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Short Communication

Curiosity killed the bat: Domestic cats as bat predators

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ABSTRACT

Domestic cats are suspected to have an impact on wild populations of birds and small mammals, but published reports of predation on bats are either rare or anecdotal. We based our study on 1012 records of bats admitted at four wildlife rescue centres in peninsular Italy in 2009–2011. We hypothesized that (1) cats prevalently prey on bats emerging from roosts, so newborns or non volant juveniles should be less exposed to predation; (2) because cats occur in human settlements, the bat species most frequently involved are house-roosting (3) predation is season-biased, most events being more likely to take place in summer when females congregate in roosts to reproduce; (4) predation events concentrate in sparse-urban and rural areas, where free-ranging cats occur more frequently; and (5) some individual cats may specialize in capturing bats. We found that predation by cats was the first cause of rescue for bats in the study area, accounting for 28.7% of records of adult bats admitted to rehabilitation centres. Although most bats caught by cats belonged to house-roosting species, at least 3 of the 11 species affected were tree- or cave-roosting. Predation affected more frequently adult females in summer and thus threatened reproductive colonies, which were often subjected to repeated predations. As predicted, predation events were associated with land cover, being more abundant in rural and sparse urban areas, where cats are more often allowed to stay outdoor, as confirmed by the results of a cat owner survey we carried out. Cats are explorative mammals, so they may be easily attracted at bat roosts by sensory cues involving sound, smell and vision. Our analysis covered a broad geographical area over a relatively long period and suggests that the threat posed to bats by cats may be significant and should be carefully considered in conservation plans. Strategies to mitigate this impact should encompass the control of feral cat populations and indoor restriction of owned cats at least where predation on bats is probable.

In human-dominated landscapes many wild animal species fall victim to opportunistic wild (Thorington and Bowman, 2003) or domestic predators including dogs (Beck, 1973; Galetti and Sazima, 2006) and cats (Churcher and Lawton, 1989). In urban areas, domestic cats are the most abundant carnivores (Coleman and Temple, 1993; Lepczyk et al., 2003) and thus can prey on a large amount of wildlife every year (Woods et al., 2003). So far, most studies have addressed the impact of cats on particular taxa (birds; e.g. Van Heezik et al., 2010), in specific geographical contexts (islands, where introduced cats can become invasive, thus being a peculiar and different case; Dickman, 1996; Medina and Nogales, 2009) or have regarded relatively limited periods (Woods et al., 2003; Lepczyk et al., 2003). Other biases that affect the current knowledge of wildlife predation by cats originate by the heterogeneous conditions of free-ranging felines (owned or feral) considered for analysis and the different methods adopted (scat/guts analysis or prey brought home), overall making comparisons of different studies difficult (Krauze-Gryz et al., 2012).

Many bat species from temperate regions roost in human-made structures, often houses (Barbour and Davis, 1969), for at least a part of their life cycle (generally the reproductive phase, when females congregate in nurseries), a habit which increases the likelihood of encountering cats. Because nursery colonies are often composed of many individuals, predators may take a large toll on them (Rodrìguez-Duràn and Lewis, 1985; Speakman, 1991; Rosina and Shokhrin, 2011; Scrimgeour et al., 2012), particularly on adults and volant juveniles, newborns and non-volant bats being less exposed to the risk of predation.

Although only occasional evidence of cat predation on bats is available (Phillips et al., 2001; Woods et al., 2003; Mastrobuoni et al., 2005), there are reasons to believe that the impact of cats on bats is most likely to have been underestimated (Altringham, 2011).

To help fill this knowledge gap, in this study we present a 3-year assessment of cat predation on bats based on the analysis of records of rescued bats available from four Italian wildlife rehabilitation centres.

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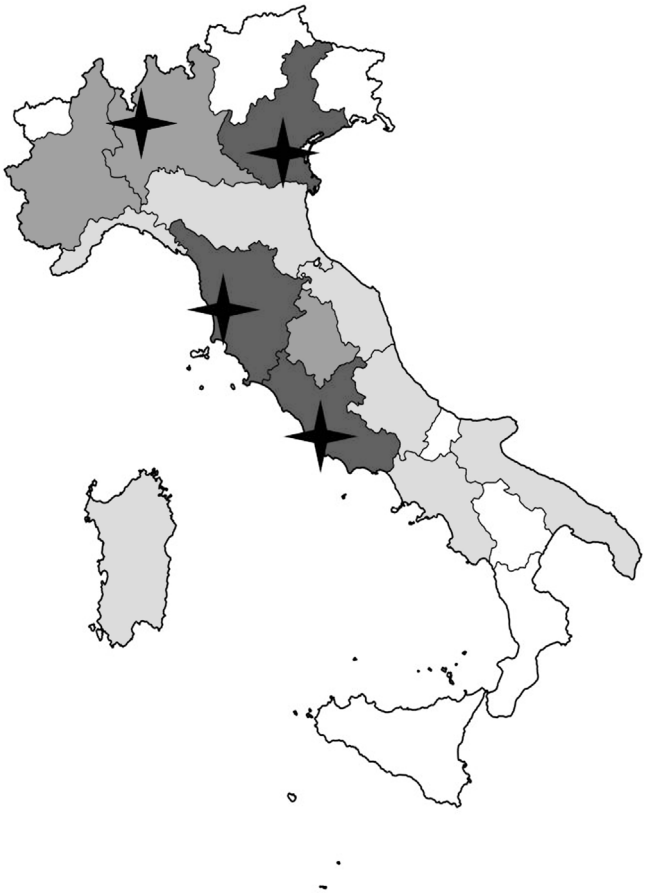

Fig. 1. Map of Italian regions indicating the place of origin of rescued bats. Dark-grey: >100 records; grey: 100–10 records; light-grey: 1–5 records; white: no records. Star-crosses indicate the position of the four wildlife rescue centres.

