Using historical accounts to set conservation baselines: the case of *Lynx* species in Spain

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Abstract The knowledge of the historical range of organisms is necessary to understand distribution dynamics and their drivers as well as to set reference conditions and conservation goals. We reviewed written sources documenting the presence of lynxes in Spain between the sixteenth and nineteenth centuries, trying to infer whether *Lynx* records referred to the Iberian (*Lynx pardinus*) or the Eurasian (*Lynx lynx*) species. We compiled 151 spatially specific, non-redundant *Lynx* records, dating between 1572 and 1897. Records appeared split in two neatly separated areas, North and South. Arguably, all historical records from the South area correspond to Iberian lynx, since almost all of them fall within the estimated range of the species in the 1950s. This suggests that the core distribution area of the species remained relatively stable for centuries, until the second half of the twentieth century. The reported range in the 1950s is thus an appropriate scenario to set conservation goals for this critically endangered species. The North area extended from Galicia and northern Portugal to the Mediterranean, mainly occupying the Atlantic-climate area of northern Iberia. Reported direct measurements and the accumulation of indirect evidences suggest that most, if not all, northern *Lynx* records refer to the Eurasian lynx, which had been previously detected in archaeological sites of the area. This species was apparently present in the Iberian Peninsula until the early-nineteenth century. Our results provide an objective, baseline distribution of *Lynx* species in Spain useful to guide conservation efforts both at the Iberian and European levels.

Keywords *Lynx pardinus* · *Lynx lynx* · Historical ecology · Species declines · Human–predator conflict · Iberian Peninsula

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Introduction

Data on the distribution of organisms and its changes constitute the basis to construct ecological knowledge and guide biodiversity conservation (e.g. Margules and Pressey 2000; Boakes et al. 2010). In most regions across the world, human pressures have been a prominent force modulating the distribution of animal species during the last millennia (Redman 1999). The description of the temporal dynamics of distribution ranges is necessary not only to understand the human impacts in order to mitigate them, but also to allow the establishment of reference conditions or baselines to set conservation goals and priorities (Meine 1999; Balée 2006). As proposed by Swetnam et al. (1999), applied historical ecology should document the past to inform the management of ecosystems and their biodiversity for the future. The baseline concept can be subjected to technical and philosophical objections due, among other reasons, to the dynamic nature of ecosystems and communities, the intergenerational loss of information about species abundances (i.e. shifting baselines) and the anthropocentrism, often ethnocentrism, in the election of the pristine reference scenario (Alagona et al. 2012). In spite of this, historical information remains as an irreplaceable, often overlooked tool for conservation practice (Willis et al. 2007; Alagona et al. 2012; McClenachan et al. 2012).

Historical baselines can be established for different levels of ecological organization and using different approaches. For example, palynological records have been used to set baselines for forest communities (Valsecchi et al. 2010) and different sources of information (from paleontology to fisheries accounts) have proven useful to identify quantitative baselines for populations of large sea animals (Lotze and Worm 2009). At the species level, historical information can be used to describe changes in the distribution ranges and setting recovery goals for declining species. The description of the historical distribution ranges rely on a variety of sources, such as those based on collection specimens (Shaffer et al. 1998; Ponder et al. 2001), paleontological remains (Nogués-Bravo et al. 2008) or written accounts (Boshoff and Kerley 2010). These sources of data may present different advantages and drawbacks, which can vary both spatially and temporally (Boakes et al. 2010). The main advantage of written accounts is usually the large data availability, especially in the case of the most noticeable components of the biota (see Boshoff and Kerley 2010).

The genus *Lynx* belongs to the Felidae family and comprises four extant species, two of them (Canadian lynx, *L. canadensis*, and bobcat, *L. rufus*) occurring in North America and the other two (Eurasian lynx, *L. lynx*, and Iberian lynx, *L. pardinus*) in Eurasia (Sunquist and Sunquist 2002). The Iberian lynx is endemic to the Iberian Peninsula and is considered the most threatened felid species globally (Von Arx and Breitenmoser-Würsten 2008). In contrast, the Eurasian lynx has a vast distribution area, currently covering from Korea to France (where it has been reintroduced), and globally is a non-threatened species (Breitenmoser et al. 2008). In spite of this, European populations of the Eurasian lynx were decimated during the last centuries, reaching their minimum in the 1950s, when the species had been totally eradicated from Western Europe (Kratochvil 1968; Breitenmoser et al. 2000).

The first detailed work on the distribution of lynxes in Spain, based on interviews, collections and extensive field sampling, was made during the 1980s and included an estimation of the range of the genus in the mid-twentieth century (Rodríguez and Delibes 1990, 1992). By that time, the Iberian lynx seemed to be the only lynx species present in Spain (Cabrera 1914; Valverde 1963) and its distribution was mainly concentrated in the south-western quadrant of the country. But old accounts reported the presence of lynxes in

other areas of the Iberian Peninsula, especially in its northern temperate-climate mountain area (e.g. Nores and Vázquez 1984). The specific identity of these lynxes has been controversial for over a century (Graells 1897) and has not yet been solved. Breitenmoser et al. (2000, 2008) propose that the Eurasian lynx has never occupied the Iberian Peninsula (see also Kratochvil 1968), but suggest that it may have coexisted with the Iberian lynx in the Pyrenees. Other authors consider some lynxes of northern Iberia as Eurasian lynx (e.g. Nores and Segura 2007), a view that is supported by the existence of bone remains of the species in different archaeological sites in northern Spain (e.g. Sommer and Benecke 2006).

