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Short Note

Range and status of the Italian hare *Lepus corsicanus* in Corsica

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Abstract

The Italian hare *Lepus corsicanus* is a species which was introduced into the island of Corsica. It is interesting to note the current extent of the population on this island compared to its vulnerable status in mainland Italy. In order to draw up the first distribution maps of *L. corsicanus* in Corsica, we collected all the observations of the species between 2002 and 2012 based on molecular or phenotypic criteria. The distribution of Italian hare covers three distinct parts on the island, for a total surface area of close to 2900 km², 97% of which is situated in a single region, namely Haute-Corse. In Corsica's main range, the species appears to demonstrate a population increase. In the other two parts of the island (Cap Corse and Sagone) the status of the species has proven to be much more precarious, the small population size or the hybridization with *L. granatensis* and *L. europaeus* being major threats to the species. This assessment shows the necessity to implement appropriate strategies to improve the conservation of *L. corsicanus* on the island.

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The natural range of *Lepus corsicanus*, also known as the Italian or Apennine hare, is the Italian peninsula and Sicily (Pierpaoli et al., 1999). In Corsica, a French island situated 83 km to the West of the Italian coasts, the most likely explanation of the origin of the hare is an anthropogenic one, for hunting purposes. The oldest evidence of genus *Lepus* on the island dates back to the first half of the 14th century (Vigne, 1999), but the oldest evidence of *Lepus corsicanus* to date in Corsica dates back to the 19th century (De Winton, 1898). The species was wrongly deemed extinct in Corsica in 1984 (Dubray and Roux, 1984) and then rediscovered on the island by Scalera and Angelici (2003). This species may have been introduced here, but its insular population presents an important biological heritage considering this species has experienced a strong decline in numbers in the continental part of its native range, where it is now classified as “vulnerable” in the Red List of Threatened Species of International Union for Conservation of Nature (IUCN; Angelici et al., 2008). Furthermore, this species is also of socio-cultural and economic interest in Corsica as it is a game species which is well regarded (Pietri, 2007).

Although other allochthonous hare species (*L. europaeus* and *L. granatensis*) have more recently been introduced (Pietri, 2007), *L. corsicanus* might be by far the most common species on the island, where, following sampling concluded in 2007, it was present in 86% of Corsica's “communes” (smallest administrative region in France; Pietri et al., 2011) with hares. This observation along with the discovery of a few hybrids resulting from crossbreeding of the Italian hare with the brown and Iberian hares (Pietri et al., 2011), underlined the urgent need of a management plan for this species on the island. To reach this goal, it is important to know the distribution of the species. This knowledge

can help in understanding the evolution of the species' populations. The purpose of this paper was thus to create the first reference maps of the distribution of *L. corsicanus* in Corsica, with a view to long-term monitoring.

L. corsicanus locality occurrence data was collected from 2002 to 2012. Firstly, hunting organizations were asked to donate tissue samples of hares killed during hunting, indicating the location of sites where the samples were harvested on 1:25000 maps along with other known sites where hares were present. Secondly, identification of the species with genetic or physical criteria was implemented in the sites indicated by hunters and in those discovered during other projects. The molecular analysis was based on the sequencing of portions of the nuclear gene transferrin and of the control region of the mitochondrial DNA (mtDNA; Pietri et al., 2011), which was followed by the removal of the hybrid cases from the samples used for the mapping work. In one sector, a molecular determination on samples of fresh faecal pellets also allowed us to cross-reference visual contacts by using sequencing of cytochrome b (Cyt b, Pierpaoli et al., 2007). Other identifications based on phenotype (coat, biometrics, and dentition) analysis (Trocchi and Riga, 2005) concerned other specimens, either dead or free-living. After overlapping the observations with the 1x1 km UTM grid, we eliminated the ones not confirmed through a second observation in the same cell, in order to rule out sporadic localizations. Quantum GIS 2.2.0 (Quantum GIS Development Team, 2014) was then used to produce areas of ranges and two distribution maps built in the ETRS89 coordinate reference system. The first one was created on the 10x10 km grid recommended by European Environment Agency (2008). On the second map we drawn the α -shape of occurrence (ASO) of the species. Its limits are the α -hull studied by Burgman and Fox (2003) for which we set $\alpha = 10$ km. A value of 10 will cause gaps of more than 20 km to appear as breaks in the range. We first made a Delaunay triangu-

