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Nomen omen. Toponyms predict recolonization and extinction patterns for large carnivores

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Abstract

The names given to places are a legacy of the past distribution of animal and plant species. The hypothesis tested in this work is that the density of toponyms can be used to predict the range of two large and charismatic species over time: the wolf and the brown bear in Italy. Kernel density maps of the toponyms were created and different thresholds of density were overlapped with the present and the historical ranges for both species. The density level maps were tested with the Kappa statistics against available historical ranges for both species. The pattern of the density in toponyms overlapped with the pattern of contraction and expansion reported in literature for both species over time. The minimum historical distributions of wolves and brown bears occurred at the highest densities of toponyms (95% isopleth value) and, overall, the various kernels thresholds showed an excellent agreement with the historical maps with an average Kappa of 0.84 ± 0.5.

Keywords

Brown bear, wolf, Italy, historical distribution, home range

Introduction

A toponym is the name given to a geographic place; it is a word of Greek origin from the combination of the terms *tòpos* "place" and *ònoma* "name". The name given to places usually reflects the usage, the most striking natural features, property or particular historical events.

Studies about the geographical distribution of toponyms are common in historical, archaeological and linguistic research (Cox et al. 2002) and have been used to reconstruct the displacement of human populations in the past, according to the fragments of the different languages that are still present in the names.

Toponyms with explicit reference to animal and plants were given according to what people used to see in their everyday life, thus names can be considered indicators of the former presence of certain species (Aybes and Yalden 1995; Boisseau and Yalden 1998; Gruezo 1999; Hough 2008). The toponyms referring to nature are labelled as phyto-toponyms, when they refer to plants, and zoo-toponyms in the case of animals. Plant common names used in toponyms depict also the usage of the species as food, medicine, fabric or for other activities (Gruezo 1999; Fagúndez and Izco 2016). Place names related to nature are not only a legacy of the former presence of species, but also provide insights about the traditional usage and interaction with the environment. According to Fagúndez and Izco (2016), toponyms are: "stable, spatially-explicit elements that may be used as indicators of bio-cultural diversity", revealing the socio-economic value given to Nature over time and therefore should be considered an important part of cultural heritage. In Europe, research about place names has been used to track recent climate changes and perceptions of those changes (Sousa and García-Murillo 2001; Sweeney et al. 2007; Sousa et al. 2010).

This study focuses on zoo-toponyms and how their occurrence can be used to infer the past distributions of wildlife. Despite the huge amount of information available in names and the importance of knowing the past distribution of the species and habitats for conservation purposes, only a limited number of studies have engaged in reconstructing bio-geographical ranges of occurrence based on toponyms. The reasons are several: the main one is that only the larger or more charismatic species have places named after them (Cox et al. 2002), meaning that only the historical presence of some mammals and birds can be inferred from toponyms. Aybes and Yalden (1995) mapped historical wolf (*Canis lupus*) and beaver (*Castor fiber*) distributions in Britain from place names only, while Poole (2015) used toponyms together with bones and other remains found at archaeological sites to infer the past presence of foxes (*Vulpes vuples*) and badgers (*Meles meles*). The latter approach was used by Boisseau and Yalden (1998) to reconstruct the crane (*Grus grus*) presence in the UK and they also demonstrated that this bird used to nest in England. The above mentioned species, in addition to being medium-large sized, do not have any similar looking animals in their range with which they could be confused. In fact, not all common names can be precisely referred to a single species. Two or more species that have a similar appearance can share the same common name: for example the word "deer" can refer to both the red deer and roe deer, as well as the word "eagle" which can identify various species of raptors (Hough 2008; Evans et al. 2012). Another issue in the use of toponyms in bio-geography is that the collaboration with a professional linguistic scholar may be necessary to extract the root of the names from different and old languages (Moore 2002). Last but not least, a distribution inferred from toponyms only can have some limits in the interpretation, if not validated with habitat availability, (Webster 2001; Evans et al. 2012), field evidence such as bones (Boisseau and Yalden 1998) or artefacts and manuscripts.

