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PERSPECTIVE

Editor's Choice

Cat–wildlife interactions and zoonotic disease risk: a call for more and better community science data

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ABSTRACT

Due to their close interaction with both wildlife and humans, free-ranging domestic animals are well-suited to act as conveyors of zoonotic pathogens. Yet, although cats *Felis catus* are major predators of bats and other groups of zoonotic concern (e.g., rodents and birds), mounting evidence suggests that their role in the emergence of zoonotic diseases may be unappreciated. Here, we use bat–cat information extracted from the popular iNaturalist platform as a case in point to illustrate the potential of community science and social media to expand our understanding of pet-wildlife interactions. Although observations of cats preying on bats were more prevalent in Europe and North America, evidence of such interactions was documented across different geographic regions, revealing a relatively high incidence of bat predation by cats and providing evidence of cat–bat interactions previously unreported in the scientific literature. The lack of surveillance focused on cats and other pets as bridging hosts for zoonotic spillover events is concerning, considering the recognised risks they pose. Community science is a relatively untapped source of information for pet-wildlife interactions of zoonotic relevance. It is crucial that we gain a better understanding of the interaction between free-ranging pets and wildlife to better understand their potential contribution to past and future disease outbreaks. Failing to do so not only jeopardises human health but also puts pets at risk.

RÉSUMÉ EN FRANÇAIS

En raison de leur interaction étroite avec la faune sauvage et l'homme, les animaux domestiques en liberté sont bien placés pour jouer le rôle de vecteurs d'agents pathogènes zoonotiques. Pourtant, bien que les chats *Felis catus* soient l'un des principaux prédateurs de chauves-souris, et d'autres groupes concernés par les zoonoses (par exemple, les rongeurs), des preuves de plus en plus nombreuses suggèrent que leur rôle dans l'émergence des zoonoses n'est peut-être pas apprécié à sa juste valeur. Nous utilisons ici des informations sur les chats et les chauves-souris extraites de la plateforme populaire iNaturalist pour illustrer le potentiel de la science citoyenne et des réseaux sociaux pour améliorer notre compréhension des interactions entre les animaux domestiques et la faune sauvage. Bien que les observations de chats s'attaquant aux chauves-souris aient été plus fréquentes en Europe et en Amérique du Nord, des preuves de telles interactions ont été documentées dans différentes régions géographiques, révélant une incidence relativement élevée de la prédation des chauves-souris par les chats et fournissant des preuves d'interactions entre chats et chauves-souris qui n'avaient pas été rapportées auparavant dans la littérature scientifique. Le manque de surveillance axée sur les chats et les autres animaux de compagnie en tant qu'hôtes intermédiaires pour les événements zoonotiques est préoccupant, compte tenu des risques reconnus qu'ils représentent. La science citoyenne est une source d'information relativement inexploitée en ce qui concerne les interactions entre animaux de compagnie et animaux sauvages présentant un intérêt zoonotique. Il est essentiel de mieux comprendre l'interaction entre les animaux de compagnie en liberté et la faune sauvage afin de mieux appréhender leur contribution potentielle aux épidémies virales passées et futures. À défaut, non-seulement la santé humaine est menacée, mais les animaux domestiques sont également en danger.

CAT-WILDLIFE INTERACTIONS AND COMMUNITY SCIENCE

Domestic cats (*Felis catus*) have been integral parts of our lives for thousands of years, serving as companions, pest controllers, and cultural symbols (Ottoni et al. 2017, Crowley et al. 2019). However, mounting evidence indicates the detrimental impact of domestic cats on wildlife, including birds, mammals, and reptiles (Baker et al. 2005, Loss et al. 2013, 2022, Vlaschenko et al. 2019, Woolley et al. 2019). Domestic cat predation on wildlife poses not only a conservation concern but also an epidemiological risk (Salinas-Ramos et al. 2021). Interactions between cats and wildlife create opportunities for the transmission of pathogens, thereby increasing the potential for zoonotic spillover from pets to humans (Salinas-Ramos et al. 2021). Furthermore, in isolated and already threatened populations, such as on islands, even a reduced number of predation events by cats can be highly detrimental and induce considerable population declines and even local extinctions (Zino et al. 2001, Bonnaud et al. 2011, Moseby et al. 2015). Additionally, certain species show behavioural changes in the presence of domestic cats, which can impact their activities and fitness, further threatening the survival of these populations (Ancillotto et al. 2019). Therefore, understanding cat–wildlife interactions is crucial not only to assess the impact of cats on wildlife but also to identify potential spillover events resulting from close contact among species.

