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Comment

Reverse of the Decline of the Endangered Iberian Lynx

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Introduction

The Iberian lynx (*Lynx pardinus*) was declared critically endangered by the International Union for the Conservation of Nature (IUCN) in 2002, and the species is a flagship for conservation in Iberia. Palomares et al. (2011) conducted an assessment of Iberian lynx conservation efforts and predicted imminent extinction due to poor management. These authors based their inferences on information collected before the most substantial conservation programs began and extrapolated data from a nonrepresentative segment of the smaller of 2 remaining populations to model extinction probabilities for the species. The authors did not use available data from the first 9 years of an ongoing 14-year spatially extensive conservation and monitoring LIFE project (European Union funded projects for environmental and nature conservation) for the Iberian lynx. Thus, they overlooked substantial increases in lynx abundance, number of populations, and distribution over the past 5 years. Here, we provide an overview of ongoing conservation efforts and the current status of the Iberian lynx.

Conservation History

In the 1960s researchers realized both abundance and distribution of the Iberian lynx had decreased dramatically since the early 20th century (Valverde 1963; Delibes 1979). However, conservation plans were not implemented until 1980. Many early conservation efforts were ineffective (Palomares et al. 2011), most likely due to insufficient funding. In 1994 the European Union and several Spanish and Portuguese government agencies committed €1,306,021 to Iberian lynx conservation (Table 1). During the 1990s widespread presence–absence surveys showed that most populations were extirpated (Gil-Sánchez & McCain 2011), and little research attention was dedicated to the species outside Doñana National Park (DNP) in southern Spain. After the species' critically endangered status was recognized by Guzmán et al. (2004), intensive monitoring and habitat and prey (rabbit [*Oryctolagus cuniculus*]) restoration programs began. Most resources (63%) have been invested in Andalusia (€59,016,062) (Table 1), where the only 2 remaining populations of the species (Sierra Morena and Doñana) (Fig. 1) were identified in 2002.

Palomares et al. (2011) criticized management plans for lacking continuity and being applied over too small an area. However, the European Union recently funded the third consecutive 5-year LIFE project for the conservation of Iberian lynx in Andalusia (ILLP) (14 years, 2002–2016). The ILLP consists of accumulated conservation actions (actions focused on increasing carrying capacity and decreasing threats), evaluations of the effectiveness of these actions, monitoring of rabbit and lynx populations by the same multidisciplinary team, and protection of 180,000 ha of habitat that encompasses 98% of the currently occupied range of both remaining populations (Simón et al. 2009). The Iberian Lynx Conservation Project in Lugar Nuevo has conducted similar work since 2002 in the remaining 2% (3243 ha) of the species' currently occupied

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Table 1. LIFE projects focused on the conservation of the Iberian lynx in the Iberian Peninsula.

