

Impacts on the Biodiversity of Vertebrate Fauna in Brazil: Domestic Cats as Exotic Predator

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ABSTRACT

Domestic cats (*Felis catus*) are listed among the 100 worst invasive species with the greatest impact on the environment and conservation, threatening a variety of native and even endangered animal species. Data indicate that they are responsible for the extinction of 33 bird species. Due to the importance of this issue and the scarcity of data in scientific manuscripts documenting species preyed upon by felines, we conducted a systematic review in the databases "Google Scholar," "ResearchGate," "Scopus," and "SciELO," seeking manuscripts containing data on species preyed upon by felines in Brazil over the past 30 years. We identified 14,980 manuscripts in the initial stage, and only 17 remained after subsequent stages and exclusion criteria, providing data on 146 species (or orders) of preyed animals, which were tabulated and discussed in this article. The number of articles already underscores the significance of this topic for conservation and may inspire further research to protect and preserve native fauna. Additionally, based on our research, we present unpublished data on cases of predation of both native and exotic species. The data on predation by domestic felines were gathered through observations, where the prey slaughtered and brought by the community cat were cataloged and listed over a 30-day period in the summer of 2020. The animal brought the prey to its feeding and resting place, in front of one of the houses where it received care. The study was conducted in the Camobi neighborhood, municipality of Santa Maria, state of Rio Grande do Sul, Brazil. Geographical coordinates: 29 41'47.9"S 53 44'20.4"W. This represents the first documented predation of two bird species (*Falco sparverius* and *Leptotila verreauxi*) and two Squamatas (*Tupinambis* and *Philodryas olfersii*) in Brazil.

any medium, provided the original author and source are credited.

The overall objective of this research is to characterize the impact of domestic cats (*Felis catus*) on Brazil's biodiversity, demonstrating control measures to prevent predation and consolidating dispersed data from

the literature succinctly, indicating the potential impact of this invasive species on the ecological balance of populations, elucidating preyed species and classes, and describing the predation of native and exotic fauna species by feral domestic felines. The results obtained can help alleviate the scarcity of information regarding the impacts of *F. catus* and support the need to implement management policies and environmental education to combat the abandonment of domestic animals and promote practices such as spaying/neutering and responsible pet adoption.

Keywords: Domestic cat; Biodiversity; fauna; *Felis catus*; predation; Brazil.

INTRODUCTION

With the domestication of felines around 10,000 years ago, they began to inhabit territories where they previously did not exist. As humanity advanced in agriculture, the presence of animal pests like rats increased. Felines saw an opportunity for easy food, offering humans a biological pest control solution in plantations ^[1]. It's believed that they arrived in the Americas via colonizing ships, either as companions or for rat control ^[2]. In contemporary society, felines have transitioned from rural animals to household companions, with their population in homes steadily rising. In countries like the United States, the United Kingdom, and much of Europe, feline ownership in homes already surpasses that of dogs ^[3].

However, the greatest issue related to felines is the significant number of undomesticated, semi-domesticated, and feral felines. Whether due to abandonment or access to the streets, these cats become efficient exotic predators, earning them a spot on the global list of the 100 worst species impacting biodiversity. Felines can travel miles per night, preying on various species. Given that Brazil harbors about 10% of the world's biodiversity, environmental impacts in the country lead to losses for numerous species, resulting in severe environmental harm. Legally, the federal constitution guarantees a balanced environment for the community (Brasil, 1988), making the state responsible for biodiversity protection, environmental education, and control measures to prevent feral felines from impacting fauna ^[4,5].

Unlike feral cats, semi-domesticated cats exhibit some level of human dependence. Many are considered community animals, lacking a specific owner but rather being cared for by the community. In such cases, these felines, while displaying natural behaviors, often prey on animals, acting as exotic fauna predators. Domestic cats are implicated in species extinctions and biodiversity decline, globally recognized among the 100 worst invasive species impacting fauna ^[1]. Brazil ranks seventeenth in biodiversity richness, underscoring the necessity to study the real impacts of these cats, showcasing the preyed species, to enact control and prevention measures in the country.

To mitigate feline impacts, responsible ownership measures such as spaying/neutering and proper care are essential. Additionally, governmental action is vital to preserve national biodiversity, aligning with the measures outlined in the country's legislation ^[6,7].