We hypothesize that (1) most predations concern adult bats emerging from roosts and volant but inexperienced juveniles, which are more easily available to cats; (2) because domestic cats are associated with human settlements, the bat species most frequently involved are house-roosting; (3) predation is season-biased, most events being more likely to take place in summer when females congregate in roosts to reproduce so that they and their young are more conspicuous and accessible to cats; (4) cats living in areas characterized by varying land use may be subject to different management and differ in the amount of time spent outdoor, thus cat impact on bats may be influenced by land use type, being particularly relevant in rural and sparse-urban areas; (5) individual cats may specialize on bats and repeatedly visit the same colony, leading to locally significant impacts. To support hypothesis 4 we also conducted a survey among cat owners to explore the occurrence of differences in the way domestic cats are managed in a range of land use types. Because gardens and courtyards are commoner in rural or sparse urban areas, we predicted that in such areas domestic cats are more often left outdoor unguarded and thus represent a more significant threat to bats.

We analyzed all records of rescued bats admitted to four LIPU (Italian League for the Protection of Birds) wildlife rehabilitation centres in 2009–2011. Centres were located in central (Lazio and Toscana) and northern (Veneto and Lombardia) Italy (Fig. 1). Records included date, species, sex (determined for 72.1% and 22.9% of adults and juveniles, respectively), age class (i.e. adult/juvenile, the former showing cartilage epiphyseal plates in finger bones and more tapered finger joints; see Anthony, 1988), reproductive status, injuries (when present) and causes of rescue. The latter were categorized as follows: (1) impact, i.e. bats which collided with buildings, vehicles and other human-made structures; (2) debilitation, i.e. animals found starving or dehydrated; (3) cat predation; (4) removal from roost, i.e. bats found in a roost and purposely taken from it by people; (5) unknown reason, and (6) fallen from roost (newborns or non-volant juveniles found on the floor beneath a roost). The people bringing bats were also briefly interviewed by the centres' staff to record the cause of rescue. In all selected centres, most admitted bats were reliably identified by trained staff; bats whose identity was uncertain were categorized as undetermined. The cryptic *Pipistrellus pipistrellus* and *P. pygmaeus*, whose distinction may be confidently done only by acoustic or molecular analysis (Jones and Parjis, 1993), were pooled together.

We assessed landscape composition within a 1-km radius circle surrounding each rescue site by photo interpretation of orthophotos (Italian Ministry for the Environment, Land and Sea) and using the gvSIG open-source GIS software (Iver, Generalitat Valencia, Universidad Jaume I and Prodevelop, Spain). The chosen radius covers the average home range size generally shown by free-ranging domestic cats (Kays and DeWan, 2004). Land cover was classified as: dense urban areas (continuous urban matrix, with multi-storey buildings and vegetation cover <20%); sparse urban areas (built-up areas dominated by single-storey buildings and vegetation cover between 20 and 50%); rural areas (single buildings or small groups, vegetation cover between 50 and 80%); scattered buildings (isolated buildings in a landscape whose vegetation cover was 80–95%); and non-urban areas (vegetation cover >95%).

To explore differences in cat management by owners in different land use types, we submitted a questionnaire to cat owners in veterinary clinics, pet shops as well as door-to-door in different urban conditions in three regions of Central Italy (Lazio, Umbria and Abruzzo), covering the previously described categories. Cat owners were asked to communicate (a) whether their cat was allowed to get access to outdoor spaces, (b) the amount of time spent outside in daytime (c) whether cats had access to outdoor during night time, and (d) how many bats their cat brought home in the last three years.

We determined the association between rescue causes of bats and respectively month, season, gender and land cover by chi-square tests on contingency tables. The same test was applied to the cat's owner surveys data: in that case we tested whether the numbers of bats brought home by cats were associated respectively with the time spent outdoor in daytime and with outdoor access during the night, as well as with land cover. Significant ($p < 0.05$) chi-square tests were followed by an analysis of residuals to determine the contribution of each category to the result (Haberman, 1973). All tests were performed with R rel. 2.14.0 (http://www.R-project.org).

We obtained records of bats admitted to four wildlife rescue centres originating from 13 Italian regions, but mainly from Lazio, Toscana (central Italy) and Veneto (northern Italy; Fig. 1). Of 1012 bats admitted to the centres, 115 (11.3%) had been preyed upon by a cat. Rescued bats belonged to 12 species, for all of which – except *Myotis bechsteinii* – cases of predation by cats had been recorded (Table 1).

In agreement with our hypothesis, only 2.4% of newborns or juveniles admitted had been caught by cats whereas adults were much more frequent: of 341 adult records, cat predation was the most frequent rescue cause (28.7%), followed by debilitation (23.3%), impact (18.2%), and removal from roost (4.6%); unknown causes accounted for 25.2% of cases. Of 671 records of newborns and juveniles, 90.0% were young bats accidentally fallen from roost, other causes accounting for 10% of the dataset. Because the method we adopted for ageing bats does not permit to distinguish between flying and non-flying juveniles, as epiphyseal plates can be seen on young bats for a few weeks after they become volant (Brunet-Rossini and Wilkinson, 2009), at least a few records from our