unpubl. data). There was a surge in exports from China from 1984-1988, with a peak of over 12,000 skins in 1986 (WCMC unpubl. data). This trade was probably in response to high pelt prices prevailing at that time, when Canada lynx populations were at a cyclic low. Given that China lacks the organized trapping infrastructure present in Russia, it is possible that the skins could have been taken originally in Siberia, unaccounted for in the official harvest (U. Breitenmoser *in litt.* 1992).

Both China and Russia announced in 1993 the setting of export quotas for lynx furs: 2,800 per year from Russia, and 1,000 per year from China (Anon. 1993b). Exports of lynx furs from these two countries are currently low, below 1,000 annually.

While lynx reintroduction in Switzerland has been considered a success, Breitenmoser *et al.* (1994) have found that the population has stopped expanding, and is threatened by an imbalanced sex ratio (lack of males). The problems facing the Swiss lynx population are discussed in Part II, Chapters 2, 3, and 6. In general, lynx adapt well to settled and cultivated areas if population levels do not become too low. Lynx have been reported from the outskirts of Moscow, Leningrad, and other large Russian towns (Heptner and Sludskii 1972).

Action Planning

Projects 16, 80, and 84-88.

Europe Sub-region

Iberian lynx, *Lynx pardinus* (Temminck, 1827)

Other Names

Pardel lynx, Spanish lynx (English); lynx d'Espagne (French); Pardelluchs (German); lince iberico (Spanish); lobo cerval (Portugese).

Description and Behavior (Plate 11)

The Iberian lynx looks like a smaller version of the Eurasian lynx, being only about half its size, with adult males weighing an average of 12.8 kg (n=5) and females 9.3 kg (n=4) (Beltrán and Delibes 1993). Iberian lynxes have a distinctly spotted coat, as do Eurasian lynxes of western Europe. However, the two are different species (Werdelin 1990, García-Perea 1992), sympatric in central Europe during the Pleistocene (Kurtén 1968, Kurtén and Grandqvist 1987), with the time of separation estimated to have occurred long before the separation of the Eurasian and Canadian lynxes. Werdelin (1981) considers that both the Eurasian and Iberian lynxes evolved from the first identifiable lynx, *Lynx issiodorensis*—the Iberian in Europe, and the Eurasian lynx (which gave rise to the Canada lynx) in China. Although the ranges of the Eurasian and Iberian lynx never overlapped very much, and have become essentially separate in recent times, the two lynxes may still co-exist in the Pyrenees Mountains between France and Spain (van den Brink 1971, Breitenmoser and Breitenmoser-Würsten 1990).

The ecology of the Iberian lynx is very different from the Eurasian lynx. While the Eurasian lynx is a forest animal which preys on ungulates, the Iberian lynx is found in scrub vegetation and preys almost exclusively on European rabbits. In both ecology and average body weight, the Iberian lynx is very similar to the Canada lynx and bobcat of North America. By weight, 93% of lynx prey during the summer season is made up of rabbits, which suffer particularly at that time from the poxvirus myxomatosis. The proportion of rabbits in the diet decreases slightly in the winter months, when rabbit numbers are at an annual low (Delibes 1980, Beltrán *et al.* 1987). At this time, red deer (fawns), fallow deer, and moufflon (juveniles) are taken (Aymerich 1982, Beltrán *et al.* 1985). In the Coto Doñana wetland area along the southwestern Spanish coast, ducks are a seasonally important food resource from March to May, during their breeding season (Delibes 1980, Beltrán and Delibes 1991). The energy requirements of the Iberian lynx have been estimated at approximately one rabbit per day (Aldama *et al.* 1991).

A radio-telemetry study in the Coto Doñana National Park showed lynxes to be primarily nocturnal, with activity peaking at twilight as the animals moved out of their daytime resting places to hunt. Daily travel distance averaged 7 km, with males generally travelling further than females. Diurnal activity peaks during the winter (Beltrán *et al.* 1987).