Project	*Start year*	*End year*	*Budget (€)*	*Action region*	*Search for lynx*	*Habitat management*	*Lynx monitoring*	*Reintroduction-area evaluation*
Conservation of the Iberian lynx	1994	1996	117,021	Portugal	X			
Lince/Castilla León—Conservation of the Iberian lynx—Castilla y Léon	1994	1998	112,000	Castilla y León (Spain)	X			
Conservation of the Iberian lynx (Comunidad de Madrid)	1994	1998	90,000	Madrid (Spain)	X			
Conservation of the Iberian lynx	1994	1998	72,000	Madrid (Spain)	X			
Conservation of the Iberian lynx	1994	1998	36,000	Madrid (Spain)	X			
Conservation of the Iberian lynx (Andalusia)	1994	1998	444,000	Andalucía (Spain)	X			
Conservation of the Iberian lynx (Castilla la Mancha)	1994	1998	306,000	Castilla-La Mancha (Spain)	X			
Conservation of the Iberian lynx (Extremadura)	1994	1998	129,000	Extremadura (Spain)	X			
Conservation of the Iberian lynx (Extremadura)	1995	1998	159,000	Extremadura (Spain)	X			
Conservation of the Iberian lynx (Castilla la Mancha)	1995	1998	382,000	Castilla-La Mancha (Spain)	X			
Conservation of the Iberian lynx (Castilla y Leon)	1995	1998	139,000	Castilla-León (Spain)	X			
Conservation of the Iberian lynx (Andalusia)	1995	1998	550,000	Andalusia (Spain)	X			
Conservation of the Iberian lynx (Madrid)	1995	1998	46,000	Madrid (Spain)	X			
Conservation of the Iberian lynx	1995	1998	91,000	Madrid (Spain)	X			
Conservation of the Iberian lynx	1995	1998	111,000	Madrid (Spain)	X			
Conservation of the Iberian lynx	1999	2001	404,185	Portugal	X			
Conservation of the Imperial Eagle, Black Vulture, Black Stork, and Iberian lynx	1999	2002	1,709,278	Castilla-La Mancha and Extremadura (Spain)	X			
Conservation of lynx pardina in Extremadura	1998	2003	1,377,197	Extremadura (Spain)	X			
Land acquisition of strategic areas in Doñana district	1999	2003	1,258,859	Andalusia (Spain)		X		
Conservation of the threatened fauna and vegetation in the Cabañeros National Park	1999	2003	6,490,930	Castilla-La Mancha (Spain)	X	X		
Population recovery of Iberian lynx in Andalusia	2002	2006	9,285,714	Andalusia (Spain)	X	X	X	X

continued

Table 1 (continued)

Project	*Start year*	*End year*	*Budget (€)*	*Action region*	*Search for lynx*	*Habitat management*	*Lynx monitoring*	*Reintroduction-area evaluation*
Conservation of the Iberian lynx in Montes de Toledo-Guadalmena	2002	2006	1,537,284	Castilla-La Mancha (Spain)	X	X		
Conservation of the Iberian lynx	2006	2007	493,443	Portugal	X	X		
Iberian lynx conservation in Lugar Nuevo*	2002	2011	5,000,000	Andalusia (Spain)		X	X	
Conservation and reintroduction of the Iberian lynx in Andalusia	2006	2011	25,971,489	Andalusia (Spain)		X	X	X
Conservation of the Iberian lynx and the Black Vulture	2010	2012	2,640,556	Portugal		X		X
Conservation of Mediterranean priority species in Castilla-La Mancha	2007	2012	3,699,135	Castilla-La Mancha (Spain)	X	X		
Recovering Iberian lynx distribution in Spain and Portugal	2011	2016	34,015,188	Spain and Portugal		X	X	X
			Total 94,000,279					

**Not a LIFE project.*

range on land adjacent to properties managed by ILLP in Sierra Morena (Guzmán et al. 2010).

Conservation Efforts

The main threats to the persistence of the Iberian lynx are low abundance of rabbits (primary prey), increased mortality due to human activity and diseases, decreased genetic diversity, and low number of populations (Rodríguez & Delibes 1992; Guzmán et al. 2004; Godoy et al. 2009). The ILLP seeks to decrease the magnitude of these threats through use of knowledge of Iberian lynx ecology and adaptive management (Salafsky et al. 2002; Sutherland et al. 2004) and by finding common points of interest among landowners, hunters, and conservationists (Mattson et al. 2006). Approximately 80% of Iberian lynx occur on private property, most of which is managed specifically for hunting of red deer (*Cevus elaphus*), Red Partridges (*Alectoris rufa*), and rabbits. Therefore, conservation agreements with landowners are essential. They allow development of site-specific actions for increasing abundance of rabbits through both habitat improvement (constructing predator-proof rabbit-rearing enclosures, extensive underground rabbit warrens, brush piles, and water sources and clearing brush and pruning forest to increase herbaceous forage) and restocking of rabbits (from nearby agricultural lands), actions that benefit landowners (increased revenue from rabbit hunting) and lynx. The conservation agreements also facilitate land uses that preserve Mediterranean scrubland and grant project personnel access to private lands (Simón et al. 2009).