All the above cited studies produced point maps of the past presence of the species and did not apply any further spatial processing to the toponyms. On the other hand, Cox et al. (2002) calculated the density of the place names to obtain areas of distribution that were later overlapped with the historical occurrence of 21 mammals, 2 snakes and one bird. Among the literature examined, this study was the only one providing a quantitative estimation of the overlap of historical ranges with place names derived distributions. In the present work I further develop the approach of Cox et al. (2002) by using different thresholds of density probability and compare them with different historical ranges at different times.

In Italy, where this study was carried out, there are many examples of phyto and zoo-toponyms (Nocentini 2004). Some examples taken from the plant kingdom include: "Rovereto, Roverè" from the presence of oak species (*Quercus petraea* and *Q. pubescens*) *Rovere and Roverella* in Italian) and the city of Avellino named after the hazelnut tree (*Corylus avellana*). To illustrate names from the animal kingdom there is "Cervara", which means a place used for hunting deers (*Cervo* in Italian); "Pescara" and "Pescaia" are instead fishing spots, deriving from *Pesce*-fish in Italian), "L'Aquila" a city named "The Eagle". Charismatic animals, such as predators and large mammals, are more likely to have been chosen for place names and they also occur in many flags and town emblems across Italy (Rome is one such example, its symbol being a female wolf nursing the twins Romolo and Remo that later founded the city).

This study focuses on two charismatic species, the brown bear and the wolf, not mistakable for other wildlife and for which historical distributions from field data are available in the Italian Peninsula. If the places were named according to the real presence of the species, we can expect that the names occur more often where the species was present in higher numbers and/or over a longer period of time.

Under this hypothesis, the frequency of the names can be a proxy for the density, thus we can expect that wolves and bears more likely survived in those hotspots of toponyms when their population decreased due to direct persecution over past centuries (Chapron et al. 2014). Similarly, when the carnivore populations increased again due to socio-economic change and afforestation (Ciolli et al. 2012; Ferretti et al. 2018) we expect that the recoloniszation pattern would follow the toponym density.

The aims of this work are to: 1) create maps of the place names linked to the Wolf (*Canis lupus*) *-Lupo-* in Italian and to the two subspecies of Brown bear *-Orso-* that occur in Italy, the European brown bear and the Marsican brown bear (*Ursus arctos arctos* and *Ursus arctos marsicanus*), the latter is an Italian endemism; 2) compare the distributions derived from the toponyms with present and past ranges of the two mammals; 3) explore the knowledge and the perception of those carnivores.

Material and methods

A list of the dialectal names for bear and wolf in the various Italian regions were retrieved from the on-line dictionary of the Italian dialects (http://ww.dialettando.com).

Open Street Map (OSM) and the map of the Italian toponyms map (PCN) were queried with the words or pattern of letters from the previously identified list. The queries were then refined by semi-automatic selection of the relevant place names, removing obvious artefacts of the queries, such as names of restaurants or family names. The place names were later categorised in three ways: according to the features they described (such as mountains, rivers, settlements...), if any; according to gender, i.e. masculine and feminine names; and finally according to their positive or negative connotation. Toponyms were labelled as negative terms if they identified hunting places, made clear reference to injury and/or death or were pejorative declinations of the name. Reference to cubs, terms of endearment and diminutives were deemed obvious positive connotations. The simple attribution of a name to a landscape element was considered as neutral, even if it is undoubtedly a sign of emotional connection with the species. The complete list of the data used for this work is available in Table 1, which also reports some additional information about the resolution and the process that was necessary before using it. Some maps were already available in digital format suitable for the GIS environment, while others were digitised from digital images. Some sources reported only the presence of the species while others provided a more detailed description of the type of occurrence. For the sake of this study, sporadic and permanent presence were considered together.