Biology

Mating season: (W) January-July, peak January-February.

Birth season: (W) March-April peak.

Gestation: (W) approx. two months.

Litter size: (W) 2-3 (M. Delibes *in litt.* 1993).

Survival to independence: (W) 1-2 kittens per female.

Age at independence: (W) 7-10 months.

Age at dispersal: (W) independent kittens remain in their natal territory until an average of 20 months (range 8-28; n=15).

Age at first reproduction: (W) Females are able to breed in their first winter, but the time of first reproduction depends upon demographic and environmental factors. In a high-

density population, such as that in Doñana NP, age at first reproduction depends upon when a female acquires a territory. This normally occurs because of either death or expulsion of a resident. One female did not reproduce until five years of age, and this only occurred when the mother died and left the territory vacant (J. Aldama, P. Ferreras *in litt.* 1993).

Age at last reproduction: (W) 10 years (male and female: M. Delibes *in litt.* 1993).

Longevity: (W) up to 13 years (Ferreras *et al.* 1992).

Habitat and Distribution

The Iberian lynx occurs in Mediterranean woodland and maquis thicket. It favors a mosaic of dense scrub for shelter and open pasture for hunting rabbits (ICONA 1992). Palomares *et al.* (1991) examined habitat preferences of lynx in the Coto Doñana area of southwestern Spain, including the national park and environs. Lynx were generally absent from cropland and exotic tree plantations (eucalyptus and pine), where rabbits were also scarce. In the park, radiotelemetry showed that more than 90% of daytime resting spots used by lynx were located in thick heather scrub (Beltrán *et al.* 1987).

The Iberian lynx has historically been restricted to the Iberian peninsula, where it was widespread (Graells 1897), and southern France (Lavauden 1930). The peninsula was apparently a Pleistocene refuge for the European rabbit, and today the race that occupies this area is only half the size of conspecifics found elsewhere in central Europe (1 vs. 2 kg: Gibb 1990). The Iberian peninsula is the only part of the Palearctic region which supports a relatively high density of lagomorphs, similar to that found in North America, home to two species of lagomorph-eating lynxes: the bobcat and Canada lynx (U. Breitenmoser, pers. comm. 1992).

By the early years of the 20th century, the Iberian lynx had become very rare in northern Spain, although it was still abundant in the center and south (Cabrera 1914). By the 1960s, its range was essentially limited to the southwestern quarter of the peninsula, an area of some 57,000 km^2, where the population probably had a continuous distribution (Rodríguez and Delibes 1990). At present, lynx range in Spain (where 95% of the population is now found) covers only 14,000 km^2, of which about 11,000 km^2 is believed to be breeding range. This represents only about 2% of the country's total area (Rodríguez and

