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SHORT COMMUNICATION

Human–felid conflict as a further handicap to the conservation of the critically endangered Iberian lynx

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Abstract Most studies on felid depredation of livestock have focused on big cats, and little attention has been paid to this type of conflict in smaller species. The medium-sized Iberian lynx (*Lynx pardinus*) is not thought to be affected by conflict with humans. However, parallel to an increase in the range of the Iberian lynx in Andújar-Cardeña, an increased incidence of Iberian lynx attacks on livestock has been recorded. A 6-year overview of Iberian lynx predation on livestock in this population shows a total of 40 attacks involving 716 kills (31 attacks on poultry and nine on sheep). Although the majority of these attacks (78 %) were carried out against poultry, sheep depredation resulted in higher economic losses, mainly in extensive flocks (4.6 times more than semi-intensive flocks). An effective compensation program has been implemented in order to mitigate the consequences of the human–lynx conflict in this area. Given that this sort of conflict could become an acute impediment to future conservation of the most endangered felid, managers should anticipate and prevent the potential conflicts that could arise as Iberian lynx colonizes more developed areas.

Keywords Human–felid conflict · Iberian lynx · *Lynx pardinus* · Livestock predation · Carnivores

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Introduction

Human–carnivore conflicts that lead to direct persecution causing increased mortality and the risk of extinction (Woodroffe and Ginsberg 1998) are one of the best-known stumbling blocks in the conservation of certain carnivore species (Treves and Karanth 2003). Wild felids are no exception since many readily kill livestock when opportunities arise, thereby provoking reprisals from the people most affected (Polisar et al. 2003; Andrén et al. 2006; Garrote 2012). For instance, anthropogenic action as a response to livestock attacks has been found to be the prime cause of mortality in some felid populations of species such as cheetah (*Acynonix jubatus*) (Marker et al. 2003), snow leopard (*Panthera uncia*) (Oli et al. 1994), and tiger (*Panthera tigris*) (Miquelle et al. 2005).

The majority of studies on felid attacks on livestock have focused on big cats and little attention has been paid to this type of conflict in smaller species (see Löe and Röskaft 2004; Loveridge et al. 2010). The small-to-medium-sized cats of the genus *Lynx* are not thought, generally, to enter into conflict with humans (Inskip and Zimmerman 2009), probably because it is known that they prefer to prey on lagomorphs (Sunquist and Sunquist 2002). However, in some Eurasian lynx (*Lynx lynx*) populations, human–felid conflict has been shown to be important (Odden et al. 2006). The smaller and critically endangered Iberian lynx (*Lynx pardinus*) is likewise not thought to be affected by conflict with humans (Inskip and Zimmerman 2009). This species is the most endangered felid species in the world (IUCN 2011), and less than a decade ago (Guzmán et al. 2004), its populations had reached a new low (160 individuals in two isolated populations). Huge efforts are currently being made to aid its recovery (Simón et al. 2012). The lack of information about potential attacks of Iberian lynx on livestock has generated the assumption that these attacks do not

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take place. However, as a result of the close monitoring of the Iberian lynx population carried out by the Iberian Lynx Life Project (ILLP) (see Simón et al. 2012), an increased incidence of Iberian lynx attacks on livestock has been recorded. These attacks are generating greater hostility to the Iberian lynx among the local population, which could threaten its survival. Consequently, a prevention and compensation program was implemented to compensate farmers for the livestock killed by Iberian lynx attacks. Farmers affected by these attacks on livestock contact ILLP personnel, and after verification, animals killed by lynx are replaced, and farm fences are fixed to prevent lynx from entering, when possible.

A better understanding of this conflict is essential if we are to find solutions that can be implemented as part of Iberian lynx conservation programs. In this study, we provide a 6-year overview of Iberian lynx predation on livestock in Andújar-Cardeña population and its consequences for the conservation of this threatened species.

Methods

The study area (2,600 km^2) is located in the eastern Sierra Morena (Southeast Spain), harboring the Andújar-Cardeña Iberian lynx population. It is a hilly area covered by well-preserved Mediterranean forests and scrubland. Large game reserves are the main land use. The eastern area is a developed area known as Viñas de Peñallana, with many small dwellings in 1–50 ha plots with small poultry coops housing up to 50 chickens. During the study period, six sheep flocks were present in the area with different management: (1) two flocks of 43 and 300 sheep that spent nights in a fold and were surveyed by a shepherd with dogs during daytime (semi-intensive) and (2) four flocks of 104, 320, 500, and 500 sheep grazing free over a large tract (extensive).