Widespread use of mobile photographic devices and social media have made it easier than ever to document the presence and interactions between wild and domestic species. An effective approach for studying cat–wildlife interactions involves collecting data directly from cat owners through online platforms, including social media sites and community science initiatives (Mori et al. 2019). Community science, also known as citizen science, entails the public's active participation in scientific research, leading to the creation of innovative data, which is subsequently validated by researchers. Data collected by the public through platforms like iNaturalist can significantly contribute to scientific research in numerous ways (Santillana et al. 2015, Kobori et al. 2016, Brown & Williams 2019, Edo-Osagie et al. 2020). Using data collected by or from the public, a wide variety of interspecific interactions have been explored, such as human–wildlife conflict (Larson et al. 2016, Drake et al. 2021), host–pathogen co-occurrence (Lawson et al. 2015), and interspecies behavioural interactions (Miller et al. 2017).

Community science has also played a significant role in investigating various aspects of domestic cat biology, including their movement, population density, and hunting behaviour (Kays et al. 2015, 2020, Roetman et al. 2018, Crowley et al. 2019). Reports of domestic cats preying on wildlife species have been widely shared through social media platforms like Facebook and Twitter, with the contribution of community science (Mori et al. 2019, Kays et al. 2020). Some of these reports have included instances of cat predation on bat species, including threatened species, such as *Miniopterus schreibersii*, *Rhinolophus ferrumequinum*, and *R. hipposideros* in Italy (Mori et al. 2019). Bats worldwide face numerous threats, and domestic cat predation ranks among the leading issues (Ancillotto et al. 2013, Rocha 2015, Welch & Leppanen 2017, Oedin et al. 2021, Borkin et al. 2022). However, most of these predatory events likely go undocumented.

INATURALIST AND CAT–BAT INTERACTIONS

As a case study of cat–wildlife interaction data sharing in online platforms, we chose to explore predation events by domestic cats towards bats. Our goal was to assess the geographical occurrence of cat predatory observations and to improve our understanding about the conservation status of bats that are most frequently reported as victims of cat predation. By doing so, we aim to raise awareness among both cat owners and naturalists regarding the significance of reporting predatory behaviour not only towards bats but also in relation to other wildlife species. This information is vital for gaining insights into the frequency of such events and ultimately improving our conservation efforts as well as our response and prevention strategies for disease outbreaks in the future.

We obtained observations of bat predation by cats from iNaturalist (www.inaturalist.org). To search for relevant data, we utilised built-in filters and keywords that were likely to be mentioned in the description of bat observations in multiple languages (English, Spanish, Portuguese, Italian, French, German, Arabic, Dutch, Russian, Chinese, Japanese), including terms such as 'cat', 'prey', and 'dead'. Similarly, we performed searches for domestic cat observations using keywords such as 'bat', 'prey', and 'predation' in the aforementioned languages. The iNaturalist website employs a species identification system that requires at least two independent confirmations by users, including professional mammalogists and chiropterologists. As several professional mammalogists and chiropterologists contribute to the identification of these observations, we are confident in the species IDs, whenever they have been validated. For non-validated observations at the species or genus level, we assign them to available and certain taxonomic categories such as family (e.g., Vespertilionidae), superfamily (e.g., Vespertilionoidea), suborder (e.g., Yangochiroptera), or order (Chiroptera).

Observations were categorised as either 'certain records' (instances where the owner witnessed the cat preying on the bat or removed the bat from the cat) or 'uncertain records' (cases where the owner assumed predation by cats based on the nature of the injury or the cat's previous hunting behaviour). We visualised the data using R version 4.1.2 (R Core Team 2018) and the ggplot2 package (Wickham & Chang 2016). The geographical distribution of observations was visualised using QGIS 3.26.3 (QGIS Development Team 2019). All the collected observations can be accessed in the iNaturalist project titled 'Bat (Chiroptera) predation by domestic cats (*Felis catus*)' (https://www.inaturalist.org/projects/bat-chiroptera-predation-by-domectic-cats-felis-catus).