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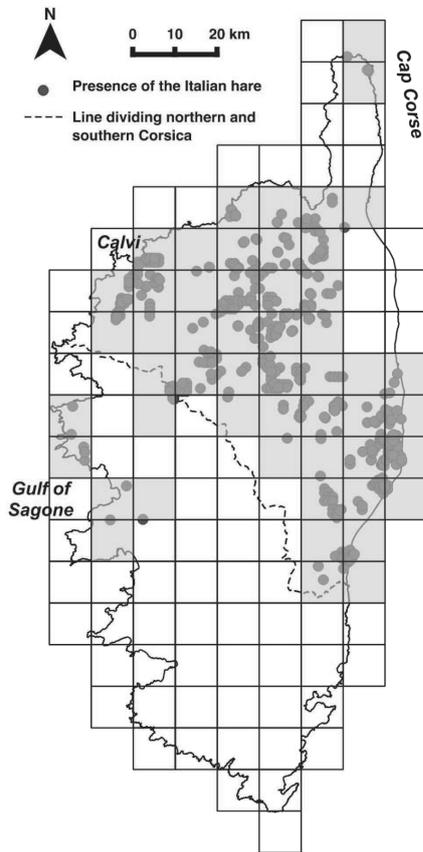


Figure 1 – Distribution of *L. corsicanus* in Corsica on the EEA grid with 10×10 km cells.

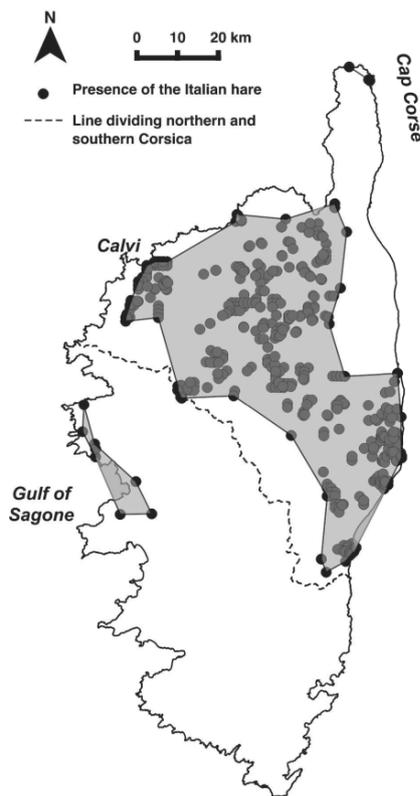


Figure 2 – α -shapes of occurrence ($\alpha=10$ km) of *L. corsicanus* in Corsica.

lation of the points with the eponymous fTools plugin in Qgis 2.2.0. We deleted all lines that were longer than 20 km and the shape including all remaining triangles was ASO.

This study recorded a total of 484 points of observation of *L. corsicanus* over the monitoring period, 474 of which fell in the Haute-Corse region. The species was present in fifty-two of the 123 squares of 100 km² covering Corsica (Fig. 1). Construction of α -shapes produced three distinct entities from the North to the South of the island (Fig. 2). The first is at the tip of the northern point of the Cap Corse and covers a surface area of 6 km². The second, and largest of the three, is spread over a major part of Haute-Corse and covers 2813 km² and the third is located in the West, close to the Golfe de Sagone, with a land surface area of 79 km² (Tab. 1). Overall these areas are located for 97% in Haute-Corse and 3% in Corse-du-Sud. The total area represents a third of Corsica.

The highly uneven spread of the insular population of *L. corsicanus* across Haute-Corse and Corse-du-Sud (Pietri et al., 2011) has been confirmed. Habitat differences between the North and the South could be the underlying cause for this assessment. However, the difference in management of hare populations between the two administrative regions might be sufficient on its own to explain the observed distribution. The Departmental Federation of Hunters of Corse-du-Sud has indeed released over 80% of the thousands of hares (*L. europaeus* and *L. granatensis*) introduced to the island over the last 30 years and the hunting season in that department is slightly longer (Pietri, 2007). The negative impact of releasing other hare species on the stability of *L. corsicanus* has also raised concern in its native range (Trocchi and Riga, 2001).