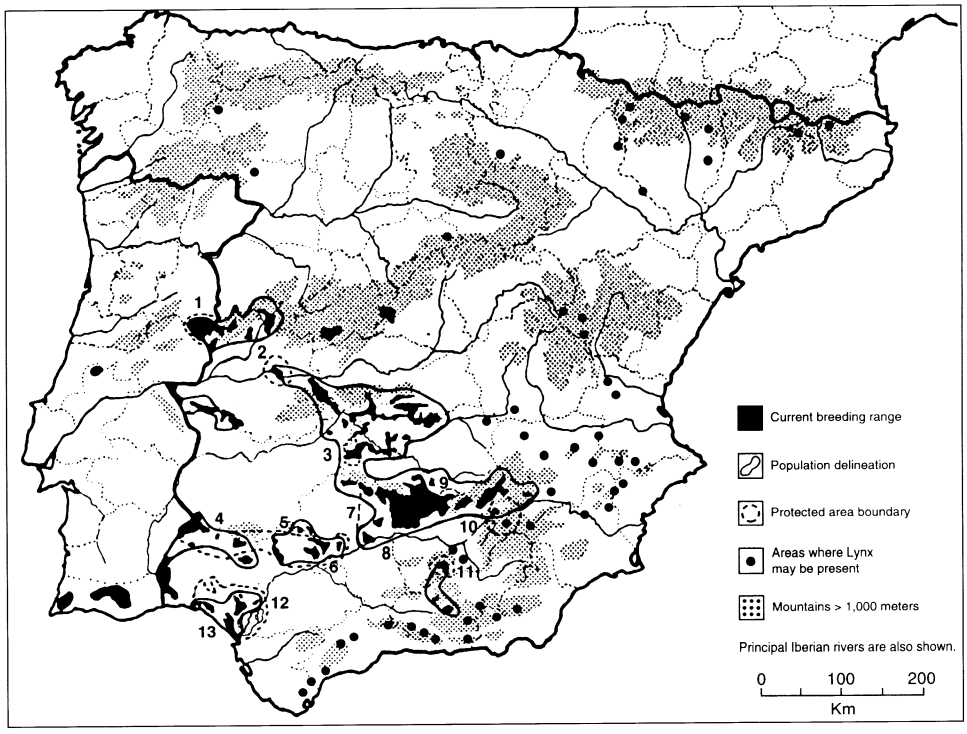

Figure 7. Distribution of the Iberian lynx (*L. pardinus*) after Rodríguez and Delibes (1992).
1. Serra da Malcata IV (Portugal); 2. Monfrague V; 3. Cabañeros V; 4. Sierra de Aracena y Picos de Aroche V; 5. Sierra Norte Natural Park; 6. Sierra de Hornachuelos V; 7. Sierra de Carde:a y Montoro; 8. Sierra de Andujar V; 9. Despeñaperros V; 10. Cazoria, Segura y la Villas Natural Park; 11. Sierra Mgina V; 12. Entorno de Doñana V; 13. Doñana II* (Spain).

Delibes 1992). Distribution in Portugal is less well-known, but has also been substantially reduced since the 1940s. There now appear to be only three breeding sub-populations in that country, occupying a total range of only about 700 km^2, with the largest now found in the Serra da Malcata Nature Reserve and the Algarve Mountains of the extreme south (Delibes 1979, Palma 1980, ICONA 1992). Lynx distribution is centered on mountain ranges, where land use is mainly in the form of privately owned hunting reserves (ICONA 1992). Lynx are mainly found between 400-900 m elevation, but will range up to 1,600 m (IUCN 19762, Palma 1980).

Population Status

Global: Category 1. Regional (Europe): Category 1. IUCN: Endangered. The Iberian lynx is the only cat species ranked in Category 1. The total number of Iberian lynx, including sub-adults but not kittens, probably does not exceed 1,200, with only about 350 breeding females (ICONA 1992, Rodríguez and Delibes 1992). The lynx population is extremely fragmented. In Spain, a comprehensive survey (Rodríguez and Delibes 1992) documented 46 isolated breeding areas, 32 areas of occasional presence, and 50 other areas where lynx presence is suspected but not confirmed (Fig. 7). Since lynx are known to dis-