OBJECTIVES

The objective of this research is to assess the impact of domestic cats (*Felis catus*) on biodiversity, with a particular focus on Brazil. This involves demonstrating effective control measures to mitigate predation and consolidating scattered data from the literature concisely, thus highlighting the potential impact of this invasive species on population ecological equilibrium and clarifying the species and classes subjected to predation. Furthermore, within this study, we aim to present data on predation conducted by semi-domiciled domestic felines, through an observational study wherein prey brought by community cats (*Felis catus*) was documented over a 30-day period during the summer of 2020. The data encompasses two bird species (*Falco sparverius* and *Leptotila verreauxi*) and two Squamatas (*Salvator merianae* and *Philodryas olfersii*), never before reported in Brazilian literature regarding their predation by *Felis catus*. These findings could help alleviate the dearth of information on the impacts of *F. catus* and provide a foundation for the implementation of environmental management and education policies. These policies aim to address the issue of domestic animal abandonment and promote practices such as spaying/neutering and responsible pet adoption.

METHODOLOGY

In the first part, we conducted a search of the scientific literature regarding the impacts of domestic cats on biodiversity using the databases "Google Scholar," "Scopus," "ResearchGate," and "Scielo" between December 2022 and February 2023. The search criteria included keywords such as "BRAZIL" accompanied by "PREDATION, FELIS CATUS, and BIODIVERSITY" in both Portuguese and English, along with variations such as:

1. "Felis catus, predation, wildlife, biodiversity, brazil".
2. "Felis catus, predação, fauna, biodiversidade, brasil".
3. "Domestic cat, predation, wildlife, biodiversity, brazil".

During the initial selection stage, all scientific manuscripts identified through these searches in the different databases, published within the last 30 years - since 1992, were considered. This encompassed various types of scientific manuscripts, including complete articles published in scientific journals, expanded abstracts from scientific event proceedings, chapters from scientific books, undergraduate completion works, dissertations, and academic theses. In the second selection stage, manuscripts were further refined based on the inclusion of the scientific name of species or class associated with the terms "Felis catus," "predation," "Brazil," and "Biodiversity." Subsequently, exclusion criteria were applied to the manuscripts selected in the second stage. Manuscripts were excluded if they were bibliographic reviews, duplicate articles across databases, or did not mention preyed species or order/family. This led to the removal of 1080 duplicate articles.

Out of the 14,980 manuscripts identified in the first stage, only 17 remained after applying the stages and exclusion criteria. These 17 manuscripts provided data on 146 species (or orders) of preyed animals. To provide a global comparison, articles with identical search terms except for "Brazil" were also analyzed.

In the second part, we present data on the predation of native and exotic species by domestic felines in southern Brazil. The methodology involved an observational study of feline behavior over 30 consecutive days in the year 2020. The felines brought their prey to a feeding and resting location, located in front of one of the houses where they received care. The study was conducted in the Camobi neighborhood, municipality of Santa Maria, state of Rio Grande do Sul, Brazil, with a geographical location of 29° 41'47.9"S 53° 44'20.4"W.

RESULTS

Firstly, we present the data found in the literature regarding the species, classes, and types of studies encountered in the systematic review. Table 1 displays the data organized by author, year of publication, and the record of the preyed animal.

Table 1: Author, year of publication of the manuscript, preyed animal and/or order: family and type of study.

Author(s)	Year	Animal Preyed		Type of study
		Scientific name	Order: Family	
Da Costa Pinto [8]	2020	<i>Artibeus lituratus</i> (Olfers, 1818).	Chiroptera: Phyllostomidae	Observatory
		<i>Phyllostomus discolor</i> (Wagner, 1843)	Chiroptera: Phyllostomidae	
		Unidentified bat parts	Chiroptera	
Campos [9]	2004	Unidentified birds	Unidentified Order and family	Scat samples
		Eggshell	Unidentified Order and family	
		<i>Olygoryzomys nigripes</i>	Rodentia: Cricetidae	
		<i>Mus musculus</i> (Schwartz & Schwartz, 1943)	Rodentia: Muridae	
		<i>Rattus novergicus</i> (Berkenhout, 1769)	Rodentia: Muridae	
		<i>Rattus rattus</i> (Linnaeus, 1758)	Rodentia: Muridae	
		<i>Cavia apera</i> (Erleben, 1777)	Rodentia: Caviidae	
		<i>Didelphis albiventris</i> (Lund, 1840)	Didelphimorphia: Didelphidae	
		<i>Lutreolina crassicaudata</i> (Desmarest, 1804)	Didelphimorphia: Didelphidae	
		<i>Lutreolina crassicaudata</i> (Desmarest, 1804)	Didelphimorphia: Didelphidae	
		<i>Galictis cuja</i> (Molina, 1782)	Carnivora: Mustelidae	
		<i>Leporidae</i> (Fischer, 1817)	Lagomorpha: Leporidae	
		<i>Dasyopus novemcinctus</i> (Linnaeus, 1758)	Cingulata: Dasypodidae	
Santos et al. [10]	2021	<i>Leptophis ahaetulla</i> (Linnaeus, 1758)	Squamata: Colubridae	Observatory
Ferreira [11]	2021	<i>Didelphis aurita</i> (Wied-Neuwied, 1826)	Didelphimorphia: Didelphidae	Scat samples
		<i>Coendou prehensilis</i> (Linnaeus, 1758)	Rodentia: Erethizontidae	
		<i>Delomys dorsalis</i> (Hensel, 1873)	Rodentia: Cricetidae	
		<i>Oxymycterus sp.</i> (Waterhouse, 1837)	Rodentia: Cricetidae	
		<i>Akodon cursor</i> (Winge, 1887)	Rodentia: Cricetidae	
		<i>Kannabateomys amblyonyx</i> (Wagner, 1845)	Rodentia: Echimydae	
		<i>Thraupis palmarum</i> (Wied, 1821)	Passeriformes, Thraupidae	
		<i>Fluvicola nengeta</i> (Linnaeus, 1766)	Passeriformes, Tyrannidae	
		<i>Troglodytes musculus</i> (Naumann, 1823)	Passeriformes: Troglodytidae	
		<i>Molothrus bonariensis</i> (Gmelin, 1789)	Passeriformes: Icteridae	