Between July 2006 and March 2012, we recorded and verified all reported attacks by Iberian lynx on livestock from the Andújar-Cardeña Iberian lynx population. The verification consists of a visit by an ILLP member who registers the date, the number of kills, the species preyed upon, and the preventive measures that are necessary to prevent future attacks. Only attacks that could be unambiguously attributed to Iberian lynx (identification by footprints, scats, photographs, radio tracking, or by the distinctive marks left on uneaten animals) are considered to be verified. Predated coops had 20–200 m perimeter and were 1.5 m high. When possible, the improvements on the coops were performed by covering all opened areas with mesh. When coops were too large for this modification, a mesh projection of 50 cm was added to the coop perimeter.

Results

A total of 40 attacks involving 716 kills were recorded during the study period: 31 attacks on poultry (chickens, turkeys, and doves) and nine on sheep. The average number of birds killed in each attack was 20.7 individuals (n=31 attacks; 1–50 individuals; standard error (SE) 13.88). In all, 61 % of attacks on poultry (n=19) occurred between April and July (Fig. 1); no attacks on poultry were recorded in January or February. A total of 64.5 % (n=20) of attacks on poultry occurred in Viñas de Peñallana, the rest (n=11) occurring in coops in private hunting estates. Total economic losses due to attacks on poultry were 3,985 €; the mean loss (±SE) was 128.5±103.1 €, and the maximum losses per attack were 525 €. A total of 22 coops were modified: eight completely closed and 14 with a mesh projection. Out of the eight enclosed coops, two suffered new attacks before modifications were completed. After modifications were completed, no attacks occurred. Two coops repaired with mesh projection were attacked again due to structural damage, and one because owners had removed chickens from the coop. Total economic cost due to coops modification was 7,376 €, and the mean loss (±SE) was 461±182.1 €.

During the study period, a total of seven different Iberian lynx (four adult males, two subadult males, and one subadult female) were identified attacking coops. These individuals could be identified by means of radio tracking, photo trapping, or direct observation inside the coops. One radio-tagged individual was detected entering coops on six occasions.

Attacks on sheep were usually multiple predation events on the same flock in successive days; nevertheless, each multiple event was considered as just a single attack. All predated ungulates were lambs of less than 1 month of age, and all attacks occurred between December and June (Fig. 1). The average number of lambs killed in each attack was 8.11 individuals (n=9 attacks; 2–18 individuals; SE

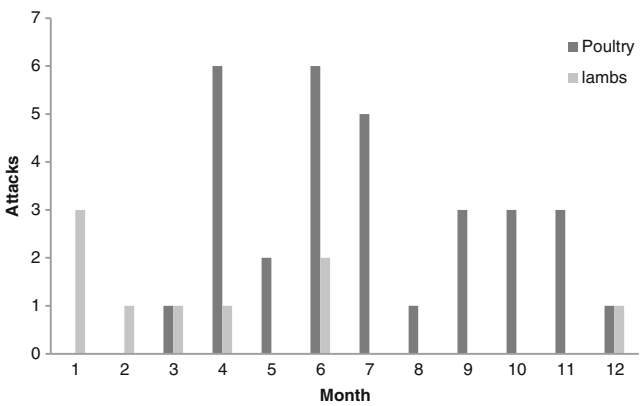

Fig. 1 Distribution of attacks (poultry and lambs) in months (January 1 to December 12)

5.64). A total of 18 % of the lambs killed (n=13) took place in semi-intensive flocks (n=4 attacks), whereas the other 82 % (n=60) were produced in extensive ones (n=5 attacks). Total economic losses due to lamb depredation were 4,380 € (60 €/lamb): 780 € in semi-intensive flocks and 3,600 € in extensive flocks. The mean loss (±SE) was 195±157 € per attack in semi-intensive flocks and 720±360 € in extensive flocks. The maximum losses per attack were 360 and 1,080 €, respectively.