The three major groups of observations revealed by the ASO (the main range, Sagone and Cap Corse) indicate the existence of at least three populations. It is important to note that the molecular analysis of 92 specimens in the main area revealed that 85 of them belonged to the *L. corsicanus* species, the remaining being six hybrids and one brown hare close to the boundary with Corse-du-Sud. However, all 386 phenotypically identified hares, either captured or observed, were attributed to *L. corsicanus*. This main population in Corsica would occupy a total surface area of close to 2813 km² if we take its ASO land area as reference, and concerns 45 contiguous cells in the 10x10 km grid. The growing number of contacts in and around the periphery of this area, consistently throughout the study period, would bring us to postulate that *L. corsicanus* in this main range has progressed both in area and in number. In the case of the Golfe de Sagone, the cumulative identifications of *L. europaeus*, *L. granatensis* and hybrids were significantly more numerous than those of *L. corsicanus*. Each species and their hybrids did not seem to occupy distinct geographical areas, but at first sight seemed to live in sympatry over the entire zone. For the Cap Corse, the situation was very different in that the few points in which the hare was present were in a confined area and concerned solely *L. corsicanus*. In both cases, the status of the Italian hare seemed to be very precarious. In Sagone, the threat is of hybridization, compounded by the continuous restocking of brown hare, and in the North of Corsica the risk of extinction could arise, both resulting from the very small size of the population and from its isolation from the main range (over 31 km away). The species seemed to be absent from more than the southern third of the island despite the fact the species had been unequivocally identified in 2000 and 2001 in the commune of Sartene (Scalera and Angelici, 2003). Despite our search for the species in this sector, no hare other than *L. europaeus* was observed. This sector consists of a vast area subject to little human influence, where the dense vegetation and difficult access might allow a small population spread over a few square kilometres to remain undetected, similar to the populations in the North of Corsica or parts of the Italian peninsula (Trocchi and Riga, 2001). Additional investigations in this area are certainly still necessary, to check if the species has disappeared or if it is still present.

Our mapping of the Italian hare in Corsica, has conclusively enabled us to know more about the conservation status of the species on the island. At the beginning of the 21st century, this leporid exhibits a very contrasted and unusual situation, with hybridization seeming to be ex-

Table 1 – Total and land areas of the three α -shapes (with $\alpha=10$ km) covering the observations of *L. corsicanus* in Corsica (in km²).

α -shape	Total surfaces			Land surfaces		
	Haute-Corse	Corse-du-Sud	Corsica	Haute-Corse	Corse-du-Sud	Corsica
Main range	2819.3	13.5	2832.8	2799.7	13.5	2813.2
Sagone	0	114.6	114.6	0	79.5	79.5
Cap Corse	6.5	0	6.5	6.5	0	6.5

ceptional in its native range (Mengoni et al., 2015). The strong cross-breeding of hares and continued releasing of *L. europaeus* in Corse-du-Sud, means we need to think urgently about the future of the hares in this region and especially of *L. corsicanus*. Improving its situation in the two ranges located more to the North seems easier in contrast. The small population of the Cap Corse needs continued protection, as has been the case since 2012 when the administration agreed to the hunters' demand of making the hunting of the species illegal. Potential protective measures to improve the habitat and reinforce this small population through the introduction of non-hybrid individuals originating from the main range, might also diminish the risk of disappearance. The critical status of the species in two ranges in the island makes the main range much more determining for the future of the Corsican population. The present favourable situation in this main zone must therefore be sustained by applying rigorous management practices. Some of these initiatives have already been established through the development of the Departmental Game and Hunting Management Guideline of Haute-Corse (Anonymous, 2011), which has organized a bag limit of one hare per hunter per day, as well as the prohibition of releasing, holding or transporting any species other than *L. corsicanus* in this region. More ambitious measures of sustainable management will be necessary, such as the suppression of as many hybrids as possible (localized), increasing operations to improve biotopes, knowledge of actual densities and hunting bags as well as better methods to deter poachers. The biological and hunting importance of this species in Corsica should induce to promote further scientific studies which are today very limited. ☞

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