In this work we review the written sources reporting the presence of lynxes in Spain between the sixteenth and the nineteenth centuries, trying to identify the *Lynx* species reported in different areas of Spain. Our aim is to use these old sources and gray literature to produce a reference, baseline account of the distribution of the genus *Lynx* in Spain. We discuss the implications of the obtained results for the management of lynx species at the Iberian and European levels.

Methods

We used three main sources of *Lynx* records: (1) systematic descriptions of the Spanish territory or parts of it, including nineteenth century geographic dictionaries or the sixteenth century Felipe II's *Relaciones*; (2) Natural History works produced by scientists and naturalists, mainly during the nineteenth century; (3) published works that review original archives and other primary sources, mainly focusing on hunted animals. These records were complemented with scattered observations recorded by travelers or naturalists. An annotated complete list of data sources is reported in Appendix S1 (supplementary material). We considered a reference to *Lynx* as a record when accounts explicitly cited the presence of lynxes in a given area. Although it suggests the existence of the species, the simple notice of a bounty to be paid for the possible killing of one lynx was not used as a record.

For each *Lynx* record we collected the approximate geographical location as well as any data on the morphological or ecological characteristics of the involved animals that could aid in the identification of the species. Each record was treated as an individual report of the presence of *Lynx*, independently of the number of individuals involved in the observation. Reports from a given location with <20 years of time lapse were also considered a single record. To estimate the geographical location, we used the central point when the record referred to geographic features (e.g. mountains, mountain ranges or valleys) and the population center when citing administrative territories (municipalities or jurisdictions). When the year of the observation was not explicitly reported, we dated records according to the year of the publication of the oldest written source.

The use of written records has some shortcomings that have been highlighted by different authors (Forman and Russell 1983; Shelton and Weckerly 2007). The most important issues hampering the interpretation of written records are those related to identification accuracy and geographical precision (Boshoff and Kerley 2010). Low accuracy in the identification may result from the use of non-standardized names (Hoving et al. 2003), which sometimes refer to groups of species (Mladenoff et al. 2002), or from confusion between similar species (Shelton and Weckerly 2007). The identification of the genus *Lynx* from historical writings is straightforward, since there are a series of popular Spanish names that are univocally used for lynxes (e.g. *lobo cerval*, and its sister forms in

Catalan, *llop cerver*, or French, *loup cervier*; *gato cerval*; *gato clavo*; *lubicán*; or, more rarely, the currently standard *lince*). On fewer occasions, writings use names that correspond to other felids, mainly *tigre* (tiger), but also *onza* (ounce), *ocelote* (ocelot) or *leopardo* (leopard). Notwithstanding the high certainty in the identification of the genus, the two species that may be present in Spain are hardly ever named differently in old writings (but see below differences in the use of *lobo*, wolf, and *gato*, cat, as names for lynxes). Thus, tentative specific identification should rely on information on the physical and behavioral characteristics of the individual animals, which is not always available (see Hoving et al. 2003 for similar problems with North American *Lynx* species). Regarding the geographical precision of the records, we only compiled those records referring to areas with an approximate diameter smaller than 50 km (Boshoff and Kerley 2010), such as villages, small valleys, mountains or small mountain ranges. We avoided the analysis of imprecise spatial references (e.g. provinces or large mountain ranges).

Results and discussion

Distribution patterns

We compiled 154 pre-1900 historical *Lynx* records across Spain. Three records from nineteenth century dictionaries were deleted because they were found to be redundant, simply reproducing the information given in earlier accounts. There were thus 151 *Lynx* records with precise location. Eight sites had two records separated for more than 20 years, and one site (Oñati, Basque Country) produced three independent records. Twenty-four records corresponded to observations made in the sixteenth or seventeenth centuries, 50 belonged to the eighteenth century and 77 were from the nineteenth century. The complete list of records can be found in Appendix S2. Appendix S3 shows the location of geographical features cited throughout the text and the position of the main mountain systems in the Iberian Peninsula.

There were two main areas with *Lynx* presence in Spain prior to the twentieth century, one centered in the south-west quadrant of the country and the other occupying its northern stripe (Fig. 1). These two areas, henceforth named South and North, can be neatly separated by the 41°N parallel.

Lynx records in the South area are mainly concentrated within mountain ranges and hilly areas (see Appendix S3). The few records from lowlands correspond to the Doñana area, which today maintains one of the two remaining Iberian lynx metapopulations (Ferreras et al. 2010). The records in the South area fits surprisingly well the estimated distribution of the Iberian lynx in the mid-twentieth century (Rodríguez and Delibes 2003) (see Fig. 1). The only important areas within this distribution range where historical records are scarce or absent are central-eastern Sierra Morena and Montes de Toledo. This lack of records is remarkable, since those two areas assumedly hosted the densest and most numerous Iberian lynx populations, at least during the mid-twentieth century (Rodríguez and Delibes 1992). The distribution of records should not be equaled to the distribution of the species, since areas occupied by the Iberian lynx might have been unrecorded through written accounts, due to the species rarity or to other reasons. In the case of central-eastern Sierra Morena and Montes de Toledo (where the species was not rare), the lack of historical written accounts on lynx presence may be associated with the depopulated nature of those territories. For example, central-eastern Sierra Morena was considered a human population desert during the eighteenth century. It only began to be populated in the second