A total of 149 observations of bat predation by cats were recorded since 2012 (Table 1, Appendix S1). Among these, 19.5% (n = 29) were suspected cases of predation by cats, while about 80.5% (n = 120) were certain cases where the observer witnessed the cat preying on the bat or bringing it onto their property. In 53.7% (n = 80) of the observations, other users confirmed the species identification, while the remaining observations are still unverified by users, therefore species ID should be handled with caution.

Nine bat families were recorded as preyed upon by domestic cats, with the Vespertilionidae family accounting for most (79.2%, n = 118) of these observations. Approximately, 7.4% (n = 11) of records with confirmed species identification belong to species categorised as Vulnerable (VU), Near Threatened (NT), Endangered (EN), or Critically Endangered (CR) based on their IUCN threat status (Fig. 1). iNaturalist data revealed at least 16 bat species and one bat family (i.e., Nycteridae) preyed upon by cats that had not been previously documented in the work by Oedin et al. (2021), which relied solely on scientific publications.

Most iNaturalist records of bat predation by cats are from North America and Europe, while limited data have been reported from Africa and most of Asia. However, this likely reflects the popularity of citizen science platforms in these regions rather than the actual higher frequency of bat predation events by domestic cats. Generally, there is a higher ratio of species observations uploaded from these continents, with North America contributing approximately 84 million observations, Europe with 26 million, Asia with 10 million, South America with 6 million, Australia with 5 million, and Africa with 4 million (as of June 2023 on inaturalist.org). Consequently, continents or countries with a larger user base are more likely to document a higher number of cat–wildlife predation events. Nevertheless, bat diversity is considerably greater in the Global South, including those under threatened categories (Frick et al. 2020), hence cat predation events are likely underestimated in these areas, and more research attention should be focused on these geographical areas.

Predation events have been reported in a total of 31 countries, with the United States having the highest number of observations (n = 45) (Fig. 2). The United States is home to ca. 58 million domestic cats, not including feral individuals (amva.org). However, there is a lack of data regarding domestic cat population sizes on a country-by-country basis, making it challenging to determine the specific relationship between cat numbers and predation incidents. Nevertheless, it is reasonable to assume that the population size of domestic cats, encompassing both feral and owned cats, plays a significant role in influencing the extent of wildlife predation events.

SPILLOVER OF BAT-ASSOCIATED ZOONOTIC PATHOGENS TO CATS

Interspecies pathogen spillover is highly possible and may frequently happen between wildlife and pets. Cats prey on multiple taxa that host zoonotic pathogens, including bats (Medina et al. 2011, Loss et al. 2013, Oedin et al. 2021), and are susceptible to a wide variety