		<i>Zonotrichia capensis</i> (Statius Muller, 1776)	Passeriformes: Passerellidae	
		<i>Muridae</i> (Illiger, 1811) unidentified	Rodentia: Muridae	
		<i>Oligoryzomys sp.</i> (Bangs, 1900)	Rodentia: Cricetidae	
		<i>Calomys tener</i> (Winge, 1887)	Rodentia: Cricetidae	
		Rodentia unidentified	Rodentia	
		Unidentified birds	Unidentified Order and family	
		Unidentified mammals	Unidentified Order and family	
		Hylidae (Haddad et al 1990 unidentified)	Anura: Hylidae	
Almeida & Jesus	2015	<i>Saltator coerulescens</i> (Vieillot, 1817)	Passeriforme: Thraupidae	Observatory
		<i>Passer domesticus</i> (Linnaeus, 1758)	Passeriforme: Passeridae	
Kerber et al. [12]	2017	8 unidentified amphibians/reptiles	Unidentified Order and family	Análise fecal
		18 aves não identificadas	Não identificada Ordem e família	
		23 unidentified mammals	Unidentified Order and family	
Ferreira [13]	2016	<i>Marmosa paraguayana</i> (Tate, 1931)	Didelphimorphia: Didelphidae	Scat samples
		<i>Didelphis aurita</i> (Wied-Neuwied, 1826)	Didelphimorphia: Didelphidae	
		<i>Sooretamys angouya</i> (Fischer, 1814)	Rodentia: Cricetidae	
		<i>Euryoryzomys russatus</i> (Wagner, 1848)	Rodentia: Cricetidae	
		<i>Akodon cursor</i> (Winge, 1887)	Rodentia: Cricetidae	
		<i>Oligoryzomys nigripes</i> (Olfers, 1818)	Rodentia: Cricetidae	
		<i>Mus musculus</i> (Schwartz & Schwartz, 1943)	Rodentia: Muridae	
Silva [14]	2018	<i>Didelphis albiventris</i> (Lund, 1840)	Didelphimorphia: Didelphidae	Scat samples
		<i>Callithrix jacchus</i> (Linnaeus, 1758)	Primates: Callithrichidae	
		<i>Rattus sp.</i> (Fischer de Waldheim, 1803)	Rodentia: Muridae	
		Unidentified mammals	Unidentified Order and family	
		Unidentified bat	Chiroptera	
		<i>Iguana iguana</i> (Linnaeus, 1758)	Squamata: Iguanidae	
		Unidentified Squamata	Squamata	
		<i>Tropidurus hispidus</i> (Spix, 1825)	Squamata: Tropiduridae	
		<i>Cyclarhis gujanensis</i> (Gmelin, 1789)	Passeriforme: Vireonidae	
		Hilydae (Haddad et al 1990) unidentified	Anura: Hylidae	
Zwarg et al. [15]	2013	<i>Columbina talpacoti</i> (Temminck, 1811)	Columbiformes: Columbidae	Animals brought in