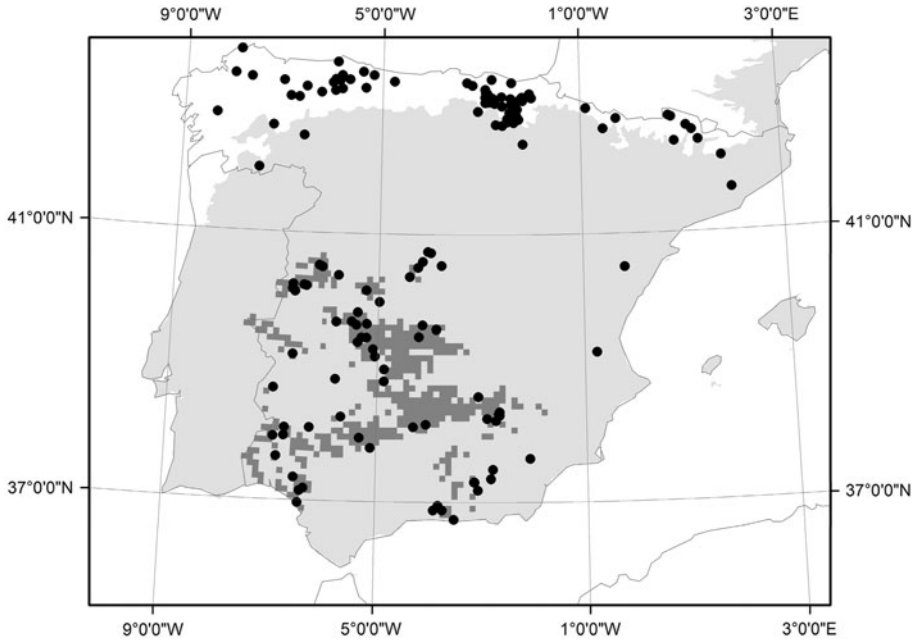

Fig. 1 Distribution of the 151 lynx records from between the sixteenth and nineteenth centuries in Spain, represented by *closed circles*. *Light grey* area represents the Mediterranean biogeographic region, while the Atlantic and Alpine biogeographic regions are pooled and represented by the white area (after European Environment Agency 2011: http://www.eea.europa.eu/data-and-maps/figures/biogeographical-regions-in-europe-1). Note that the portion of Northern Africa shown in the map is not included in this biogeographical regionalization. The *dark grey squares* represent the estimated distribution range of the Iberian lynx (*Lynx pardinus*) in Spain in 1950, based on 10 × 10 km UTM squares, after Rodríguez and Delibes (2003)

half of that century, through the development of enlightenment progressive initiatives to colonize the area which involved the creation of several new towns and the recruitment of thousands of settlers, more than 7,000 of them from Germany and France (e.g. Hauben 1965).

In the North area *Lynx* records are distributed along the Pyrenean and Cantabrian mountain ranges, expanding to the west throughout Galicia and the north of Portugal (Sarmiento 1760, quoted a letter from the governor of Chaves, near the Spanish border, asking help to kill a harmful tiger). The North area largely corresponds to the Atlantic and Alpine bioclimatic areas of the Iberian Peninsula, in which the characteristics of climate and biological communities differ from those of the spatially dominant Mediterranean-climate area (see Fig. 1). There were especially dense concentrations of records in the Basque Country and Asturias, which could be in part related to the effort searching in historical archives made by researchers from those areas (e.g. López de Guereñu 1957; Nores and Vázquez 1984; Torrente and Llaneza l 1996; Ruíz de Azua and Fernández 2005) as well as by the existence of detailed geographical accounts that preceded those from other Spanish territories (e.g. Martínez-Marina 1802).

Besides the two main areas commented above, there were a small number of isolated *Lynx* records along the Mediterranean slope. The scarcity of records suggests that lynxes were rare in the Eastern Iberian Peninsula at least during the last centuries. In agreement

with this, Graells (1897) noted that lynxes were scarce along the Spanish coast and Cabrera (1914) reported that they seemed to have disappeared from both eastern and northern Spain.

Iberian or Eurasian lynx?

Bone remains belonging to the Eurasian lynx have been identified in archaeological sites of northern Spain (e.g. Castaños 1990; Sommer and Benecke 2006) and apparently recent remains, seeming to be no more than a few 100 years old have been found in sinkholes, although they have not been accurately dated (Altuna 1980; Nores 1999). These findings have already shown that two *Lynx* species inhabited the Iberian Peninsula, probably in historical times. On the other hand, remains belonging to Iberian lynx have been also described from northern Spanish sites (e.g. Yravedra 2005). Thus, once that archaeological works have demonstrated the existence of two *Lynx* species, historical accounts may represent the most accurate source to estimate their past status and distribution range. Identifying *Lynx* species mentioned by each historical account in an unequivocal manner is not possible, but accounts often provide information on the behavior of the species or measurements of individuals that allow inferring the most probable species implied. We assumed that all records from the South area correspond to Iberian lynx, since, as explained above, records matched the known distribution of the species until the mid-twentieth century. Furthermore, there are not paleontological evidences of the presence of Eurasian lynx in central or southern Iberia. Thus, we concentrated the identification efforts on records from the North area.