In order to obtain a continuous distribution of the species from the points, the toponym maps were processed with a Gaussian Kernel utilization distribution for each species separately. The Gaussian Kernel is commonly used in home range studies to map the area where an animal is likely to be at any given time (Worton 1987) expressed as density distribution. In home range estimation, the input points can be the locations of a single animal taken by GPS, to estimate individual home ranges, or the locations of all marked animals, to infer the distribution of the entire population (Clapp and Beck 2015). The 'core home range' is defined at the 90% or 95% threshold of the Kernel distribution and the 'total home range extent' at the 50% (Clapp and Beck 2015). In this study toponyms coordinates were used instead of animal locations to calculate two utilization distribution maps, one for each large carnivore considered. Using toponyms instead of locations of the whole populations, I expected that the 95% isopleth value (core home range) described the strongholds where the species were more abundant and therefore persisted longer in time of human persecution. Similarly, the 50% isopleths described the range of occurrence of the species when not disturbed by human presence. Cohen's Kappa coefficient (Smeeton 1985) was used to compare the maps of different isopleths of the density of place names with the historical distributions of bear and wolf (see Table 1), taken as ground truth. The Kappa value gives an idea of the spatial agreement of the maps and it can range from -1 to 1: negative value means no concordance, 0–0.20 slight, 0.21–0.40 fair, 0.41–0.60 moderate, 0.61–0.80 good and 0.8–1 excellent concordance.

All data were processed at a resolution of 1 km in the ETRS89 coordinate reference system using GRASS GIS 7.4 (GRASS Development Team 2012) for processing and QGIS 2.18 Las Palmas (QGIS Development Team 2015) for digitalization and layout (Preatoni et al. 2012; Rocchini and Neteler 2012).

Table 1. Data used to assess the recolonisation and extinction patterns of large carnivores in Italy. LCI stands for Large Carnivore Initiative (http://www.lcie.org), PCN is the National Cartographic Portal of Italy created by Italian Ministry of the Environment (http://www.pcn.minambiente.it), OSM is Open Street Map (http://ww.osm.org) and ISTAT is the Italian National Institute of Statistics (http://datiopen.istat.it/).

Topic	Year	Type of map	Resolution	Type of information	Processing	Source
Toponyms	2011	Shapefile	250 m	Italian toponyms	Query	PCN
Toponyms	2018	Shapefile	5 m	Various type of locations	Query	OSM
Italian regions	2012	Shapefile	–	Boundaries of Italian regions	None	ISTAT
Bear	500 B.C	Image	100 km	Modelof presence	Digitalisation	Albrecht et. al 2017
Bear	1950	Shapefile	10 km	Presence of the species	None	Chapron et al. 2014
Bear	2011	Shapefile	10 km	Permanent and sporadic occurrence	None	Chapron et al. 2014
Bear	2011	Image	10 km	Permanent and sporadic occurrence	Digitalisation	LCI
Wolf	1900	Image	Not given	Presence of the species	Digitalisation	Randiet al. 2000
Wolf	1973	Image	Not given	Presence of the species	Digitalisation	Randiet al. 2000
Wolf	1985	Image	Not given	Presence of the species	Digitalisation	Randiet al. 2000
Wolf	1950	Shapefile	10 km	Presence of the species	None	Chapron et al. 2014
Wolf	2011	Shapefile	10 km	Permanent and sporadic occurrence	None	Chapron et al. 2014
Wolf	2015	Image	5 km	Permanent and sporadic occurrence	Digitalisation	Boitani et al. 2017

Results

The query of the PCN map returned about of 2700 records, of which 644 were considered meaningful for the names linked to brown bear. The same query on OSM instead yielded 623 records (valid 330) including names of places such as bars, restaurants and toy shops. The search of the words related to wolf on the PCN map returned 1636 records of which 1555 were valid, and only 423 from OSM. Due to their greater number, only the results from PCN map were further processed. Place names carrying obvious reference to those carnivores are located all across Italy, as shown in Fig. 1. The occasional toponyms in Sardinia actually described rock formations shaped like a bear or a wolf but, according to Cagnolaro et al. (1974), neither of these carnivores was ever present in this Island. To date I have not found evidence of bear/wolf-shaped formations in peninsular Italy, but as the species were present, the occasional rocks would not affect the density of the toponyms. Table 2 summarizes the results of the queries and of the classifications.

Some place names were found more than once at different places. Overall there were a total of 431 unique terms for bear and 1026 for the wolf: *Valle dell'orso* -valley of the bear- was the single commonest toponym with 18 occurrences while *Fosso del lupo* – ditch of the wolf- recurred 45 times. Most of the toponyms referred directly to natural features such as mountains, peaks, water sources or streams, but quite surprisingly, one of the most recurrent landmarks, named after both bears and wolves, was human settlements (Table 2); this category included castles, bridges, villages and isolated houses.