		<i>Turdus rufiventris</i> (Vieillot, 1818)	Passeriformes: Turdidae	for care – predation reported
		<i>Brotogeris tirica</i> (Gmelin, 1788)	Psittaciformes: Psittacidae	
		<i>Pitangus sulphuratus</i> (Linnaeus, 1766)	Passeriformes: Tiranídeos	
Campos et al. [16]	2007	<i>Cavia aperea</i> (Erleben, 1777)	Rodentia: Caviidae	Visual observations and scat samples
		<i>Dasytus novemcinctus</i> (Linnaeus, 1758)	Cingulata: Dasypodidae	
		<i>Didelphidae</i> (Gray, 1821) não identificado	Didelphimorphia: Didelphidae	
		<i>Didelphis albiventris</i> (Lund, 1840)	Didelphimorphia: Didelphidae	
		<i>Galictis cuja</i> (Molina, 1782)	Carnivora: Mustelidae	
		<i>Lutreolina crassicaudata</i> (Desmarest, 1804)	Didelphimorphia: Didelphidae	
		<i>Muridae</i> (Illiger, 1811) unidentified	Rodentia: Muridae	
		<i>Murinae</i> (Illiger, 1811) unidentified	Rodentia: Muridae	
		<i>Oligoryzomys nigripes</i> (Olfers, 1818)	Rodentia: Cricetidae	
		<i>Leporidae</i> (Fischer, 1817)	Lagomorpha: Leporidae	
Assis et al. [17]	2022	<i>Leptodactylus latrans</i> (Steffen, 1815)	Anura: Leptodactylidae	Observatory
		<i>Boana faber</i> (Wied-Neuwied, 1821)	Anura: Hylidae	
		<i>Tropidurus torquatus</i> (Wied-Neuwied, 1820)	Squamata: Tropiduridae	
		<i>Oxyrhopus rhombifer</i> (Duméril, Bibron & Duméril, 1854)	Squamata: Dipsadidae.	
		<i>Oxyrhopus petolaris</i> (Linnaeus, 1758)	Squamata: Colubridae.	
		<i>Oxyrhopus guibeii</i> (Hoge & Romano, 1977)	Squamata: Dipsadidae.	
		<i>Micrurus corallinus</i> (Merrem, 1820)	Squamata: Elapidae	
		<i>Phimophis guerini</i> (Duméril, Bibron & Duméril, 1854)	Squamata: Colubridae.	
		<i>Dipsas mikania</i> (Schlegel, 1837)	Squamata: Dipsadidae,	
		<i>Brotogeris chiriri</i> (Vieillot, 1818)	Psittaciformes: Psittacidae	
		<i>Turdus rufiventris</i> (Vieillot, 1818)	Passeriformes: Turdidae	
		<i>Tangara sayaca</i> (Linnaeus, 1766)	Passeriformes: Thraupidae	
		<i>Lasiurus ega</i> (Gervais, 1856)	Chiroptera: Vespertilionidae	
		<i>Glossophaga soricina</i> (Pallas, 1766)	Chiroptera: Phyllostomidae	
Gaiotto et al. [18]	2020	Unidentified mammals	Unidentified Order and family	Scats samples
		<i>Rattus Rattus</i> (Linnaeus, 1758)	Rodentia, Muridae	
		<i>Rattus norvegicus</i> (Berkenhout, 1769)	Rodentia, Muridae	
		<i>Kerodon rupestris</i> (Wied-Neuwied, 1820)	Rodentia, Caviidae	
		<i>Trachelepis atlântica</i> (Schmidt, 1945)	Squamata, Scincidae	
		Unidentified rodentia	Rodentia	

		Unidentified birds	Unidentified Order and family	
		Unidentified fish	Unidentified Order and family	
		<i>Argonauta sp.</i> (Linnaeus, 1758)	Octopoda, Argonauta	
		Unidentified Gastropoda	Unidentified Order and family	
		<i>Goniopsis cruentata</i> (Latreille, 1802)	Decapoda, Grapsidae	
Ferreira et al. [19]	2014	<i>Didelphis aurita</i> (Wied-Neuwied, 1826)	Didelphimorphia, Didelphidae	Scat samples
		<i>Coendou prehensilis</i> (Linnaeus, 1758)	Rodentia, Erethizontidae	
		<i>Oxymycterus sp.</i> (Schinz, 1821)	Rodentia, Cricetidae	
		<i>Delomys dorsalis</i> (Hensel, 1873)	Rodentia, Cricetidae	
		<i>Kannabateomys amblyonyx</i> (Wagner, 1845)	Rodentia, Echimydae	
		<i>Mus musculus</i> (Schwartz & Schwartz, 1943)	Rodentia, Muridae	
		<i>Rattus Rattus</i> (Linnaeus, 1758)	Rodentia, Muridae	
		<i>Oligoryzomys sp.</i> (Bangs, 1900)	Rodentia, Cricetidae	
		<i>Calomys tener</i> (Winge, 1887)	Rodentia, Cricetidae	
		<i>Sooretamys angouya</i> (Fischer, 1814)	Rodentia, Cricetidae	
		Rodentia unidentified	Rodentia	
		Mammals unidentified	Unidentified Order and family	
		<i>Thraupis palmarum</i> (Wied, 1821)	Passeriformes, Thraupidae	
		<i>Fluvicola nengeta</i> (Linnaeus, 1766)	Passeriformes, Tyrannidae	
		<i>Troglodytes musculus</i> (Naumann, 1823)	Passeriformes, Troglodytidae	
		<i>Molothrus bonariensis</i> (Gmelin, 1789)	Passeriformes, Icteridae	
		<i>Zonotrichia capensis</i> (Statius Muller, 1776)	Passeriformes, Passerellidae	
		Passeriform not identified	Passeriformes	
		Birds not identified	Unidentified Order and family	
		Anura. Hylidae not identified	Anura, Hylidae	
Ferreira & Genaro [20]	2017	Trochilinae not identified (Vigors, 1825)	Apodiformes, Trochilidae	Feces
		<i>Columbina talpacoti</i> (Temminck, 1811)	Columbiformes, Columbidae	
		<i>Molothrus bonariensis</i> (Gmelin, 1789)	Passeriformes, Icteridae	
		<i>Passer domesticus</i> (Linnaeus, 1758)	Passeriformes, Passeridae	
		<i>Zonotrichia capensis</i> (Statius Muller, 1776)	Passeriformes, Passerellidae	
		<i>Coereba flaveola</i> (Linnaeus, 1758)	Passeriformes, Thraupidae	
		<i>Ramphocelus bresilius</i> (Linnaeus, 1766)	Passeriformes, Thraupidae	
		<i>Sicalis flaveola</i> (Linnaeus, 1766)	Passeriformes, Thraupidae	