There are data from three direct measurements of lynxes killed in northern Spain. Sarmiento (1760) reports a female killed in León (NW Spain) that had some 105 cm (five handspans) in length and 56 cm in height. Izaguirre (1934) reports the measurements of two lynxes killed in the Basque Country in 1762 and 1776, one of which also had 105 cm in length and weighed 23 kg, while the other, noted as "hefty", weighed 39 kg. All these measurements fit with the size and weight of the Eurasian lynx, although the last weight could be exaggerated. The heftiness of killed lynxes is occasionally reported in other accounts from northern Spain. Some authors provide general dimensions, apparently not based on the measurement of specific carcasses. For example, Martínez-Marina (1802) writes that lynxes from Asturias had the size of a medium-sized dog, with a height of some 84 cm (one Castilian yardstick), which would correspond to the Eurasian lynx, although he latter adds that lynxes are only slightly larger than foxes (*Vulpes vulpes*), which would fit more with the size of an Iberian lynx. On the other hand, López-Seoane (1861) wrote that lynxes in Galicia were between 76 and 92 cm in length, which would correspond to the size of the Iberian lynx, although the author did not explicitly say whether measures were taken directly from Galician lynxes or reproduced as secondary data with an unknown origin. Additionally, Sarmiento (1760), who recognized the existence of two species, wrote that the *lobos cervales* killed in Galicia, north-western Spain, were "more hefty and ferocious" than the *gatos clavo* (Iberian lynxes) hunted "in Andalucía, especially in the Coto de Doña Ana", referring to the area currently known as Doñana.

The interactions with livestock can be an indirect way of identifying specific records of the Eurasian lynx. Predation on livestock is very rarely reported for the Iberian lynx (Valverde 1963; Calzada 2010; but see Garrote et al. 2013) and the direct persecution of the species has been was mainly based either on its assumed negative effects on game animals (e.g. Cazurro 1894) or on the commercial value of its fur (e.g. Ferreras et al. 2010). On the other hand, the Eurasian lynx does predate on livestock (e.g. Stahl et al. 2002),

often generating conflicts with the local human interests, and is frequently characterized by popular legends as ferocious and sanguinary (e.g. Lavauden 1930; Hainard 1961; Meurger 1990). These conflicts and legends arise very often in *Lynx* records from northern Spain, as seen in the following examples from different locations along the Iberian northern fringe. Sarmiento (1760) reports a lynx that was "more ferocious and caused more devastation than wolves" and other three that made "a lot of harm on livestock and humans", all of them killed in Galicia in the eighteenth century. Torrente and Llaneza (Torrente and Llaneza l 1996) compiled *Lynx* records from Asturias, most of which described fearsome livestock predators, such as the one killed in 1751 that "with the biggest ferocity tore into pieces all kind of livestock". Fernández and Ruíz de Azua (2003) argue that historical *Lynx* references in the Basque Country correspond to the Eurasian lynx and cite the writer Vicenta Moguel, who in 1804 informed that lynx "is occasionally seen in these territories, causing great damage among sheep and cattle". In Catalonia, Maluquer (1992) reproduced a testimony from 1789 in Trivia, a Pyrenean village, stating that lynxes "do nothing but cut the throat of livestock and suck its blood". We have not recorded any equivalent story in written accounts from the South area, in spite of the high number of reports collected. Accordingly, Inskip and Zimmermann (2009), in a global review of human–felid conflicts, classified the Iberian lynx as a "No conflict" species and the Eurasian lynx as a "High conflict" species. Supporting the view of lynx as a threat for livestock in northern Spain, bounties paid to hunters for killing lynxes were high in this area (and not in the South area), in some occasions equivalent to bear killings and well higher than those paid for killing wolves (Rubio-Marcos 2004; Ruíz de Azua and Fernández 2005).

The most important 19th geographical dictionaries (Miñano 1826; Madoz 1845-50) contain information on different villages and territories collected in a systematic way across Spain. This allows other possible, indirect approaches to inform about the identity of lynxes recorded in historical accounts. For example, in the North area lynx are most often referred to as *lobo* (wolf) *cerval* (see Table 1), accounts often making a clear difference between common and *cerval* wolves (wolf and lynx, respectively). The second most frequent name given to lynxes in that area was *tigre* (tiger), while they were never called *gato* (cat). Contrastingly, in the South area *gato* (either *gato cerval* or *gato clavo*) was the most frequent lynx name, while *lobo* was quite rare and *tigre* was never mentioned. The distribution of names gives the impression that lynxes in the North area were larger, more harmful animals than those found in the South area. The use of the today's standard *lince*, a highbrow import in Spanish language, was rare in the nineteenth century, although it was most commonly used in the South area.

According to the information included in the historical geographical dictionaries, lynxes from the North area rarely coexisted with rabbit, the staple prey of the Iberian lynx (e.g. Palomares et al. 2001). Instead, they were cited in most cases together with roe deer (*Capreolus capreolus*) and hares (*Lepus* spp.), which are considered important prey of the Eurasian lynx (e.g. Odden et al. 2006) (Table 1). In clear contrast, in the South area rabbit was the most frequent potential prey cited together with lynxes, followed by red-legged partridge (*Alectoris rufa*) and red deer (*Cervus elaphus*). Thus, the composition of the potential prey communities suggests that the North area would be more suitable for the Eurasian lynx, while the South area would include more typical Iberian lynx habitats.