About the bear, the commonest place names referred to valleys, mountains and rivers but there were also 18 names mentioning caves and dens. In the case of the wolf, similarly, most frequent names referred to valleys and mountains but there were also 124 references to howling places *Cantalupo* – singing wolf-, an indication of the knowledge about the ecology and ethology of these carnivores.

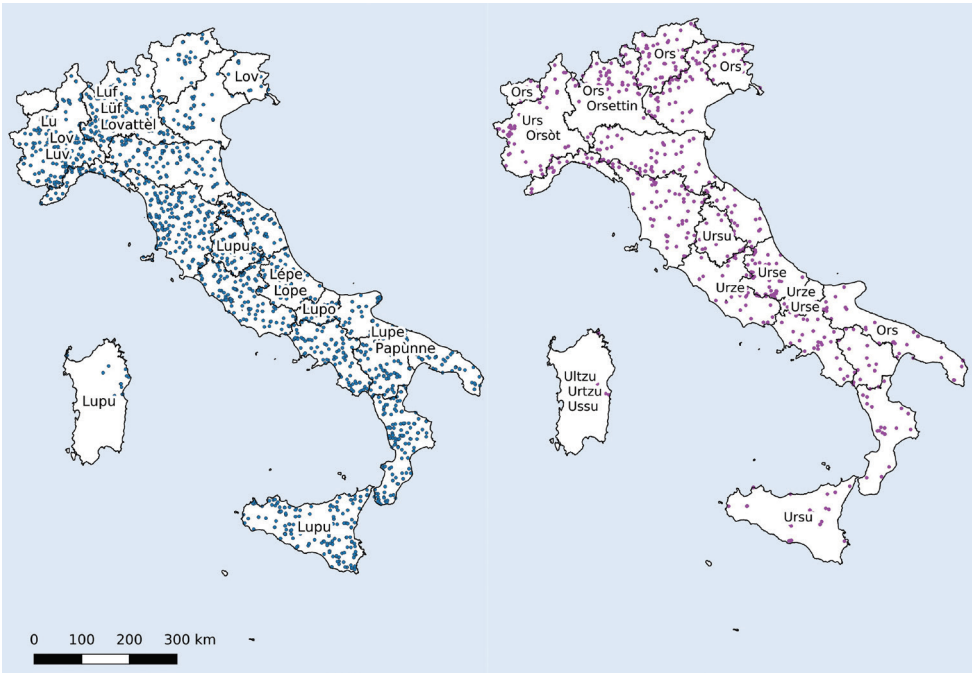

Figure 1. Locations of the toponyms referring to the wolf (left) and the bear (right); the regional dialectal names are reported only when different from the Italian *lupo* -wolf- and *orso* -bear-.

Table 2. Number and percent of the toponyms related to the bear (N=644) and the wolf (N=1555) in Italy, classified according to the type of the most recurrent features named after the species and the occurrence of female, pejorative and endearment terms.

	Bear		Wolf	
	(N)	Percent (%)	(N)	Percent (%)
Top feature	Valley (81)	17.5	Settlement (379)	17.9
Second top feature	Settlement (71)	11.0	Ditch (137)	8.8
Third top feature	Mount (62)	9.6	Valley (113)	7.3
Female names	37	5.7	104	6.7
Derogatory names	58	9.0	171	11.0
Terms of Endearment	11	1.7	7	0.5

Toponym locations were used to create two maps of density distribution, one for each species (Fig. 2): the density map for the bear name places had two big hot spots in the eastern Alps and in the Apennines, while the density of wolf names was high in various parts of the Italian peninsula. These maps were later reclassified according to the following thresholds: on top of the classic home range levels of 50%, 90% and 95%, also the standard quantiles of 25% and 75% were used. A new map was created for each level. All the density level maps were tested with the Kappa statistics against the available historical ranges for both species.