Since 2002 the ILLP has improved the quality of 158,173 ha of habitat in 46 territory recovery units (areas $\geq$500 ha in which territories of breeding-aged females are restored) and restocked approximately 55,000 wild rabbits. Currently 158 conservation agreements pertain to over 180,000 ha. Rabbit densities have significantly increased in Sierra Morena (from 1.52/ha in 2003 to 4.05/ha in 2010; paired t test: $t = -4.11$, df $= 1,32$, $p < 0.01$) and remain stable in areas of Doñana where territory recovery units have been restored (1.43/ha in 2003 and 1.77/ha in 2010; $t = 0.94$, df $= 1,227$, $p = 0.35$). Inside DNP, however, where rabbit restocking has occurred but habitat improvement of territory recovery units has been limited, rabbit densities have decreased slightly from 1.5/ha in 2003 to 0.77/ha in 2010 ($t = -1.4$, df $= 1,1026$, $p = 0.17$).

The ILLP has addressed natural and human-caused mortality of lynx. Public outreach, patrols for illegal poaching, and increased actions to increase the safety of animals crossing roads (i.e., under- and overpasses for animals, reduced speed zones, and fencing and reflective lighting designed to discourage lynx from crossing roads in dangerous areas) have greatly decreased anthropogenic lynx mortality (Simón et al. 2009). In Sierra Morena,

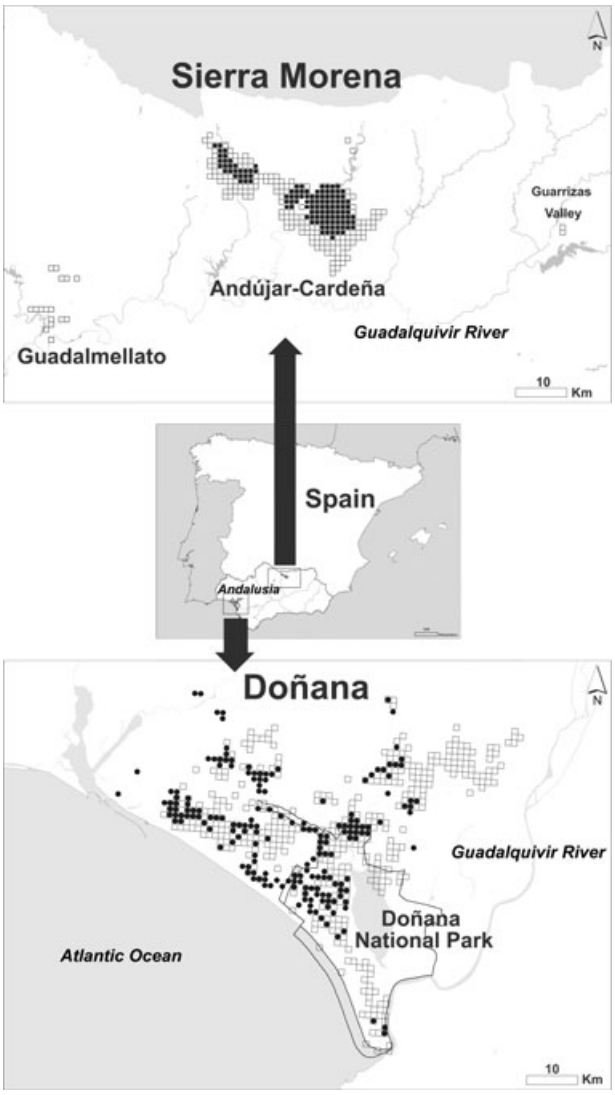

Figure 1. Distribution of Iberian lynx estimated from camera-trapping data and locations of systematic surveys for Iberian lynx scats in the 2 areas where the last 2 populations exist (150 km apart): Doñana and Sierra Morena, Andalusia, Spain (dots, occupied 1 × 1 km grid cells in 2002; open squares, occupied 1 × 1 km grid cells in 2010; open-square clusters to the east and west of the core Sierra Morena population, areas where translocated animals were released in 2010 and 2009, respectively) (data from Ministerio de Medio Ambiente and Consejería de Medio Ambiente de la Junta de Andalucía).