Table 1. Bat species predated by domestic cats recorded on iNaturalist

Scientific name	Common name	IUCN	Number of observations	Country	Certainty
Antrozous pallidus	Pallid Bat	LC	1	United States	Uncertain (*n* = 1)
Artibeus sp.*	Neotropical Fruit Bats	NA	2	Ecuador, Mexico	Certain (*n* = 2)
Chalinolobus gouldii	Gould's Wattled Bat	LC	1	Australia	Certain (*n* = 1)
Chalinolobus tuberculatus	Long-tailed Wattled Bat	CR	1	New Zealand	Uncertain (*n* = 1)
Cynopterus brachyotis	Lesser Short-nosed Fruit Bat	LC	1	Philippines	Certain (*n* = 1)
*Eptesicus fuscus**	Big Brown Bat	LC	20	Canada, United States	Certain (*n* = 17), uncertain (*n* = 3)
Eumops sp.*	Bonneted Bats	NA	1	Ecuador	Uncertain (*n* = 1)
Hipposideros cineraceus	ashy roundleaf bat	LC	1	Brunei	Certain (*n* = 1)
Laephotis capensis	Cape Serotine	LC	2	South Africa	Certain (*n* = 2)
Lasionycteris noctivagans	Silver-haired Bat	LC	4	Canada, United States	Certain (*n* = 3), uncertain (*n* = 1)
Lasiurus borealis	Eastern Red Bat	LC	2	United States	Certain (*n* = 1), uncertain (*n* = 1)
Lasiurus cinereus	Hoary Bat	LC	2	Canada, United States	Certain (*n* = 1), uncertain (*n* = 1)
Lasiurus frantzii	Western Red Bat	NA	1	United States	Certain (*n* = 1)
Lasiurus seminolus	Seminole Bat	LC	1	United States	Uncertain (*n* = 1)
Lasiurus xanthinus	Western Yellow Bat	LC	2	Mexico, United States	Certain (*n* = 2)
Miniopterus sp.*	Bent-winged Bats	NA	1	South Africa	Certain (*n* = 1)
*Molossidae**	Free-tailed Bats	NA	2	Brazil, Mexico	Certain (*n* = 1), uncertain (*n* = 1)
Molossus sp.*		NA	1	Brazil	Certain (*n* = 1)
Mops pumilus	Little free-tailed bat	LC	1	South Africa	Certain (*n* = 1)
Myotis sp.*	Mouse-eared Bats	NA	7	Austria, Canada, Mexico, United States	Certain (*n* = 6), uncertain (*n* = 1)
Myotis evotis	Miller's Myotis	LC	2	United States	Certain (*n* = 2)
Myotis lucifugus	Little Brown Bat	EN	5	Canada, United States	Certain (*n* = 2), uncertain (*n* = 3)
*Myotis nigricans**	Black Myotis	LC	1	Brazil	Certain (*n* = 1)
Myotis septentrionalis	Northern Myotis	NT	1	United States	Certain (*n* = 1)
*Myotis thysanodes**	Fringed Myotis	LC	1	United States	Certain (*n* = 1)
Natalus sp.*		NA	1	Mexico	Certain (*n* = 1)
*Neoromicia capensis**	Cape serotine	LC	7	South Africa	Certain (*n* = 7)
Nyctalus leisleri	Lesser Noctule	LC	1	Italy	Certain (*n* = 1)
Nycteris hispida	Hairy Slit-faced Bat	LC	1	Republic of Congo	Uncertain (*n* = 1)
Nycteris thebaica	Egyptian Slit-faced Bat	LC	2	South Africa	Uncertain (*n* = 2)
Nycteris tragata	Malayan Slit-faced Bat	NT	1	Malaysia	Certain (*n* = 1)
Nyctinomops sp.*		NA	1	Mexico	Certain (*n* = 1)
Nyctophilus sp.*	Australian Long-eared Bats	NA	2	Australia	Certain (*n* = 2)
Pipistrellus sp.*	Pipistrelles	NA	11	Bulgaria, France, Italy, Luxembourg, United Kingdom	Certain (*n* = 9), uncertain (*n* = 2)
*Pipistrellus kuhlii**	Kuhl's pipistrelle	LC	3	France, Italy	Certain (*n* = 3)
Pipistrellus nathusii	Nathusius' Pipistrelle	LC	1	Bulgaria	Certain (*n* = 1)
Pipistrellus pipistrellus	Common Pipistrelle	LC	1	Germany	Certain (*n* = 1)
Plecotus sp.*	Long-eared Bats	NA	1	Spain	Certain (*n* = 1)
Plecotus auritus	Brown Big-eared Bat	LC	8	Belgium, France, Germany, Russia, United Kingdom, Switzerland	Certain (*n* = 6), uncertain (*n* = 2)
Pteropus sp.*	Flying Fox	NA	1	Malaysia	Certain (*n* = 1)
Pteropus alecto	Black Flying Fox	LC	1	Australia	Uncertain (*n* = 1)
Pteropus poliocephalus	Grey-headed Flying fox	VU	2	Australia	Uncertain (*n* = 2)
*Rhinolophus ferrumequinum**	Greater Horseshoe Bat	LC	1	Hungary	Certain (*n* = 1)
*Rhinolophus hipposideros**	Lesser Horseshoe Bat	LC	3	Austria, Italy, United Kingdom	Certain (*n* = 3)
Rhinolophus megaphyllus	Eastern Horseshoe Bat	LC	1	Australia	Uncertain (*n* = 1)
Rhogeessa sp.*	Little Yellow Bats	NA	1	Costa Rica	Certain (*n* = 1)

(Continues)

Table 1. (Continued)