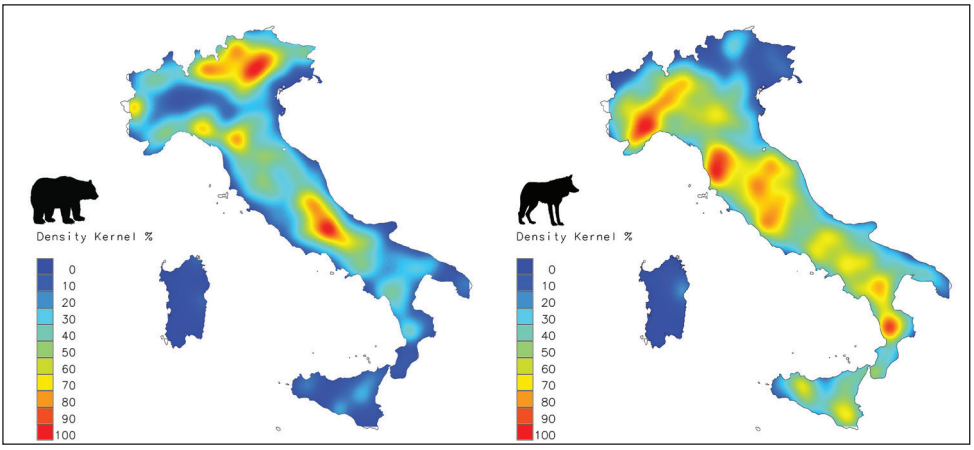

Figure 2. Density maps of the toponyms related to the brown bear (left) and to the wolf (right).

Table 3. Results of the Kappa statistics for each combination of historical ranges and thresholds of toponym density distribution. The cut off thresholds were chosen according to the HR theory and the pairing with historical distributions was decided according to the better fitting Kappa. Bear 2011 a is the distribution according to Chapron et al. (2014) and Bear 2011 b is the one from Large Carnivore Initiative. The highest level of accuracy is reported in bold. The area of the range of historical occurrence is also reported.

	Area (km²)	Kernel thresholds				
Sp. time		**25**	**50**	**75**	**90**	**95**
Bear Roman times	186039	**0.56**	0.33	0.11	0.44	0.01
Bear 1950	2600	0.62	0.79	0.94	0.97	**0.98**
Bear 2011 a	11930	0.65	0.81	0.93	0.95	**0.96**
Bear 2011 b	36238	0.67	0.84	**0.90**	0.89	0.88
Wolf 1900	109513	0.39	**0.68**	0.67	0.67	0.62
Wolf 1950	9832	0.06	0.62	0.74	0.79	**0.94**
Wolf 1973	14195	0.08	0.64	0.76	0.81	**0.93**
Wolf 1985	27418	0.12	0.65	0.75	0.79	**0.89**
Wolf 2011	72423	0.27	0.66	0.72	0.73	**0.75**
Wolf 2015	89876	0.33	0.65	**0.71**	0.69	0.69

Table 3 reports the accuracy assessment for every combination of historical distributions and thresholds of toponym density using Kappa. Range contractions, that is smaller areas, are better classified by 90 and 90 thresholds, while large ranges better overlap with lower thresholds, as expected.

The maps of Figs 3 and 4 report the best matching pairs of historical ranges and density isopleths as illustrated in Table 3.

In agreement with the initial hypothesis, place names can be considered a proxy for locations: the different levels of the density in toponyms overlapped with the pattern of contraction and expansion of both species over time, average Kappa was 0.84 ± 0.5 (ranging from 0.67 to 0.95, 0.5 Standard Error). In particular, the smallest areas of occurrences for wolf and brown bears coincided with the highest densities of toponyms related to them.

Discussion

The best source for name places, both in terms of quantity and quality, proved to be the map of toponyms provided by the National Geo Portal for Italy. Once the locations of the place names of bears and wolf were retrieved, it was possible to analyse their spatial distribution and density as well as the recurrence and meaning of the names.

Distribution

The geographical location and spread of the toponyms allowed to test the hypothesis that name places are not only a legacy of a former presence but also a proxy for the density of the species.

In order to test it, the density of toponyms was calculated as in Cox et al. (2002). In addition, we further processed the results according to the home range theory and developed two series of maps of different densities that were used to identify hot spots of presence and to make comparisons with literature ranges, see Figs 2, 3 and 4.