		<i>Thraupis (Tangara) palmarum</i> (Wied, 1821)	Passeriformes, Thraupidae	
		<i>Tangara seledon</i> (Statius Muller, 1776)	Passeriformes, Thraupidae	
		<i>Troglodytes musculus</i> (Naumann, 1823)	Passeriformes, Troglodytidae	
		<i>Fluvicola nengeta</i> (Linnaeus, 1766)	Passeriformes, Tyrannidae	
		<i>Tyrannus melancholicus</i> (Vieillot, 1819)	Passeriformes, Tyrannidae	
		Passeriform not identified	Passeriformes	
Martins et al. [21]	2019	<i>Tropidurus torquatus</i> (Wied-Neuwied, 1820)	Squamata, Troupiduridae	Observatory
		<i>Tropidurus hispidus</i> (Spix, 1825)	Squamata, Troupiduridae	
		Tropidurus unidentified	Squamata, Troupiduridae	
Silveira [22]	2019	<i>Phaethon lepturus</i> (Daudin, 1802)	Pelecaniformes, Phaethontidae	Observatory
		<i>Trachelepyis atlântica</i> (Schmidt, 1945)	Squamata, Scincidae	

Regarding the predation carried out by the observed feline in the study, Table 2 presents the data of the preyed animals with their common and scientific names, along with their respective order/family, as shown in Table 1. The American Kestrel bird, Sipo Snake, Tegu Lizard cub, and White-tipped Dove were preyed upon only once each. The remaining animals were preyed upon at least twice by the feline studied in this work.

Table 2: Animals preyed upon by the domestic feline, including their common and scientific names, as well as their order and families.

Common Name	Scientific name	-
American Kestrel	<i>Falco sparverius</i> (Linnaeus, 1758)	Falconiformes, Falconidae
American Kestrel	<i>Columbina talpacoti</i> (Temminck, 1811)	Columbiformes, Columbidae
American Kestrel	<i>Leptotila verreauxi</i> (Bonaparte, 1855)	Columbiformes, Columbidae
House Sparrow	<i>Passer domesticus</i> (Linnaeus, 1758)	Passeriformes, Passeridae
Sipo Snake	<i>Philodryas olfersii</i> (Lichtenstein, 1823)	Squamata: Colubridae
Puppy Tegu Lizard	<i>Salvator merianae</i> (Duméril & Bibron, 1839)	Squamata, Teiidae
Saffron Finch	<i>Sicalis flaveola</i> (Linnaeus, 1766)	Passeriformes, Thraupidae
Great Kiskadee	<i>Pitangus sulphuratus</i> (Linnaeus, 1766)	Passeriformes, Tyrannidae
Black Rat	<i>Rattus Rattus</i> (Linnaeus, 1758)	Rodentia, Muridae
Norway Rat	<i>Rattus norvegicus</i> (Berkenhout, 1769)	Rodentia, Muridae
Home Rat	<i>Mus musculus</i> (Schwartz & Schwartz, 1943)	Rodentia, Muridae

DISCUSSION

Regarding the unique report presented, literature documents the predation of various snakes by domestic cats [10,17]. The predation of the Linnaeus Sipo was opportunistic, occurring while it was preying on a bird's nest when it was itself preyed upon by the feline. This marks the first documented instance of this species being preyed upon by domestic cats in Brazil. Among the bird species, all preyed species have abundant populations in the area (except for the *Falconidae*), which facilitates predation. The predation of the Columbiforme *Leptotila verreauxi* represents the first record of this species being preyed upon by felines in the country. As for the Rodentia species listed, all are documented in existing literature regarding mammalian predation by domestic cats, likely due to their high population density in urban environments, such as unwanted synanthropic fauna. Regarding the predation of Tupinambis, there are no reports of these species being preyed upon by domestic cats. However, there is literature documenting the predation of other Squamata species in Table 3 [10,17,18].