Scientific name	Common name	IUCN	Number of observations	Country	Certainty
Scotophilus sp.*	Yellow House Bats	NA	3	India, Malawi, South Africa	Certain (*n* = 3)
Scotophilus dinganii	Yellow-bellied House Bat	LC	1	South Africa	Certain (*n* = 1)
Scotophilus kuhlii	Lesser Asian Yellow Bat	LC	1	Thailand	Certain (*n* = 1)
Sturnira sp.*	Yellow-shouldered Bats	NA	1	Mexico	Certain (*n* = 1)
Tadarida aegyptiaca	Egyptian Free-tailed Bat	LC	1	South Africa	Uncertain (*n* = 1)
*Tadarida brasiliensis**	Mexican Free-tailed Bat	LC	4	Mexico, United States	Certain (*n* = 4)
Vespertilio murinus	Particoloured Bat	LC	3	Germany, Russia	Certain (*n* = 3)
*Vespertilionidae**	Evening Bats	NA	13	Australia, Canada, France, Germany, Italy, Netherlands, Romania, South Africa, United States	Certain (*n* = 12), uncertain (*n* = 1)
*Vespertilioninae**	Vesper Bats	NA	5	Indonesia, Italy, Russia, United States	Certain (*n* = 5)
*Vespertilionoidea**	Vespertilionoid Bats	NA	1	United States	Certain (*n* = 1)
Unknown*		NA	1	United States	Certain (*n* = 1)
Total			149	31	

*Includes unconfirmed species IDs (as of 12th June 2023).

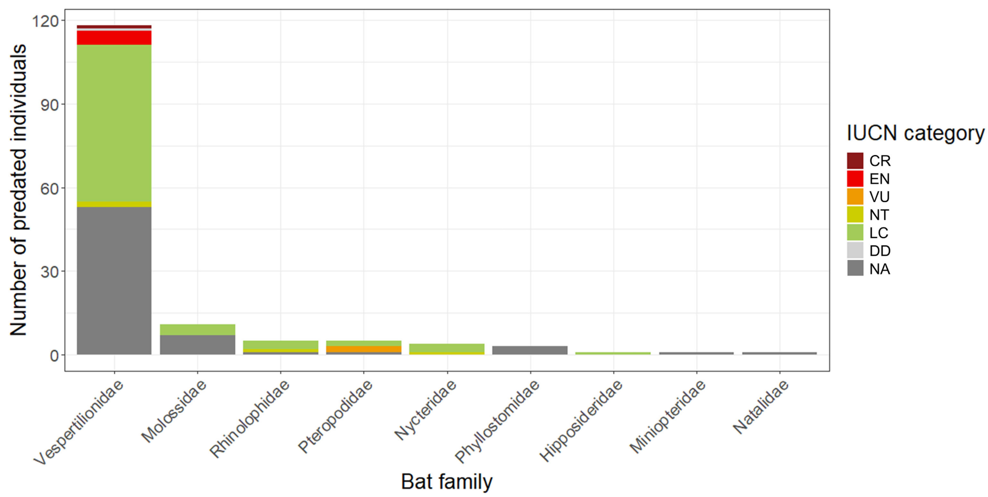

Fig. 1. Number of individual bats preyed by domestic cats according to families and IUCN categories.

of parasites and pathogens, including zoonotic ones (Patterson et al. 2020, Zhang et al. 2020, Mendoza Roldan & Otranto 2023). Indirect evidence that domestic cats can acquire viruses from bats during hunting or consumption has emerged in several cases (Salinas-Ramos et al. 2021). Bats are known to host a variety of lyssaviruses, including rabies virus, which have high potential to interspecies spillover among mammals, including humans (Begeman et al. 2018, Wang & Anderson 2019, Leopardi et al. 2021). Bat-associated rabies has also been detected in domestic cats, which was likely the result of cat–bat interactions (Dacheux et al. 2009, Leopardi et al. 2021, Wilson et al. 2022). However, although some evidence exists regarding bat-to-cat rabies transmission, it is nearly impossible to estimate the number of such spillover events under natural circumstances, and most of them remain undocumented.