The maps on the left of Fig. 3 depict the ranges of occurrence of the brown bear in Italy from Roman times to the present. Once widespread in the whole peninsula, the bear population declined over time due to habitat loss and direct persecution (Mustoni et al. 2003), and now it survives only in two separate populations. The maps on the right of Fig. 3 represent the best overlapping density maps of the toponym according to the Kappa statistics (see Table 3). The density of the place names accurately predicts the location and extent of the residual populations in the 1950s: the alpine in the north and the Marsican bear in the centre. Despite the map of Roman times, distribution has been obtained from a model with a coarse resolution; the overlap with the kernel is satisfactory (0.56), while for more recent and field derived maps, the matching with the toponym is excellent with Kappa always over 0.9. Presently, both populations are slowly recovering, following the afforestation trend that started after the 1950s (Tattoni et al. 2011; Ferretti et al. 2018) and the legal protection of the species. The alpine population is increasing faster than the southern one, thanks to a European reintroduction project (Tattoni et al. 2015; Tosi et al. 2015) and to the immigration of bears from Slovenia (Preatoni and Tattoni 2006). For the year 2011, are reported two sources that have a different spatial resolution and way of accounting for permanent and occasional presence (see Chapron et al. (2014) and LCI (https://www.lcie.org/). The one by Chapron and colleagues is more conservative than the one from LCI, but the toponyms still overlapped in accordance with both at different levels.

The maps on the left of Fig. 4 show the distribution of the wolf over time according to various sources and the maps on the right show the best matching threshold of the toponym density map (see Table 3). As for the bear, the maps of the density of the toponyms accurately predict the location and extent of the wolf population that shrunk from the beginning of the last century to a minimum in the 1970s, when it became extinct in the Alps and the northern part of the peninsula. In the 1970s, only isolated populations were found in the Apennines (Randi et al. 2000). After being granted legal protection in

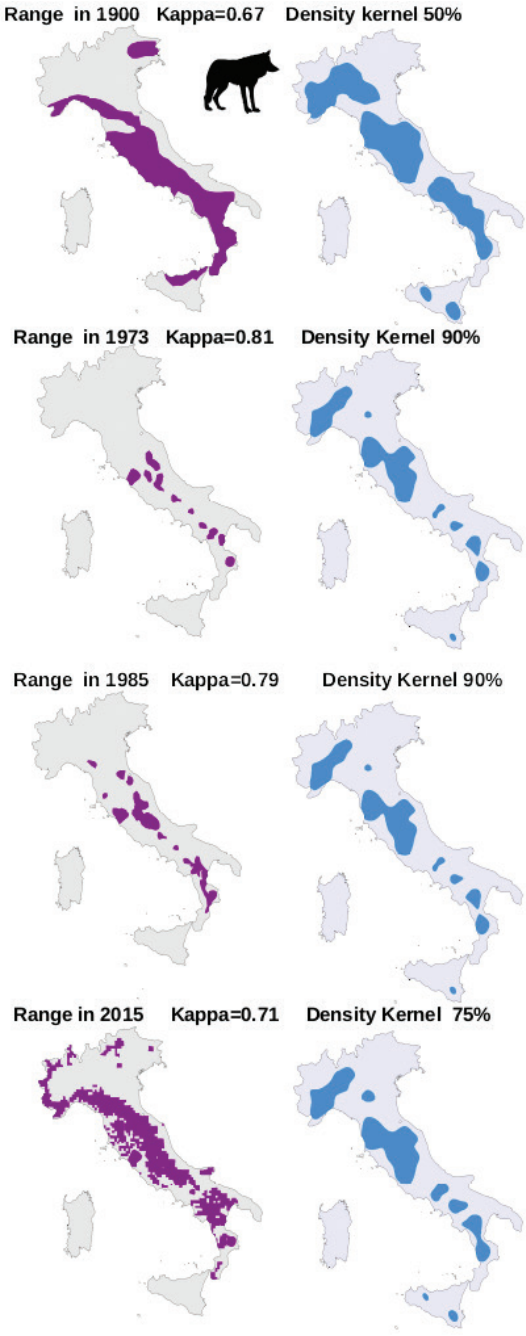

Figure 3. Historical ranges of occurrence of the brown bear in Italy (maps on the left): the Roman time distribution was redrawn from Albrecht et al. (2017), 1950 and 2011 were downloaded from Chapron et al. (2014) while the other map of 2011 was adapted from the Large Carnivore Initiative 2018 www.lcie.org. The isopleths of the best matching density kernel calculated from the toponyms are reported in the maps on the right. The thresholds of the density kernel and the Kappa parameter of spatial concordance are reported for each pair of maps.