human-caused mortality decreased from 40% of radiocollared Iberian lynx ($n = 10$) in 1992–1995 (Rodríguez & Delibes 1995) to 7.4% ($n = 27$) in 2006–2010 (G test: $G = 32.7$, df = 1,1, $p < 0.01$). In Doñana deaths of radiocollared lynx caused by humans decreased from 58.4% ($n = 30$) in 1983–1989 (Ferreras et al. 1992) to 11.1% ($n = 27$) in 2006–2010 ($G = 53.3$, df = 1,1, $p < 0.01$). The ILLP conservation medicine program has minimized major risks from infectious diseases (López et al. 2009, 2011; Meli et al. 2009). Genetic diversity in the Doñana population was increased (Godoy et al. 2009; Palomares 2009) through the translocation of 4 individuals (3 males, 1 female selected on the basis of their ancestral lineage and reproductive, social, and health status) from Sierra Morena to Doñana (Ruiz et al. 2009*a*, 2009*b*). As a result, there are currently 8 F1 and 8 F2 crossed individuals in the Doñana population.

To decrease extirpation risk due to low numbers of populations, the reintroduction program has begun to create new populations in areas where Iberian lynx were recently extirpated. Sites for reintroduction were selected through detailed site evaluations (García & Gil-Sánchez 2008), following guidelines from the IUCN (1998). Seventeen Iberian lynx have been released in 2 portions of the former range (approximately 50 km to the east and west of the remnant Sierra Morena population) (Fig. 1). Eleven of the 12 Iberian lynx released into Guadalmellato have remained within the reintroduction area, and 4 females have raised 10 offspring. Five Iberian lynx were released in Guarrizas, 2 of which were the first captive-raised individuals released into the wild (Simón 2010). In addition, genetic samples have been preserved from >200 individuals (León-Quinto et al. 2009), and a captive-breeding program was initiated with individuals removed from the wild by ILLP (Vargas et al. 2008; Simón et al. 2009). By continuing these programs in 2011–2016, the ILLP hopes the Iberian lynx will be downlisted to the IUCN category endangered by 2016.

Monitoring

Palomares et al. (2011) suggest that managers working to conserve Iberian lynx have limited confidence in scientific knowledge and that few resources have been dedicated to monitoring the effectiveness of actions. The ILLP has a multidisciplinary team of research scientists who evaluate the effectiveness of all actions (e.g., Román et al. 2006; Simón et al. 2009; Gil-Sánchez et al. 2011). Moreover, all programs implemented through the ILLP have been reviewed by an international group of researchers and managers, and ongoing external cross-validation analyses (Gusset et al. 2010) are evaluating the effectiveness of ILLP actions. In the past, indirect methods, such as sighting reports and mailed surveys, were used to monitor Iberian lynx populations (i.e., Rodríguez & Delibes 1992); however, use of anecdotal data overestimates lynx abundance and distribution because species are misidentified and there are temporal and spatial inaccuracies (Guzmán et al. 2004; Gil-Sánchez & McCain 2011). Currently, camera-trap data collected following internationally standardized methods are used to estimate Iberian lynx abundance, distribution, home range, reproductive success, and individual body condition (Guzmán