In summary, the sum of all the evidences, albeit none of them individually conclusive, suggests that the Eurasian lynx occupied the northern strip of the Iberian Peninsula until the beginning of the nineteenth century. This distribution is coherent with the presence of different organisms typical of temperate and boreal environments in northern Spain, including trees (e.g. sessile oak, *Quercus petrea*, or lime, *Tilia cordata*), birds (capercaille,

Table 1 Names give to lynxes (A) and potential coexisting prey (B) in North and South Spain according to the Miñano (1826) and Madoz (1845–1850) geographic dictionaries. Percentages regarding names can sum more than 100 % because lynxes can receive more than one name in any specific locality

(A) % times lynxes named as

	n	Lince (lynx)	Lobo (wolf)	Gato (cat)	Tigre (tiger)	Other
North	26	11.5	53.8	0	30.8	11.5
South	15	40.0	13.3	53.3	0	0

(B) % times lynxes coexisting with

	n	Hares	Partridge	Roe deer	Red deer	Rabbit
North	26	65.4	57.7	69.2	19.2	11.5
South	15	40.0	53.3	26.7	46.7	53.3

Tetrao urogallus, or black woodpecker, *Dryocopus martius*) and mammals (edible dormouse, *Glis glis*, or pine marten, *Martes martes*). The historical occurrence of the Iberian lynx in the same area is not clearly supported by written accounts, although its presence is probably difficult to prove from these sources. In any case, indirect evidences, such as the environmental characteristics and the composition of potential prey communities, also suggest that the Iberian lynx should have been at least very rare, if not absent, in the North area during the last centuries.

Past patterns, future goals

The review of historical *Lynx* records in Spain shows that the genus had two main distribution focuses, which were environmentally different and, at least to some degree, spatially isolated. The North and South areas followed contrasted trajectories. As said above, the South area largely corresponds to the estimated distribution of the Iberian lynx in Spain in the mid-twentieth century, while lynxes were exterminated from the North area before the twentieth century. The last written report we know corresponds to an individual killed in 1837 in Villanañe, Basque Country (Becerro *in* Ruíz de Azua and Fernández 2005).

There are Pleistocene and Holocene sites with Iberian lynx remains, at least until the Iron Age, across most of the Iberian Peninsula (e.g. Yravedra 2005) and neighboring areas of southern France (Vigne and Pascal 2003). Besides, some isolated small populations can have occupied the north and the east of Iberia until recently, as suggested both by our results and by previously published works (e.g. Valverde 1963; Rodríguez and Delibes 1990). However, observed distribution patterns imply that the core of the Iberian lynx range has been concentrated in the south-western quadrant of the Iberian Peninsula at least during the last centuries. That suggests that the main distribution area of the Iberian lynx remained relatively stable, in terms of spatial extent and location, for centuries, probably until the 1950's. The small isolated populations outside of the core range would have been be condemned to disappear the same way as those that disappeared from the south-western quadrant between 1950 and 2000 (Rodríguez and Delibes 2003).

The current extremely small distribution range of the species seems thus the result of a recent decline, occurring, or at least being especially intense, in the second half of the twentieth century (Rodríguez and Delibes 2002). Important management efforts, including in situ and ex situ measures, are currently being developed to ensure the survival of the

Iberian lynx (e.g. Simón et al. 2009). Long-term objectives of these conservation measures must include the recovery of the species original range. This work provides an objective baseline to delimit that original range, which can be roughly taken as the estimated distribution of the species in the 1950s (after Rodríguez and Delibes 1990, 2003).

The Eurasian lynx seems to have been historically widespread in northern Iberia, from Galicia and northern Portugal to the Mediterranean. However, the species was probably always rare, at least since the 1500s. Old accounts never refer to it as a common species and hunted or observed individuals were frequently described in detail (the color of their fur, the presence of spots and the ruff beneath the chin), something that would have been unnecessary for common animals. In some reports it was even signaled that nobody in the region knew the killed animal (e.g. Sarmiento 1760). It is not possible to reconstruct the decline of the Eurasian lynx in northern Spain due to the irregular availability of accounts, which are rarer and more spatially concentrated from the time when the species was arguably more widespread (sixteenth and seventeenth centuries). In any case, there are very few reliable lynx accounts from northern Spain since the first quarter of the nineteenth century. The Eurasian lynx probably became extinct latter, at the beginning of the twentieth century, both in the French Pyrenees (although there are isolated reports of hunted animals as far as 1950s; e.g. Beaufort 1965) and in the Alps (Breitenmoser 1998). The collapse of the Eurasian lynx range in Spain occurred much earlier than that of the Iberian lynx. Direct prosecution certainly played a central role in this decline. As previously mentioned, the species was popularly depicted as a sanguinary livestock predator and bounties were paid for its killing. Reductions of wild prey populations, such as roe deer, chamois (*Rupicabra pyrenaica*) and red deer or wild boar (*Sus scrofa*) due to human pressure (see Gortázar et al. 2000) may have intensified the decline of the species. Besides, population density of the Eurasian lynx should be naturally smaller than that of the Iberian lynx, given the larger size and greater spatial requirements of the former (home range sizes of the Eurasian lynx are between 10 and 60 times larger than those of the Iberian lynx; Ferreras et al. 1997; Herfindal et al. 2005). Indeed, this made the Iberian populations of the Eurasian lynx more prone to local extinctions than those of the Iberian lynx.