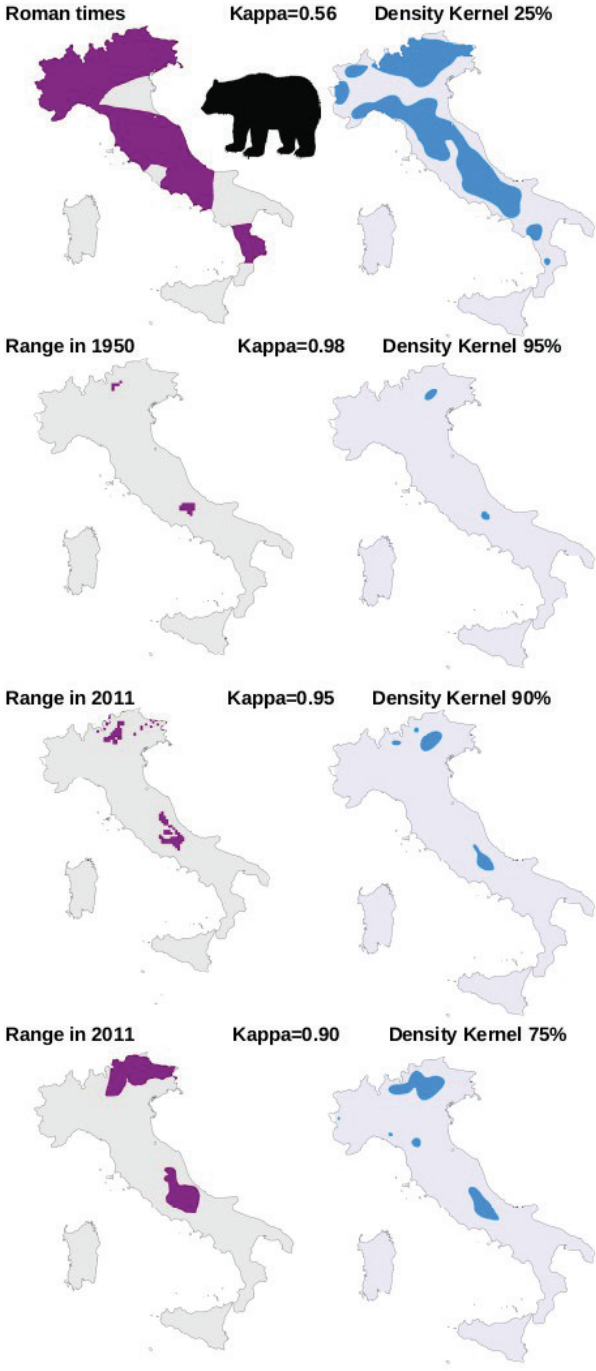

Figure 4. The maps on the left depict the historical ranges of occurrence of the wolf in Italy: the distributions in 1900, 1973 and 1985 were adapted from Randi et al. (2000) and the one in 2015 from Boitani et al. (2017). The isopleths of the best matching density kernel calculated from the toponyms are reported in the maps on the right. The thresholds of the density kernel and the Kappa parameter of overlapping are also reported for each pair of maps.

1981, the wolf population naturally recovered throughout Italy, almost to its 20th century status. The maps of 1950 are very similar to those of 1973 and they were omitted from Fig. 4. The main differences between the 1900 and the present distribution are in the western Alps, where the wolf is currently found and in Sicily, where the species is now absent but was present in the previous century instead. In the case of the wolf, the toponym derived maps and the distributions had good overlap with a 0.67 <Kappa <0.81.

The drivers for contraction and expansion of the wolf and the bear in Italy were both environmental and socio economic. What brought both species to the brink of extinction was direct persecution in addition to habitat loss. In fact, after being granted legal protection, the wolf population recovered to its 1900 status after just 40 years. For the bear, on the other hand, recovery is at a much lower pace. The ecology of the two species can explain the difference in the observed rate of recovery. The brown bear has a lower birth rate, females gave birth every second year and are mostly philopatric (Zedrosser et al. 2007) so even when surrounded by a suitable habitat the females tend to live near the home range of their mothers.