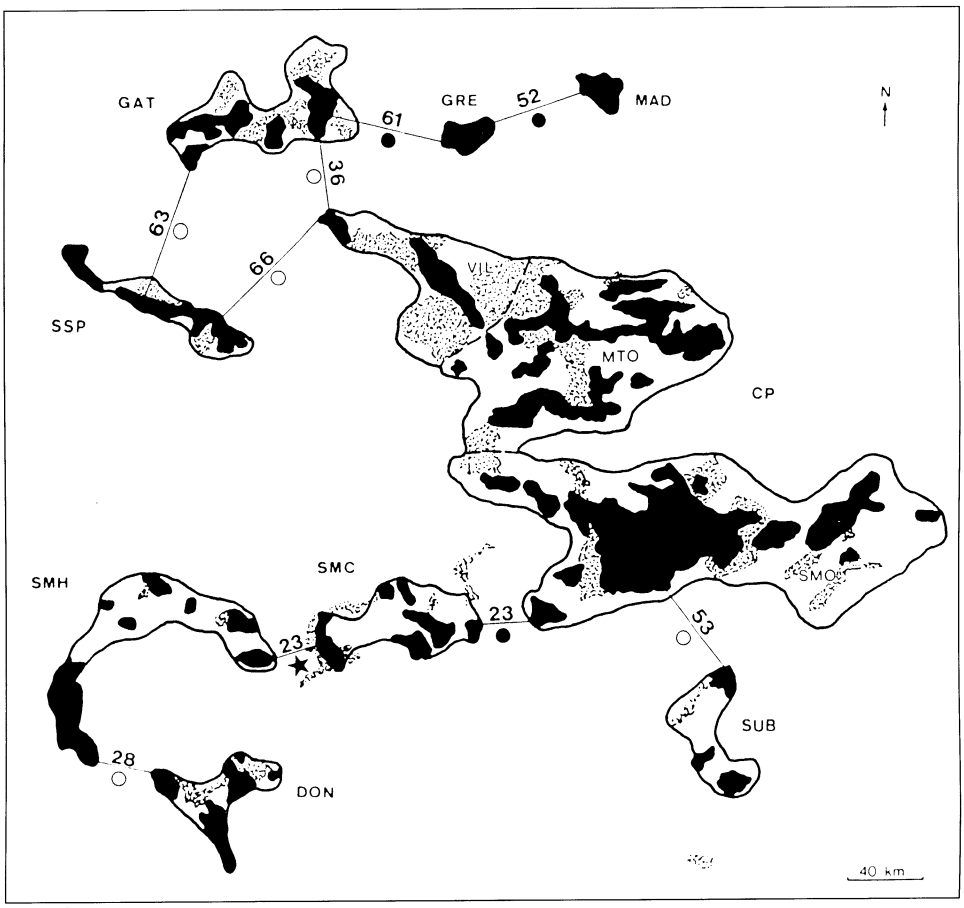

Figure 8. Population structure of the Iberian lynx in Spain (Rodríguez and Delibes 1992). Continous lines surround the nine estimated populations, including breeding (shaded black) and occasional presence areas (stippled). The breeding populations are the same as those shown in Figure 7. Broken lines further delineate three sub-populations (VIL, MTO, SMO). Straight lines represent minimum barrier breadth (km). Symbols indicate the degree of barrier penetrability for lynx: star = high; solid circle = low; open circle = null. GAT = Sierra de Gata. GRE = Sierra de Gredos. MAD = Alto Alberche. SSP = Sierra de San Pedro. CP = Central population (VIL = Villuercas; MTO = Montes de Toledo; SMO = Eastern Sierra Morena). SMH = Western Sierra Morena. SMC = Central Sierra Morena. DON = Doñana; SUB = Sierra Subbéticas.

Table 3
Comparative Importance (%) of Different Causes of Mortality Among Lynxes in Spain (after Rodríguez and Delibes 1990)

Period	Guns	Traps/ Snares	Dogs	Road	Other	N
1958	21.2	67.0	3.5	—	8.2	170
1958-1977	26.0	62.7	2.6	0.1	8.6	689
1978-1988	26.1	44.4	6.7	7.0	15.7	356
Total	25.4	58.0	4.0	2.1	10.6	1,215

perse up to 30 km (Beltrán 1988), the 48 isolated breeding areas and 32 areas of occasional presence are likely to make up nine distinct sub-populations (Fig. 8). These sub-populations are probably genetically isolated, having been separated by intensive agriculture and settlement by an average distance of 45 km. Only two sub-populations occupy areas larger than 2,000 km^2.