The addition of northern Iberia to the previously known historical range of the Eurasian lynx in Western Europe follows the recognition that the species lived in Britain until medieval time (Hetherington et al. 2005). This means that, at a European scale, the spatial baseline to develop conservation measures for the Eurasian lynx has been considerably enlarged in the last years. In Britain, proposals to reintroduce the Eurasian lynx rapidly appeared (e.g. Hetherington 2006). The temperate-climate area in northern Iberian Peninsula probably fulfills the ecological requirements for hosting Eurasian lynxes. In the context of rural depopulation, forest masses are expanding (Navarro and Pereira 2012), favoring increases in the ranges and densities of different ungulate species, such as the roe deer (Acevedo et al. 2005). As in the Alps (see Breitenmoser 1998), current habitat conditions are probably better than they were in the time when the species was eradicated. Similar environmental and socioeconomic conditions allowed the recovery of the Eurasian lynx populations in the Alps or the Jura Mountains, following reintroduction projects (Linnell et al. 2009) (but see Schmidt-Posthaus et al. 2002 for potential problems for the long term survival of these reintroduced populations). Does this mean that plans to reintroduce the Eurasian lynx in northern Spain should be established? We think that not necessarily, at least not first and foremost. Reintroductions are lengthy and complex conservation measures, especially so in the case of large carnivores, and their implementation should be fully justified (Kramer-Schadt et al. 2005). Too often reintroductions are performed mainly with aesthetic or sociopolitical reasons, instead of responding to a

real conservation need (Pérez et al. 2012). The conservation urgency is clear in the case of the Iberian lynx and efforts must be continued there, but the Eurasian lynx is a non-threatened species that is in general expanding its range across Europe, with the exception of the critically endangered Balkan population (Breitenmoser et al. 2000). We believe that the roadmap for the recovery of the original range of the Eurasian lynx in Europe should be internationally planned, instead of being a collage of several isolated initiatives. Quick, decided actions are mandatory for species or populations at the blink of extinction. But for the Eurasian lynx there is time enough for planning, coordinating and implementing management actions with long-term, large-scale conservation targets.

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References

Acevedo P, Delibes-Mateos M, Escudero MA, Vicente J, Marco J, Gortázar C (2005) Environmental constraints in the colonization sequence of roe deer (*Capreolus capreolus* Linnaeus, 1758) across the Iberian Mountains, Spain. J Biogeogr 32:1671–1680

Alagona P, Sandlos J, Wiersma YF (2012) Past Imperfect: using historical ecology and baseline data for contemporary conservation and restoration projects. Environ Philos 9:49–70

Altuna J (1980) Hallazgo de un lince nórdico (*Lynx lynx* L. Mammalia) en la Sima de Pagolusieta, Gorbea (Vizcaya). Munibe 3/4:317–322

Balée W (2006) The research program of historical ecology. Ann Rev Athropol 35:75–98

Beaufort F (1965) Lynx des Pyrénées, *Felis* (L.) *lynx lynx*. Mammalia 29:589–601

Boakes EH, McGowan PJ, Fuller RA, Chang-qing D, Clark NE, O'Connor K, Mace GM (2010) Distorted views of biodiversity: spatial and temporal bias in species occurrence data. PLoS Biol 8:e1000385

Boshoff AF, Kerley GIH (2010) Historical mammal distribution data: How reliable are written records? S Afr J Sci 106(1/2):1–8

Breitenmoser U (1998) Large predators in the Alps: the fall and rise of man's competitors. Biol Conserv 83:279–289

Breitenmoser U, Breitenmoser-Würsten C, Okarma H, Kaphegyi T, Kaphegyi-Wallmann U, Müller UM (2000) The action plan for the conservation of the Eurasian Lynx (*Lynx lynx*) in Europe. Nature and Environmental Series No. 112. Council of Europe Publishing, Strasbourg

Breitenmoser U, Mallon DP, von Arx M, Breitenmoser-Wursten C (2008) *Lynx lynx*. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.2. http://www.iucnredlist.org. Accessed 6 Nov 2012

Cabrera A (1914) Fauna Ibérica: mamíferos. Junta para la Ampliación de Estudios e Investigaciones Científicas, Madrid

Calzada J (2010) El lince ibérico en el Ordenamiento Jurídico. De alimaña a exterminar a especie protegida. In: Calzada J, Mora Ruiz M, Giles Carnero R, Márquez Ruiz C (eds) Lince ibérico: aspectos jurídicos para la conservación de la especie. SECEM, Málaga, pp 21–48

Castaños PM (1990) Los carnívoros de los yacimientos prehistóricos vascos. Munibe 42:253–258

Cazurro M (1894) Fauna matritense. Mamíferos. Actas Soc Esp Hist Nat 23:188–226

Fernández JM, Ruíz de Azua N (2003). Mastofauna. In: Fernández JM (coord). Estudio faunístico del Parque Natural de Gorbeia. Diputación Foral de Álava, Vitoria, pp 283–356

Ferreras P, Beltrán JF, Aldama JJ, Delibes M (1997) Spatial organization and land tenure system of the endangered Iberian lynx (*Lynx pardinus*). J Zool 243:163–189

Ferreras P, Rodríguez A, Palomares F, Delibes M (2010) Iberian lynx: the uncertain future of a critically endangered cat. In: Macdonald DW, Loveridge AJ (eds) Biology and conservation of wild felids. Oxford University Press, Oxford, pp 511–524