The results presented by Cox et al. (2002) reported an average 83% overlap between name place distribution for 17 species and their historical ranges, which is similar to what is found in this study, where the average Kappa is of 0.84. In the present work a higher Kappa (0.9) overlapped better in case of habitat reduction.

Perception of the species

Positive and negative connotation of place names are a legacy of the complex relationship between humans and large carnivores. Various natural features such as mountain tops, valleys and rivers have been named after these two mammals. However, some names clearly had a negative connotation, more rarely a positive one, while most of the times they were neutral.

Especially in the case of the wolf, nearly 11% of the names contained aggressive words that referred to the unconcealed wish for a dead or injured wolf. Toponyms such as *Lupara*, that indicate the place of the capture of the wolf (Calabrese 2015) and, later in time, the specific model of gun designed for wolf hunting, was found 87 times. *Caccialupo* -hunt the wolf- recurred 13 times and *Mazzalupo* -kill the wolf- 12 all around the country. Other expressions had a more regional connotation such as *Cecalupo* -blind the wolf- that occurred only in the region around Rome or *Scannalupi* -slay the wolves- present only on the island of Sicily. Competition for sheep, cattle and game species was harsh until 1950 when most of Italy relied on agriculture, and the desire to get rid of this predator was strong. Only a single place name directly expressed love towards the wolf: *Bacialupo*, literally meaning 'kiss the wolf', and six names refer to wolf pups.

Toponyms about bears suggested a slightly less negative association: only about 9% of them contained an explicit reference to capture or killing. Similarly to the wolf, the name *Orsara-* the place to hunt the bears- recurred 53 times throughout Italy, while *Mazzalorsa*, a combination of the words (*Am*)*mazza* -kill- and *l'orsa* – the female bear- occurred 4 times in the southern region of Puglia, and *Orsaccia* a pejorative term, just

once. Quite interestingly, the harmful terms always referred to the female bear, maybe perceived as more dangerous than the males because female bears can become very aggressive when defending their cubs. Overall, references to the female of the species were around 6% for both carnivores. The dozen names (2%) containing a direct reference to bear cubs were found only in north-west Italy; a direct expression of love or compassion was not very common for either the bear or the wolf.

Bears and wolf are indeed icons of wilderness (Tattoni et al. 2017a) and their names are still a popular choice for hotels and restaurants, a recognised index of their cultural value (Schirpke et al. 2018).

Conclusions

In this work I successfully applied the home range theory to the locations of toponyms for two large carnivores, and found a good overlap of place-names densities with extinction and recolonisation dynamics.

The semantic analysis of the names revealed a mixture of fascination with the wolf and bear, as well as fear of these animals, on the part of Italians in the past.

Such an exercise can raise public awareness about the past presence of the species on the Italian peninsula. The maps can be presented in discussions with stakeholders or during dissemination events to highlight the historical heritage of the territories and the cultural value of large carnivores. By analysing names, we can discover that the coexistence was not always peaceful and that large carnivores evoked awe and admiration but also fear. Acknowledging that the relationship was not easy in the past, but still predators were considered worth naming places after them, can help to understand the overall complexity of the issue.

Where people lost contact with large carnivores, they also abandoned traditional practices to protect herds and properties from them (D'Cruze et al. 2014) and they are not ready to implement necessary measures when the predators return. Traditional ecological knowledge fades in few generations if there is no day to day contact with the species or the environment in which the species are found (Tattoni et al. 2017b). However, toponyms last longer than human memories and are there to remind us of previous and not so remote times. The geographical analysis of name places may thus provide important information for species and habitat conservation or restoration, although its application is likely limited to large, charismatic species (Cox et al. 2002).

Nomen omen is a Latin idiomatic phrase that can be translated as: "destiny is in your name": Name place can explain your destiny, at least if you are a large carnivore.

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Supplementary material 1

Figure S1. Relationship between the degree of accuracy (Kappa) and the area occupied by the species

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Data type: statistical data

Explanation note: Relationship between the degree of accuracy (Kappa) and the area occupied by the species according to the literature at different thresholds of the density distribution with the regression line for each.

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