Direct transmission of potentially zoonotic pathogens from bats to cats poses a serious, yet preventable (discussed below), public health threat. For example, we encountered evidence of two domestic cats (one visibly wearing a collar, suggesting ownership rather than being feral) preying on a *Mops* (*Chaerephon*) *pumilus* (observation ID: 92137264, Fig. 3a,b), a known host of the Bombali ebolavirus (Goldstein et al. 2018). However, bat-to-cat transmission of the virus has not been documented, and the pathogenicity of the Bombali virus to cats or humans is unknown, although its viral glycoprotein can facilitate entry into human cells under laboratory conditions (Goldstein et al. 2018). Cats are also

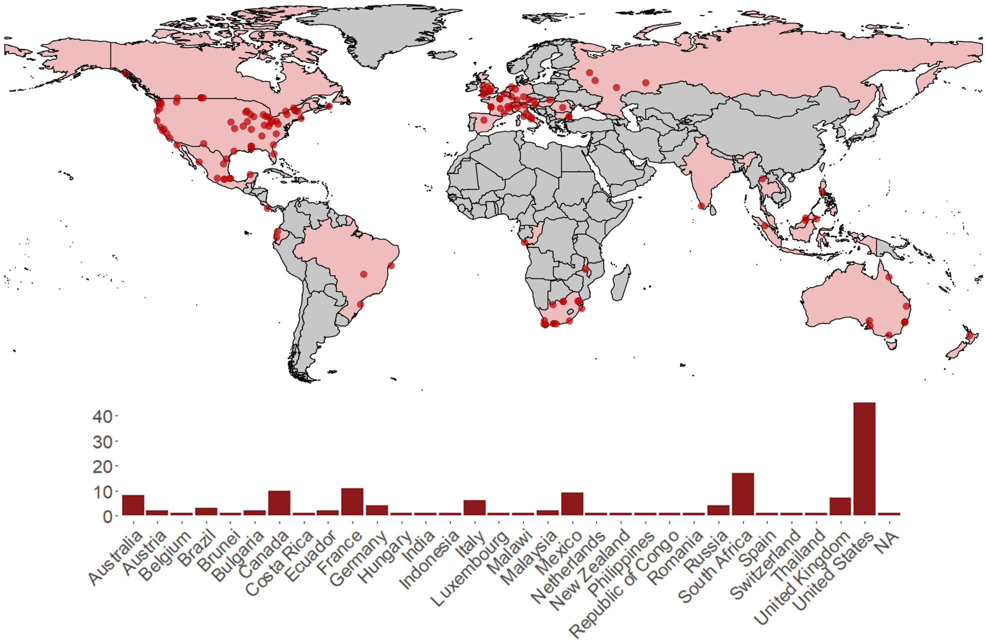

Fig. 2. Global distribution of bat predation by domestic cats observed on iNaturalist.

susceptible to bat-associated zoonotic viruses, such as Ebola, Hendra, and Nipah viruses (Glennon et al. 2018). Additionally, during this study, *Eptesicus fuscus*, which was preyed upon by cats multiple times, was found to potentially harbour paramyxoviruses closely related to Human Parainfluenza Virus 4, thereby increasing its zoonotic potential (Hause et al. 2021).

Moreover, domestic cats are susceptible (Westbury et al. 1996), and may potentially transmit Hendra virus, a bat-borne Henipavirus mostly found in Australia, to horses (Williamson et al. 1998). Hendra virus has caused mortality rates of up to 70% in humans (Eaton et al. 2005). Furthermore, Nipah virus, another highly zoonotic bat-borne *Henipavirus*, has been found in naturally infected cats (Amaya & Broder 2020).

Besides viruses, domestic cats may also become infected by potentially zoonotic bacterial pathogens associated with bats through close contact; however, their susceptibility is often unknown. For example, bat species that were documented to be predated by cats in this work, such as *Eptesicus fuscus* may harbour *Borrelia*, a tick-borne pathogen (Banerjee et al. 2020). *Myotis lucifugus* has been found infected with Candidatus *Bartonella mayotimonensis*, a *Bartonella* species associated with humans (Lilley et al. 2017), as well as *Mycoplasma*, an environmentally transmitted pathogen (Mascarelli et al. 2014, Szentivanyi et al. 2023). Additionally, *Neoromicia capensis* can be infected by *Rickettsia*, a vector-borne pathogen (Dietrich et al. 2017), while *Plecotus auritus* can host *Bartonella* (Goedbloed et al. 1964, Gardner et al. 1987). Lastly, *Tadarida brasiliensis* has been found to be infected by *Bartonella*, and *Rickettsia* (D'Auria et al. 2010, Cicuttin et al. 2017), as well as environmentally transmitted pathogens such as *Coxiella* (Müller et al. 2020), *Leptospira* (Mayer et al. 2017, Saraullo et al. 2021), and *Mycoplasma* (Newman et al. 2018). Several of these (or closely related) pathogens have been found in domestic cats before; however, their origin in these hosts is often unknown (Álvarez-Fernández et al. 2018, Dorsch et al. 2020, Springer et al. 2020, Salinas-Ramos et al. 2021, Saengsawang et al. 2022).