Forman RT, Russell EW (1983) Evaluation of historical data in ecology. Bull Ecol Soc Am 64:5–7

Garrote G, López G, Gil-Sánchez JM, Rojas E, Ruiz M, Bueno JF, de Lillo S, Rodriguez-Siles J, Martín JM, Pérez J, García-Tardío M, Valenzuela G, Simón MA (2013) Human–felid conflict as a further handicap to the conservation of the critically endangered Iberian lynx. Eur J Wildl Res 59:287–290
Graells MP (1897) Fauna mastodológica ibérica. Mem Real Acad Cien Exact Fís Nat 17:1–806
Gortázar C, Herrero J, Villafuerte R, Marco J (2000) Historical examination of the status of large mammals in Aragon, Spain. Mammalia 64:411–422
Hainard R (1961) Mammifères sauvages d'Europe. I: Insectivores, Chéiropteres, Carnivores. Editions Delachaux & Niestlé, Neuchatel
Hauben JP (1965) The first decade of an agrarian experiment in Bourbon Spain: the 'new towns' of Sierra Morena and Andalusia, 1766–76. Agric Hist 39:34–40
Herfindal I, Linnell JDC, Odden J, Nilsen EB, Andersen R (2005) Prey density, environmental productivity, and home range size in the Eurasian lynx (*Lynx lynx*). J Zool 265:63–71
Hetherington D (2006) The lynx in Britain's past, present and future. Ecos 27:67–74
Hetherington DA, Lord TC, Jacobi RM (2005) New evidence for the occurrence of Eurasian lynx (*Lynx lynx*) in medieval Britain. J Quat Sci 21:3–8
Hoving CL, Joseph RA, Krohn WB (2003) Recent and historical distributions of Canada lynx in Maine and the Northeast. Northeast Nat 10:363–382
Inskip C, Zimmermann A (2009) Human-felid conflict: a review of patterns and priorities worldwide. Oryx 43:18–34
Izaguirre R (1934) Las Ciencias Naturales y los archivos. Katamotz: ¿Tigre? Rev Int Estud Vascos 25:707–714
Kramer-Schadt S, Revilla E, Wiegand T (2005) Lynx reintroductions in fragmented landscapes of Germany: projects with a future or misunderstood wildlife conservation? Biol Conserv 125:169–182
Kratochvil J (1968) Survey of the populations of the genus *Lynx* in Europe. Acta Sci Nat Acad Sci Bohemoslov Brno 2:5–12
Lavauden L (1930) Essai sur l'histoire naturelle du lynx. Imp. Allier, Grenoble, France
Linnell JDC, Breitenmoser U, Breitenmoser-Würsten C, Odden J, von Arx M (2009) Recovery of Eurasian lynx in Europe: what part has reintroduction played? In: Hayward M, Sommers M (eds) Reintroduction of top-order predators. Blackwell, Oxford, pp 72–91
López de Guereñu G (1957) La caza en la montaña alavesa. Munibe 9:226–262
López-Seoane V (1861) Fauna mastológica de Galicia. Imp. Miras, Santiago de Compostela, Spain
Lotze HK, Worm B (2009) Historical baselines for large marine animals. Trends Ecol Evol 24:254–262
Maluquer J (1992) Notícia de la fauna de Catalunya i d'Andorra al final del segle. XVIII. Butll Inst Catalana d'Hist Nat 60:5–20
Margules CR, Pressey RL (2000) Systematic conservation planning. Nature 405:243–253
Martínez-Marina F (1802) Diccionario geográfico-histórico de España. Imprenta Viuda de D, Joaquin Ibarra, Madrid
McClenachan L, Ferretti F, Baum JK (2012) From archives to conservation: why historical data are needed to set baselines for marine animals and ecosystems. Conserv Lett 5:349–359
Meine C (1999) It's about time: conservation biology and history. Conserv Biol 13:1–3
Meurger M (1990) Les félins exotiques dans le légendaire français. Communications 52:175–196
Mladenoff DJ, Dahir SE, Nordheim EV, Schulte LA, Guntenspergen GG (2002) Narrowing historical uncertainty: probabilistic classification of ambiguously identified tree species in historical forest survey data. Ecosystems 5:539–553
Navarro LM, Pereira HM (2012) Rewilding abandoned landscapes in Europe. Ecosystems 15:900–912
Nogués-Bravo D, Rodríguez J, Hortal J, Batra P, Araújo MB (2008) Climate change, humans, and the extinction of the woolly mammoth. PLoS Biol 6(4):e79
Nores C (1999) ¿Es el lobo cerval un lince boreal *Lynx lynx*? IV Jomadas de la Sociedad Española de Conservación y Estudio de los Mamíferos. Segovia, 5–7 Dec 1999
Nores C, Segura A (2007) Mamíferos. In: Nores C, García-Roves P (coord) Libro Rojo de la Fauna del Principado de Asturias. Consejería de Medio Ambiente, Ordenación del Territorio e Infraestrucutras. Obra Social "la Caixa". Oviedo, pp 362–468
Nores C, Vázquez VM (1984) Datos sobre la presencia del lince en Asturias desde el Siglo XVIII. Acta Biol Mont 4:361–370
Odden J, Linnell JDC, Andersen R (2006) Diet of Eurasian lynx, *Lynx lynx*, in the boreal forest of south-eastern Norway: the relative importance of livestock and hares at low roe deer density. Eur J Wildl Res 52:237–244
Palomares F, Delibes M, Revilla E, Calzada J, Fedriani JM (2001) Spatial ecology of Iberian lynx and abundance of European rabbits in southwestern Spain. Wildl Monogr 148:1–36