Table 3. Provides a comparison of the prey documented in this study with Brazilian literature, along with the status of the species in Brazil.

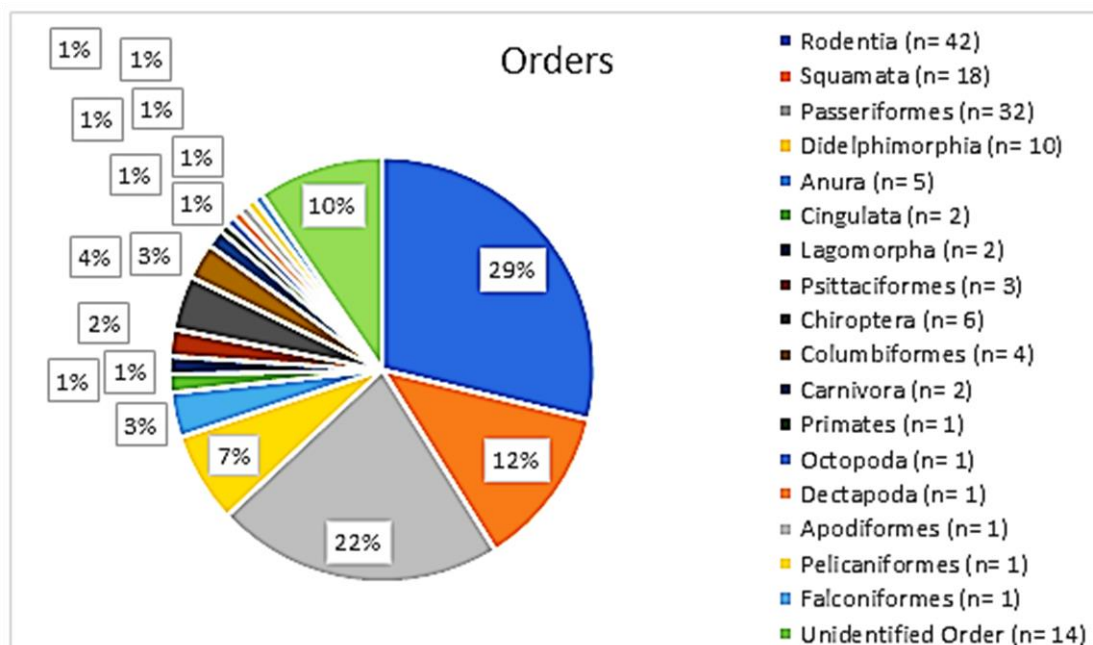
Preyed animal		Study
Species	Scientific name	Author and year of publication
Native	<i>Falco sparverius</i>	Not cited in Brazilian literature
Native	<i>Columbina talpacoti</i>	Ferreira and Genaro 2017; Zwarg 2013.
Native	<i>Leptotila verreauxi</i>	Not cited in Brazilian literature
Exotic	<i>Passer domesticus</i>	Almeida and Jesus 2015; Ferreira and Genaro 2017
Native	<i>Philodryas olfersii</i>	Not cited in Brazilian literature
Native	<i>Salvator merianae</i>	Not cited in Brazilian literature
Native	<i>Sicalis flaveola</i>	Ferreira and Genaro 2017
Native	<i>Pitangus sulphuratus</i>	Zwarg et al 2013
Exotic	<i>Rattus Rattus</i>	Ferreira et al. 2014;
		Ferreira 2016;
		Campos 2004;
		Gaiotto et al. 2020
Exotic	<i>Rattus norvegicus</i>	Campos 2004;
		Gaiotto et al. 2020
Exotic	<i>Mus musculus</i>	Ferreira et al. 2014;
		Ferreira 2016;
		Campos 2004;

Among the species preyed upon by this feline, 4 of them are invasive species in the country, such as the Rodentias and *Passer domesticus* (36% of the species listed in the article), but most of them are native species (64%). The feline while assisted in the control of exotic fauna (invasive species) acted as an exotic predator of native species, generating environmental impact on the biodiversity of the fauna.

The animal was captured and subjected to castration by the CED method – Capture, sterilization, and return. After sterilization the animal began to allow greater human contact, allowing touch. After 3 months the animal was adopted by one of the community members and it was kept indoor, without access to the street.

Alongside the extensive systematic review conducted, the most preyed-upon orders were Rodentia (29% of the reports), followed by Passeriformes (22%) and Squamata (12%). Among the 14 records of unidentified species, there are 5 records of birds, 1 predation of eggshells, 5 of mammals, 1 of Amphibians, 1 of Fish, and 1 of Gastropoda, with each record possibly involving more than one unidentified animal. The preyed orders are illustrated in Figure 1.