Furthermore, susceptibility of cats to certain recently discovered bat-associated pathogens, which are found in preyed bats is currently unknown, such as Lloviu virus (Kemenesi et al. 2022, Tóth et al. 2023), or *Leptospira* spp. (Soupé-Gilbert et al. 2022); however, should be further explored in the future.

Although we are not aware of any records of domestic cats being infected by bat-associated bacterial pathogens, spillover of these pathogens from bats to cats is possible, either through direct contact with bat body fluids during hunting and consumption or through vectors, such as blood-sucking ectoparasites. While bat-associated ectoparasites have not been observed feeding on cats, there have been reports of bat ticks feeding on other mammals, including humans (Péter et al. 2021). Hence, bat-to-cat ectoparasite transmission may also be possible, but it requires more research attention in the future.

Fig. 3. (a and b) Predation of *Mops* (*Chaerephon*) *pumilus* by domestic cats (Photo: MJ Botha, iNaturalist: inaturalist.org/observations/92137264).

SPILLOVER OF CAT PATHOGENS TO BATS AND OTHER WILDLIFE

Domestic cats have been identified as reservoirs and sources of zoonotic pathogens and parasites in disease emergence scenarios (Mendoza Roldan & Otranto 2023). Cats can carry a wide variety of pathogens and some of which can spillover to wildlife and livestock, leading to irreversible and costly damage to conservation efforts and the economy. In Spain, cross-species transmission of parvovirus infection has been suggested between wild carnivores and domestic cats (Calatayud et al. 2020). Furthermore, a recent study in Australia demonstrated that cat-associated diseases cause an annual loss of up to AU$18.3 million in livestock production (Legge et al. 2020).

Animal rescue centres often receive bats captured by domestic cats (Ancillotto et al. 2013), attempting to increase their chances of survival and their safe return to nature. Molecular-based surveillance of cat predation events has successfully used forensic DNA analysis to detect domestic cat DNA on injured bats, with cat DNA found on two-thirds of the injured bats (Khayat et al. 2020). A previous study showed that 44% of cat-preyed bats harboured potentially zoonotic bacteria (Mühldorfer et al. 2011), suggesting cat-to-bat transmission. In the future, we recommend screening bats admitted to rescue centres, with known contact with domestic cats, for cat-associated pathogens to determine the true extent of cat-to-bat disease transmission.

SARS-COV-2 AND H5N1

The full genomes of multiple bat coronavirus (e.g., BANAL-52 and RaTG13) suggest that wild horseshoe bats are the probable taxa of origin of SARS-CoV-2 (Zhou et al. 2020, Temmam et al. 2022). Yet, aligning with previous spillover events of the bat-associated coronaviruses SARS-CoV and MERS-CoV, many scientists support that direct bat-to-human transmission was unlikely and instead an intermediary animal was implicated (Rocha et al. 2021). Due to their close interaction with both bats and humans, free-ranging domestic animals are well-suited to act as conveyors of bat-related zoonotic pathogens. Evidence that cats are susceptible to severe acute respiratory syndrome (SARS) coronavirus and can efficiently spread the virus to uninfected animals has been available for nearly two decades (Martina et al. 2003). Cases of cat infection by SARS-CoV-2 were reported in Wuhan at the onset of the COVID-19 pandemic (Zhang et al. 2020) and since then multiple similar reports have emerged from a wide variety of locations – e.g., Italy (Patterson et al. 2020), Portugal (Barroso et al. 2022), UK (Hosie et al. 2021), Brazil (Calvet et al. 2021), and USA (Amman et al. 2022). SARS-CoV-2 is a bat-associated virus (Letko et al. 2020), and a recent review compiled evidence of cat predation on ca. 7% of the world's bat species (Oedin et al. 2021). Yet, robust evidence of cat-to-human transmission has only recently emerged (Sila et al. 2022). If cat-to-human transmission of SARS-CoV-2 is as easy as human-to-cat transmission, then bat predation by cats needs to be considered as a potential source of the initial SARS-CoV-2 outbreak. Furthermore, considering that reverse transmission of SARS-CoV-2 has been suggested in bats (Olival et al. 2020), it is plausible that cats could also transmit the virus back to bats, including strains bats are naïve to. This could cause unpredictable challenges to bat conservation efforts. While direct evidence of pathogen spillover from domestic cats to bats has not been documented, the possibility of such spillover is not only possible, but likely.