Pérez I, Anadón JD, Díaz M, Nicola GG, Tella JL, Giménez A (2012) What is wrong with current translocations? A review and a decision-making proposal. Front Ecol Environ 10:494–501
Ponder WF, Carter GA, Flemons P, Chapman RR (2001) Evaluation of museum collection data for use in biodiversity assessment. Conserv Biol 15:648–657
Redman CL (1999) Human impact on ancient environments. University of Arizona Press, Tucson
Rodríguez A, Delibes M (1990) El lince ibérico en España. Distribución y problemas de conservación. Instituto Nacional para la Conservación de la Naturaleza, Madrid
Rodríguez A, Delibes M (1992) Current range and status of the Iberian lynx *Felis pardina*, Temminck 1824 in Spain. Biol Conserv 61:189–196
Rodríguez A, Delibes M (2002) Internal structure and patterns of contraction in the geographic range of the Iberian lynx. Ecography 25:314–328
Rodríguez A, Delibes M (2003) Population fragmentation and extinction in the Iberian lynx. Biol Conserv 109:321–331
Rubio-Marcos E (2004) Pasiegos de Burgos. Los últimos trashumantes. Author, Burgos
Ruíz de Azua N, Fernández JM (2005) Presencia histórica del lince o "tigre" en el País Vasco. Avnia 10:82–95
Sarmiento M (1760) Discurso sobre un animal feroz y desconocido que a la vista del Monasterio benedictino de San Pedro de Montes, en El Bierzo, se vió, se mató, se cogió y se desolló; y cuya piel se conserva hoy en el Monasterio. Copy of the unpublished manuscript preserved at the Fundación Universitaria Española, Madrid (edited by José Santos Puerto, 2010–2011, Revista de Estudios Bercianos 25–26: 27–54)
Schmidt-Posthaus H, Breitenmoser-Würsten C, Posthaus H, Bacciarini LN, Breitenmoser U (2002) Causes of mortality in reintroduced Eurasian lynx in Switzerland. J Wildl Dis 38:84–92
Shaffer HB, Fisher RN, Davidson C (1998) The role of natural history collections in documenting species declines. Trends Ecol Evol 13:27–30
Shelton SL, Weckerly FW (2007) Inconsistencies in historical geographic range maps: the gray wolf as an example. Calif Fish Game 93:224–227
Simón MA, Cadenas R, Gil-Sánchez JM, López-Parra M, García J, Fernández L et al (2009) Conservation of free-ranging Iberian lynx (*Lynx pardinus*) populations in Andalusia. In: Vargas A, Breitenmoser-Wursten C, Breintemoser U (eds) Iberian lynx ex situ conservation: an interdisciplinary approach. IUCN/SSC, Cat Specialist Group. Fundación Biodiversidad, Madrid, pp 43–49
Sommer RS, Benecke N (2006) Late Pleistocene and Holocene development of the felid fauna (Felidae) of Europe: a review. J Zool 269:7–19
Stahl P, Vandel JM, Ruette S, Coat L, Coat Y, Balestra L (2002) Factors affecting lynx predation on sheep in the French Jura. J Appl Ecol 39:204–216
Sunquist M, Sunquist F (2002) Wild cats of the world. The University of Chicago Press, Chicago
Swetnam TW, Allen CD, Betancourt JL (1999) Applied historical ecology: using the past to manage for the future. Ecol Appl 94:1189–1206
Torrente JP, Llaneza L (1996). Sobre'l llobu cerval y la so presencia n'Asturies. Asturies 2:81–86
Valsecchi V, Carraro D, Conedera M, Tinner W (2010) Late Holocene vegetation and land-use dynamics in the Southern Alps (Switzerland) as a basis for nature protection and forest management. The Holocene 20:483–495
Valverde JA (1963) Información sobre el lince español. Servicio Nacional de Pesca Fluvial y Caza, Madrid
Vigne JD, Pascal M (2003) Le Lynx pardelle : *Lynx pardinus* (Temminck, 1827). In: Pascal M, Lorvelec O, Vigne JD, Keith P, Clergeau P (coords) Évolution holocène de la faune de Vertébrés de France: invasions et disparitions. Institut National de la Recherche Agronomique, Centre National de la Recherche Scientifique, Muséum National d'Histoire Naturelle, Paris, pp 87–88. http://inpn.mnhn.fr/espece/cd_nom/60619/tab/fiche. Accessed 1 Nov 2012
Von Arx M, Breitenmoser-Würsten C (2008) *Lynx pardinus*. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.2. http://www.iucnredlist.org. Accessed 6 Nov 2012
Willis KJ, Araújo MB, Bennett KD, Figueroa-Rangel B, Froyd CA, Meyers N (2007) How can a knowledge of the past help to conserve the future? Biodiversity conservation strategies and the relevance of long-term ecological studies. Philos Trans R Soc B 362:175–186
Yravedra J (2005) Aprovechamiento cárnico de lince (*Lynx pardina*) durante el Pleistoceno Superior en el interior de la Península Ibérica. Munibe 57:303–311