Figure 1: Preyed orders according to the literature. Total data: 146 records.



Beneficially felines contribute to the control of invasive species in Brazil, such as rats and sparrows. However, the predation carried out by domestic cats almost entirely generates negative impacts on the biodiversity of the fauna, the vast majority of the species brought in this review preyed upon by felines are native to the country. Historically, we see the impact of cats worldwide, have been responsible for the extinction of species. It is estimated that annually in the United States cats are responsible for the deaths of 2.4 billion birds, 12.3 billion mammals, 478 million reptiles and 173 million amphibians, and worldwide have been directly or indirectly responsible for the extinction of 33 species of birds. According to Ferreira et al. felines were the main causes of the extinction of *Cyanoramphus novaezelandiae erythrotis*, a subspecies of New Zealand parakeet, and only one pet feline of a lighthouse keeper on an island in this country was responsible in one year for the extinction of a non-flying bird in, *Xenicus lyalli*, a species of lark [3].

Regarding endangered species, in this review, two listed species, *Kerodon rupestris* and *Phaethon lepturus* are on the "Official National List of Endangered Species of Fauna", being the Rock cavy (*Kerodon rupestris*) Vulnerable (VU) and the White-tailed Tropicbird (*Phaethon lepturus*) in danger (EN) being the latter on the list permanently, being

fully protected by the legislation of the country, demonstrating the relevance of the predation of felines on the fauna [23].

In veterinary services, it is common to receive wild animals with traumas caused by domestic animals, especially birds. It can be estimated that it is a tiny percentage compared to the number of animals preyed upon in free life. One of the articles covered in this review has as a source of data on species preyed upon by cats the care of species attacked by cats [15].

An important concept to be defined is that of wandering and feral animals, since there are differences in the behavior and environmental impact caused by felines. Felines considered wanderers, are those that still have some degree of relationship of dependence with humans, termed as communitarian or semi-domestically wild. Ferals are animals that have returned to their wild state, have no bond with humans, and often coexist in colonies of mother and cub [1,2,14]. Feral animals are opportunistic, efficient predators of medium and small animals. They generally inhabit colonies of high population density and generate great impact on fauna, competing with native species and preying on endangered animals as reported [18,24]. In addition to feral animals, a major problem is cats with access to the street, which even without physiological need will prey on animals by instinct. The chances of domestic animals becoming predators of fauna is even greater when they receive less care. Nutritional deficiencies cause felines to seek to supplement their diet for their subsistence [14]. Still, wandering and semi-domesticated cats often do not feed on the slaughtered prey, or do not slaughter their prey, generating stress. The stress caused by the chase can result in the death of the animals due to capture cardiomyopathies, or it can affect the behavior and reproductive aspects [25].

In addition, Almeida & De Jesus added that felines do not only compete with each other, but also with other predators, such as birds of prey, reptiles and canids [26]. The risk to conservation is even greater in the vicinity of protected areas, preservation areas, reserves and islands. According to a survey conducted by Sampaio & Schmidt, domestic cats are present in at least 34 Conservation Units in Brazil. Due to this proximity, hybridization of the species can still occur, by crossing domestic cats with wild species, generating an even greater impact. And more, the interaction of wild and domestic animals allows the transmission of diseases [9,27]. Domestic cats are potential transmitters of diseases to native fauna. Cats can transmit diseases such as rabies, FIV, FeLV, toxoplasmosis, sarcosporidiosis, sporotrichosis, among others, to wild mammals. The transmission of pathogens also occurs from wild animals to domestic animals. Still, many of the potentially transmitted have zoonotic character [13,28,29].

In addition, it is important to mention the consequences of predation carried out by cats on islands, which are devastating. Island species are vulnerable due to a lack of adaptation to predators such as domestic animals. At the national level, one of the biggest problems is in Fernando de Noronha, where feral cats have a population of more than a thousand cats, which results in a gigantic impact on the local fauna. As published by Paula (2021) it is one of the highest population densities of felines in the world. There the felines are responsible for the predation of endemic species of the island, such as the lizard *Mabuia (Trachylepis atlantica)*, as reported by Gaiotto et al. and Silveira.

As explained in the results obtained in this review, there are not yet many published reports on the real impact of animal predation on wildlife. Recent studies have used fecal analysis to identify prey. Based on characteristics of the hairs and other taxa comparing them with the existing scientific collections. Most of the studies carried out are dissertations or theses, due to the time required for execution. Moreover, non-lethal attacks are even more common, but due to the difficulty of observation there are few studies, and most of the records of predation in peri-urban regions. A proof of the scarcity of data is this systematic survey, where of the almost 15,000 articles in the

databases surveyed, only 17 presented predation data from *Felis Catus* without being a bibliographic review or being repeated in the databases.