Only the central population, consisting of three sub-populations (VIL, MTO & SMO on Fig. 8), is believed to be viable, consisting of some 800 lynx. The remaining sub-populations are estimated at between 13-63 animals (Rodríguez and Delibes 1992). Small population size is a proven threat to the Iberian lynx: it has disappeared from 91% of the areas less than 1,000 km^2 in size which were estimated to have harbored it in 1960 (Rodríguez and Delibes 1990).

Iberian lynxes have been studied using radiotelemetry in the Coto Doñana NP since 1983. In good quality habitat, lynx density (including sub-adults but not kittens) was estimated at 16 individuals per 100 km^2 (Palomares *et al.* 1991). Rodríguez and Delibes (1992) estimated densities across lynx range based on the relationship between reports of lynx presence and actual numbers present, known from the Doñana study area. Densities for the nine genetically isolated sub-populations were estimated at between 4.5-10.1 individuals per 100 km^2. For resident adults in the Doñana, annual home range averages 18 km^2 for males (monthly home range averages 10 km^2) and 10 km^2 for females (monthly home range averages 8 km^2) (M. Delibes *in litt.* 1993). Home ranges are intrasexually exclusive, with complete intersexual overlap (Beltrán *et al.* 1987).

Protection Status

CITES Appendix I. National legislation: fully protected in Spain and Portugal (ICONA 1992). The Spanish government paid a bounty for destruction of lynx up through the 1950s; the lynx was not declared a protected species until 1973 (ICONA 1992). At present, the fine for willful killing of a lynx is very high, approximately U.S. $8,000 (Delibes 1989).

Principal Threats

The decline of the lynx population since the 1960s has been primarily caused by habitat loss and a decline of their main prey species, the European rabbit. The poxvirus, myxomatosis, was introduced from South America in the early 1950s and had a devastating impact on European rabbits, which had no natural immunity. In the early years of the epidemic, rabbits virtually disappeared from many areas. European rabbits are in the process of developing genetic resistance to myxomatosis, which is no longer such an important threat. However, a new disease, viral hemmorrhagic pneumonia, hit the Spanish population in 1988, causing high initial mortality of adult rabbits (Gibb 1990, Villafuerte and Moreno 1991). At the same time, large-scale habitat conversion has taken place in Spain and Portugal, where the pasture-scrub-woodland mosaic preferred by rabbits was replaced by wheat fields and industrial forest plantations. Rabbits are declining even in the montane hunting reserves, probably because small-scale grazing and cultivation have been abandoned in these areas, and the pastureland preferred by rabbits is invaded by thicket (ICONA 1992).

Nevertheless, there are some areas where habitat quality and rabbit density appear sufficient, yet no lynx are found. Particularly in these areas, it seems that humans are directly responsible for an appreciable level of lynx mortality (Delibes 1989). This is true even for the population living in the area receiving the greatest protection, the Doñana NP complex. Most of the deaths recorded there in the last 10 years were human-related, and only 8.3% of the annual mortality rate can be related unequivocally to

natural causes (Ferreras *et al.* 1992). Rodríguez and Delibes (1990) compiled records on cause of death for 1,215 lynx killed in Spain over the past 30 years.

Traps and snares, particularly gin traps set for rabbits, have been the principal known cause of death for lynx, although the practice of trapping rabbits is now declining. Road deaths were comparatively unimportant (or seldom reported) before 1978, but are expected to increase as Spain undertakes an ambitious program of road-building in the 1990s (ICONA 1992).

The small, isolated sub-populations of Iberian lynx are theoretically vulnerable to genetic drift, where alleles with low frequency are likely to disappear from the population gene pool. Beltrán and Delibes (1993) found preliminary evidence for this happening in Coto Doñana, where the population of approximately 40-50 lynx has been isolated since the early 1960s. Three pelage patterns were present in the population at that time, but now no animals exhibit the rarer fine-spotted pattern.

