and wolf–dog hybridization

Stray dogs compete with wolves for food and range (Boitani, 1983) and cause extensive losses to livestock and game species (Kreeger, 1977). Bibikow (1988) provides data from Russia which strongly suggests that wolves limit stray dog numbers.

For the whole region of Castilla-León (94,000 km²) questionnaires were sent to gamekeepers enquiring about the presence of stray dogs (defined as those which breed in the wild, live in packs, prey on livestock and game, and are afraid of people). Of gamekeepers living in wolf country ($n = 213$), 9.8% had noticed the presence of stray dogs, while outside the wolf's range this percentage rose to 38.0% ($n = 149$), the difference being significant ($G = 21.71$, d.f. = 1, $p < 0.001$). These findings agree with those of Bibikow (1988).

As far as we know, wolf–dog hybridization has been reported in the USSR (Bibikow, 1988), Italy (Boitani, 1982), Portugal (Fonseca, 1982) and Spain (Valverde & Hildago, 1979). In Spain hybrids were noticed in the early 1970s in Extremadura, where at that time the wolf was almost extinct. Nevertheless during the last few years we, and the field observers in our study, have examined some 600 wolf carcasses and found no conclusive evidence of hybridization. In three cases some rare features were noted, but we were not able to resolve whether they were the results of hybridization with dogs or of natural wolf variation. Thus wolf–dog hybridization nowadays seems to be exceptional in Spain.

Although the causes of hybridization are not well-understood (Bibikow, 1988), we suppose that it takes place mainly when wolves are so scarce that individuals cannot find natural mates (Carbyn, 1988). If this is so, there is no danger of extensive hybridization in the continuous range of the northern half of Spain, but there is a real possibility in the small ranges of Extremadura and Sierra Morena.

Wolf management

In Spain, laws regulating wolf management are under the jurisdiction of the regions (autonomous communities). In the six regions of the northern half of Spain where the wolf exists it is a game species. In two regions in the southern half of the country (Extremadura and Andalusia) it is fully protected, and in the third (Castilla-La Mancha) it is a game species but no hunting licences have been issued in recent years.

Nevertheless, wolf management is strongly conditioned by public opinion. The wolf is a very popular species among conservationists and many urban people, who disapprove of legal hunting and population control, but the opposite attitudes exist in rural areas. To assess public opinion in rural Castilla-León (where damage to livestock is low) we sent questionnaires to gamekeepers asking about attitudes toward wolves in their neighbourhood. The reply selected by 53.1% of the total ($n = 273$) was 'the wolf must be eradicated', 34.8% that 'it must be controlled', and 12.1% were 'indifferent'. None considered that 'the wolf increases the hunting or recreational value of the area'.

In most of the regions where the wolf is a game species, hunting rules are rather restrictive but illegal killing is widespread and few efforts are

made by the authorities to apprehend offenders. This approach to management seeks to avoid public criticism but lacks scientific basis.

Damage to livestock is the main cause of wolf unpopularity among rural people. Compensation of 262,500 US\$ was paid for damage by the different region's environmental agencies between March 1986 and February 1987, that is, a quarter of the total annual estimated damage. In the regions of Galicia and Castilla-León, where almost 90% of Spanish wolves are found, compensation was paid for 1% and 14% of the damage to livestock, respectively.

Since extensive illegal killing cannot in practice be suppressed while livestock owners are suffering high economic losses, we suggest prompt compensation for damage throughout the country. Wolf management must be carried out according to management plans based on continuous monitoring of the populations. In the wolf areas of southern Spain recovery plans need to be implemented.

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