Cat-associated zoonotic risks are further illustrated by the recent cases of H5N1 in cats (Rabalski et al. 2023). As bird flu spreads to more wild bird and mammal species, the risk of cat-mediated transmission to humans increases (Kuiken et al. 2004), and outbreaks of bird flu in mink farms (Kupferschmidt 2023) are concerning in light of previous research showing that SARS-CoV-2-infected free-ranging cats potentially bridge mink farms and human households (Amman et al. 2022, van Aart et al. 2022).

A CALL FOR MORE (AND BETTER) DATA ABOUT CAT–WILDLIFE INTERACTIONS

Cats are some of the most loved pets, and despite the well-known impacts of free-ranging cats on wild species, some owners will continue to allow some degree of outdoor access to their cats. This practice is not only problematic for wildlife species, but could also risk the life of these pets, as they are often being predated by other species, such as foxes and coyotes (Sogliani & Mori 2019, Gelmi-Candusso et al. 2023). Despite scarce, some literature shows that particular interventions can reduce the overall tendency of cats to prey upon wild animals (e.g., providing cats with a high meat protein diet significantly reduces their tendency to capture other species, especially when combined with interactive playtime (Cecchetti et al. 2021)). Yet, there is an urgent need to science-driven, evidence-based management strategies that promote responsible pet ownership and the management of unowned and owned free-ranging, so to reduce zoonotic disease risk and ensure the protection of native species and the ecosystem services and ecological processes they sustain (Mori et al. 2019, Mendoza Roldan & Otranto 2023, Soto et al. 2023).

Encouraging citizen participation in data collection can provide valuable information that may not be readily accessible to scientists (see Mori et al. 2019 as an example). This approach allows for the acquisition of data on a significant spatiotemporal scale without excessive resource requirements. However, it is crucial, especially when specific needs arise, to guide citizen data collectors in improving the quality of the information they gather and share. Therefore, we provide recommendations based on our utilisation of citizen data in this study.

Prey species identification:

- Capture as many photographs of the prey's body, focusing on clear and detailed images of the face and profile.
- If possible, include reference elements in the photo, such as an object of known size (e.g., a ruler), to provide a sense of scale.
- Avoid taking photos against dark backgrounds, as they can hinder the clarity of the animal's features.

Providing context for the predation event:

- Take the time to describe the circumstances and details of what you witnessed.
- If feasible, provide information about the cat responsible for the predation, specifically attempting to determine whether it was a domestic, stray, or feral cat.

Facilitating communication with scientists:

- Whenever possible, allow scientists to contact you for further information regarding your observation.
- Stay engaged with the tool or platform used to share your observations, periodically logging in to check for updates or additional inquiries.

Furthermore, the establishment of nationwide cat registries by legislative bodies would likely be beneficial in advancing our understanding of fluctuations in the population numbers of domestic cats. This, in turn, has the potential to contribute to a more precise prediction of the potential risks cats pose to wildlife. Unfortunately, with the exception of a limited number of examples, the adoption of obligatory cat registration remains largely uncommon across most countries (Rand et al. 2018, Fossati 2022, Sumner et al. 2022).

Despite increasing awareness of the zoonotic risks associated with free-ranging cats, there is currently a lack of information regarding the interaction between cats and potential hosts of zoonotic diseases. Therefore, their potential role as bridging hosts for zoonotic spillover remains poorly understood. However, by following the aforementioned recommendations, citizen observers can make valuable contributions towards enhancing our understanding of the potential role of free-ranging cats in pathogen transfer between wildlife and humans. Our collective efforts in collecting and sharing high-quality data on the interactions between cats and wildlife play a crucial role in advancing our comprehension of the risks associated with zoonotic spillover and the magnitude of conservation impacts linked to free-ranging cats. Failing to do so jeopardises the well-being of both humans and cats as well as the long-term viability of numerous wild species.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of this article at the publisher's website.

Appendix S1. Data of domestic cat–bat predation observations from iNaturalist.