The Spanish government is in the process of developing a national conservation strategy for the Iberian lynx, with the goal of enabling the lynx to occupy as large a range as possible on a permanent basis. Management measures will be applied first to the largest population nuclei (the eastern Sierra Morena, the Toledo Mountains, the corridors between these two zones, and certain parts of Extremadura). Measures include completion of detailed surveys of the conditions faced by each lynx sub-population (land use, land ownership, habitat condition, rabbit density); banning rabbit trapping; taking active steps to increase rabbit populations (such as brush clearance); and establishment of a captive breeding program (now underway) (Rodríguez and Delibes 1990, ICONA 1992).

Action Planning

Projects 81-83.

European wildcat, *Felis silvestris, silvestris* group Schreber, 1775

Other Names

Forest wildcat (English); chat forestier, chat sauvage, chat silvestre (French); Wildkatze (German); gato montés, gato silvestre (Spanish); vairi katu, antarayin katu (Armenian); diwa kotka (Bulgarian); ghjattu volpe (Corsican); kodka divoká (Czech); wilde kat (Dutch); tkis cata (Georgian); vadmacska (Hungarian); gatto selvatico (Italian); zbik (Polish); gato bravo (Portugese); pisica-salbatica (Romanian); dikaja koschka (Russian); macka diva (Slovakian); yaban kedisi (Turkey); sauvadge tché (Wallon: Belgium).

Description and Behavior (Plate 12)

The forest wildcats of Europe and western Russia are grey-brown in coat color, with bushy, blunt-ended tails and a well-defined pattern of black stripes. Although they tend to look bigger than African wildcats because of their thick winter fur, an extensive series of weight measurements have shown that they are not: males weigh an average of 5 kg and females 3.5 kg (Condé and Schauenberg 1971). However, the authors did record strong seasonal weight fluctuations ranging up to 2.5 kg, with heaviest male weights recorded from September to the end of February (France).

The fossil record suggests that the European form of the wildcat is the oldest, descended from Martelli's cat (*Felis [silvestris] lunensis*) about 250,000 years ago (Kurtén 1968). Molecular analysis indicates that the African wildcat diverged from the European form only about 20,000 years ago (Randi and Ragni 1991). This is corroborated by the fact that fossil specimens of African wildcats are only known with certainty from the late Pleistocene (Savage 1978). The domestic cat was derived from African wildcats between 4,000-8,000 years ago (Clutton-Brock 1981, Davis 1987, Kitchener 1992). Hybridization is common between European wildcats and domestic cats, and Kitchener (1992) discusses characters (pelage pattern, gut length, skull morphology) that can be used to distinguish reliably pure wildcats from hybrids or domestic tabbies. Many hybrids are more like wildcats in size and morphology than domestic cats: perhaps there is differential survival of hybrid forms in the wild that favors larger cats. Large black cats observed in Scotland ("Kellas cats") and the Caucasus (Satunin 1904, Aliev 1973) are probably introgressive hybrids, with variable proportions of wildcat genes (Kitchener and Easterbee 1992). Black forms (melanistic) have never been recorded in wildcats in Europe, despite being a common coat color mutation in other species of felid (Clark 1976, Robinson 1976, Todd 1977).

As with other wildcats, rodents are the staple of their diet across most of their range (Lindemann 1953, Novikov 1962, Nasilov 1972, Sladek 1973, Condé *et al.* 1972, Ragni 1978, Habijan and Dimitrijevic 1979, Hewson 1983, Stahl 1986, Riols 1988, Fernandes 1993, Ionescu 1993). However, rabbits comprise the major prey where they occur, as in central Spain (Aymerich 1982), and an agricultural area in northeastern Scotland (Corbett 1979). Birds (both passerine and ground-dwelling) are of secondary importance (B. Ragni, P. Stahl *in litt.* 1992). The composition of the diet shows only minor seasonal variations: rabbits or rodents are the major year-round food items. No one