In city areas where anthropogenic pressure is present, the transmission of pathogens between wild, domestic and human animals occurs more frequently [30]. In addition, small green areas in urban regions allow close contact of the population and their domestic animals with wildlife, and visitors should be aware of their actions, which directly impact the fauna, controlling their pets and leaving no anthropic trace in the places [31]. In forest fragments and urban parks, even endangered animals are present, requiring care from the population to preserve them [32].

The abandonment of these animals contributes considerably to the creation of colonies of feral felines. The abandonment and neglect of domestic animals is an emerging concern for unique health, not only in Brazil but worldwide, many of these animals are not vaccinated and do not have a responsible guardian. Recalling that the abandonment of animals is an environmental crime in the country, subject to detention of up to five years [33,34].

The awareness of owners to the potential risks that their cats can cause to nature is indispensable. Luchese reported that most of the owners interviewed in his study did not recognize the impact that cats can have on wildlife [35]. The success of the control measures depends on the awareness of the owners and the population. Santos et al. states that "among the main measures that can be adopted for the preservation of natural resources, awareness is one of the most important". Most of the control measures must come from the owners of the animals, when they have them, from the general population and from the public power. It is essential that domiciled animals have responsible ownership. Responsible ownership recommends that animals receive appropriate care and that their 5 freedoms and animal welfare are assured [36].

It is important to keep guides and leashes during walks and only release the pets in areas where it is safe and under supervision, away from wild animals. One can also make use of collars with rattle, which alert wild animals of the proximity of the predator. However, the constant rattle can affect animal welfare, and can stress the animal generating discomfort and anguish [37].

The measures should always seek the best option for domestic and wild animals, always seeking to respect animal welfare. To prevent the access of domestic cats to wild animals, in Brazil it is common to screen the windows preventing the exit of domestic felines and the implementation of environmental enrichment within the homes. To control wandering and feral animals, the most successful measure and adherence to date is the CED – capture, sterilization and return, carried out in several countries and in Brazil, where feral animals are captured, castrated and returned to their places of origin. The castration of wandering and feral animals is indispensable for the population control of the colonies [38].

An example of the success of the CED technique occurred in Japan, where the capture and sterilization and return of animals to colonies was performed, and animals where rehabilitation was possible were referred for responsible adoption [39]. This technique is already used by individual protectors, NGOs and public authorities in Brazil.

In extreme cases, where castration cannot be effective due to the number of animals in existence, there are more drastic measures that can be taken. An example occurred in Australia, where due to the feral cat population being in the millions, controversial measures were taken, such as the extermination of colonies with poisoned baits. It is worth mentioning that poisoned baits may have led to the death of animals that were trying to be protected, and should be implanted very carefully and only as a last resort.

Definitive solutions are difficult, one must have knowledge of colonies of feral animals for the control measures to be carried out, for this one can have help of the population in notifying the existence of these. Measures of environmental education of the population, castration campaigns and control of populations of feral animals,

keeping domestic animals without access to conservation units is indispensable. In addition, pet owners must understand the potential risk their animals pose to biodiversity, not only preying on, but also transmitting disease and competing with natural predators [24].

Educational practices, especially in conservation areas and their buffer zones, are indispensable. Environmental education events promote the population's knowledge of the biological wealth and local ecology. Awareness actions allow conserving and reducing conflicts with biodiversity, protecting native species from anthropomorphic action and domestic animals [40].

The practice of environmental education in conservation units and their respective buffer zones is provided for in national legislation, according to the National System of Conservation Units, Law 9.985/200, in order to avoid human actions on native fauna and flora, preventing environmental damage and preserving biodiversity for the collective.

CONCLUSION

Alien species rank as the second greatest global threat to biodiversity, with their impacts trailing only behind habitat loss. Studies examining the effects of domestic cats on biodiversity in Brazil are scarce, as highlighted in the article, yet they reveal alarming data regarding prey numbers, including two species classified as threatened or vulnerable. While most observational work tends to be opportunistic, this study provides data on the predation of both native and exotic species by domestic cats in Brazil. Among these are two bird species (*Falco sparverius* and *Leptotila verreauxi*) and two Squamata species (*Salvator merianae* and *Philodryas olfersii*), which have not been previously reported as preyed upon by *Felis catus* in Brazilian literature. It is imperative to conduct further studies on the impacts caused not only by felines but also by all domestic species. These studies should not solely originate from universities but should also involve the country's public authorities, as mandated by national legislation. Hence, it is crucial to implement measures to manage and control populations of feral animals, while also educating the public about the risks posed by their pets to wildlife. Such efforts are vital for preserving the country's biodiversity, particularly in and around protected areas.

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