Discussion

This is the first study reporting Iberian lynx attacks on livestock. The historical lack of information regarding Iberian lynx predation on livestock is most likely attributable to the fact that for decades, most studies on Iberian lynx ecology have been historically conducted inside Doñana National Park, where negligible amounts of livestock are available as prey. However, long-term Iberian lynx conservation projects have been developed over the last decade over the species' entire distribution range, thus allowing identification of areas where attacks on livestock have occurred. Moreover, the range of the Iberian lynx in Andújar-Cardeña has increased from 11,900 ha and 59 individuals in 2002 to 26,000 ha and 179 individuals in 2010 (Simón et al. 2012). Under this expansive scenario, the lynx has occupied a developed area (about 10 % of the occupied territory) where there is a high abundance of unprotected livestock, facilitating the attacks that provoke human–felid conflict (Kolowski and Holekamp 2006).

Although the majority of the attacks (78 %) were against poultry, total economic losses and losses per attack were higher in lamb depredation. Nonetheless, all known Iberian lynx killed as a response to attacks on livestock have been provoked by owners of depredated coops; two cases were identified by the ILLP radio-tracking program in Sierra Morena. The compensation program started in 2006 to offset the damage caused by the Iberian lynx. No further poaching cases associated with the conflict between humans and lynx have been detected since 2008, despite the fact that between 43 and 50 % of the lynx population inhabiting semi-humanized areas is being tracked by the radio-monitoring program since that year. Interestingly, we have released three individuals trapped in five different coops during the last year (thanks to the collaboration of the owners). Compensating losses is a necessary and effective measure in a short-term perspective; nevertheless, in a long-term perspective, the best strategy would be to pay for preventive measures due its effectiveness and relative low cost. After compensating losses and repairing coops, the conflict usually disappears.

Although our data do not allow definitive conclusions, they suggest that males, irrespective of their age, are more prone to attack coops than females. Similarly, the record of a single individual committing six attacks could underscore the theory of the "problem animal" (Linnell et al. 1999) that some particular animals are more prone to prey on livestock. Regardless, more research is needed in order to make solid conclusions.

Iberian lynx depredation over domestic ungulates is similar to that reported in big cats in (1) the selection of young domestic ungulates (Michalski et al. 2006), (2) the seasonality of attacks during the lambing season (Palmeira et al. 2008), and (3) the higher incidence of attacks in extensive and non-surveyed flocks with low control level (Thirgood et al. 2005). During our study period, the first detected attack on extensive sheep flocks took place in 2011 due to, prior to that, the distribution of the Iberian lynx in Andújar-Cardeña did not coincide with extensive sheep flocks focused on reproduction (to produce lambs for human consumption). We consider that loss compensation is a good measure to avoid human–felid conflict in the case of depredation on semi-intensive flocks (Linnell et al. 2012) because the cost is reasonable (few lambs lost, with sufficient compensation for the owners). In depredation on extensive flocks, however, economic losses are high, and compensation usually does not offset the loss for the affected owners. Thus, it is necessary to find a solution to minimize attacks on extensive flocks. As a preventive measure, the effectiveness of the installation of electric fences aimed at preventing Iberian lynx incursions will be tested. Similar experiments to prevent attacks by predators have been performed with varying degrees of success (Linhart et al. 1992; Silveira et al. 2008). An additional goal of these preventative measures is to encourage a change in the management of flocks, which would inherently reduce the vulnerability of sheep to future attacks.

The problem of predation on lambs cannot be considered as very serious in the Andújar-Cardeña Iberian lynx population, since just two extensive flocks with lambs occur in the area, and the economic cost of the damage is not high. Similarly, in the Guadalmellato Iberian lynx reintroduced population (Córdoba; see Simón et al. 2012), attacks on sheep have already been recorded despite the scarcity of flocks. However, there are potential reintroduction areas where the presence of extensive flocks is common. For instance, at least 15 extensive flocks are present in the Guarrizas (Jaen) reintroduction area.

The hostility of the local human population could have serious negative effects on the future of conservation of this species. In the current scenario of an expanding population, conservation managers should anticipate the potential conflicts that could arise as lynx colonize more humanized areas through the implementation of preventative measures such

as the improvement of coops and folds for livestock susceptible to attacks and the promotion of more intensive management of extensive flocks. Therefore, in light of the results we present here, we suggest that (1) provisions for compensation, which are generally lacking at present (ICNB 2008; MARM 2008), should be included in all future Iberian lynx conservation plans; (2) a compensation and prevention program should be included in Spanish and Portuguese conservation laws to ensure that there will be sufficient funding to solve this problem if and when it reappears; and (3) the potential conflicts from lynx depredation on livestock should be considered when assessing the suitability of new areas for Iberian lynx reintroduction.

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