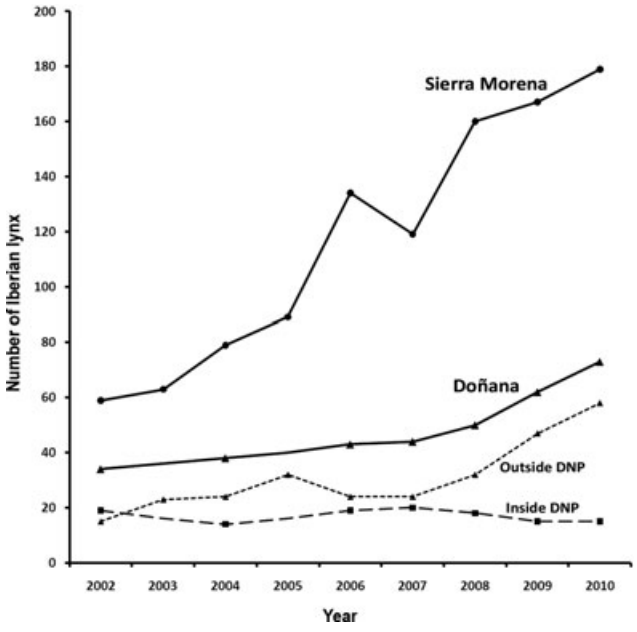

Figure 2. Minimum number of Iberian lynx in the last 2 populations in Doñana and Sierra Morena (Andalusia, Spain) photographed during camera-trap monitoring in 2002–2010 (DNP, Doñana National Park). Sampling effort in Doñana was constant among years, except in 2003 and 2005, for which information from inside DNP is lacking. Sampling effort in Sierra Morena was constant from 2004 to 2010; however, in 2002 and 2003 about 10% of the occupied area was not surveyed.

et al. 2004; Garrote et al. 2011; Gil-Sánchez et al. 2011). Rabbit populations were not adequately monitored in earlier projects, as Palomares et al. (2011) suggest; however, ILLP has developed a monitoring program that includes scientifically validated methods (e.g., indices of abundance per kilometer [Buckland et al. 2001], direct rabbit censuses [Moreno et al. 2007], and pellet and latrine counts [Ferreira et al. 2010]).

Population Trends

Between 2002 and 2010, the minimum number of camera-trapped individuals increased from 93 to 252 (Fig. 2) and the occupied area (estimated from camera-trapping data and systematic surveys for lynx scats [Gil-Sánchez et al. 2010]) increased from 29,300 to 70,300 ha (Fig. 1). The Doñana population increased from 34 to 73 individuals (Fig. 2) and the area they occupied increased from 17,400 to 44,300 ha (Fig. 1). Abundance was stable in 1980–2007, but almost doubled in 2007–2010 (Fig. 2). Lynx abundance inside DNP did not increase during this period, likely because of disease (López et al. 2009; Meli et al. 2010) and the fact that it is difficult to increase the abundance of rabbits in areas where habitat quality has not been increased (Delibes-Mateos et al. 2009). Palomares et al. (2011) stress establishing 10 breeding territories inside DNP to prevent extirpation of the Doñana population; however, this goal has been exceeded outside of the park. The increases in abundance, genetic diversity, and area occupied by the entire Doñana population currently represents the best demographic situation in the last 25 years (see Palomares et al. 1991; Ferreras 2001; Garrote et al. 2011). The larger Iberian lynx population in Sierra Morena has increased the most in terms of individuals (59–179 individuals) (Fig. 2) and area occupied (11,900–26,000 ha) (Fig. 1). Moreover, the 2 newly reintroduced populations further strengthen the Sierra Morena population because they have begun to exchange individuals and lynx are now distributed over a much larger area than in previous decades.

The current conservation status of the Iberian lynx is more positive than Palomares et al. (2011) describe. The use of incomplete (only the DNP segment of the Doñana population) and outdated (before 2005) information generated inaccurate conclusions regarding the extinction risk of the species (Palomares et al. 2011). The actual number of populations in and area occupied by Iberian lynx have increased dramatically over the last 9 years, likely as a result of diverse and comprehensive conservation efforts. Meaningful projections of extinction probability must incorporate all current data from all populations. The criticisms by Palomares et al. (2011) of resource management and the scientific knowledge of involved practitioners are personal opinions that are not supported by empirical data. The progress toward recovery of the Iberian lynx suggests that conservation efforts have been conducted in a successful manner. Furthermore, misrepresentation of efforts to conserve Iberian lynx and their population history may negatively affect public and professional perceptions and could reduce the probability of success of the conservation actions currently underway. The Iberian lynx is not free from the risk of extinction due to continued habitat loss, anthropogenic mortality, and diseases of both lynx and rabbits; however, the species' population trend has improved since comprehensive conservation programs for the 2 remaining populations were launched in 2002.

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