

Trends in admission to the Wildlife Screening Center in Espírito Santo State, Brazil, from 2011 to 2021

Hellen Alves dos Santos¹ , Rosângela Aparecida Müller² , Christina Pettan-Brewer³ , Josiano Cordeiro Torezani⁴ ,
Blima Fux² , and Creuza Rachel Vicente² 

1. Biology School, Federal University of Espírito Santo, Fernando Ferrari Av., 514, Goiabeiras, Vitória, Espírito Santo, 29075-910, Brazil; 2. Post-Graduate Program in Infectious Diseases, Federal University of Espírito Santo, Marechal Campos Av., 1468, Maruípe, Vitória, Espírito Santo, 29047-105, Brazil; 3. Department of Comparative Medicine, School of Medicine, University of Washington, 1959 NE Pacific St., Seattle, WA, 98195, USA; 4. Brazilian Institute of Environment and Renewable Natural Resources, Dourados St., Barcelona, Serra, Espírito Santo, 29166-085, Brazil.

Corresponding author: Creuza Rachel Vicente, e-mail: vicentecrachel@gmail.com

Co-authors: HADS: hellenalves.bio@gmail.com, RAM: rosangela.barros@ufes.br, CPB: kcpb@uw.edu, JCT: josiano.torezani@ibama.gov.br, BF: blima.fux@ufes.br

Received: 25-09-2024, **Accepted:** 04-10-2024, **Published online:** 26-10-2024

doi: www.doi.org/10.14202/IJOH.2024.209-215 **How to cite this article:** dos Santos HA, Müller RA, Pettan-Brewer C, Torezani JC, Fux B, and Vicente CR (2024) Trends in admission to the Wildlife Screening Center in Espírito Santo State, Brazil, from 2011 to 2021, *Int. J. One Health*, 10(2): 209–215.

Abstract

Background and Aim: The Wild Animal Screening Center in Espírito Santo State (CETAS-ES), Brazil, treats wildlife from trafficking and illegal trade, accidents, captivity, and rescue from out of their habitat. The present study described the trends in wildlife admission to the CETAS-ES over the past 10 years and discussed the impact of animal exploitation.

Materials and Methods: This descriptive study used a database provided by the CETAS-ES with data on animals admitted between 2011 and 2021, including admission year, origin, place of captivity, taxonomic category, sex, life stage, and health status.

Results: Over 10 years, 23,176 animals were admitted, with an annual average of 2,106 admissions. Seizing was the most common origin (60.39%), followed by rescues/collections (22.60%) and voluntary delivery (11.7%), whereas 5.3% had unidentified origins. Birds were the most frequently admitted animals (80.6%) and were predominant among those seized (97.5%), rescued/collected (46.7%), and voluntarily delivered (73.2%). Mammals represented 45.0% of rescues/collections and reptiles represented 19.0% of voluntary deliveries.

Conclusion: The admissions reveal a vulnerable scenario for wildlife in the Brazilian Atlantic Rainforest of Espírito Santo State, mainly affecting birds. Seizing was a common occurrence over the decade, reinforcing the necessity of actions to prevent wildlife trafficking and illegal trade.

Keywords: Atlantic Rainforest, biodiversity, fauna, wildlife trade.

Introduction

Wildlife exploitation occurs for different reasons, affecting natural areas, causing biodiversity loss, and introducing exotic animals into new habitats. It also facilitates pathogen spillover and spreading, with substantial reports of wildlife being infected with ectoparasites [1–7]. Institutions rehabilitating these animals are crucial for preserving biodiversity and providing information on the risks to these animals [8]. The Wild Animal Screening Center in Espírito Santo State (CETAS-ES) identifies, evaluates, treats, and rehabilitates wildlife experiencing trafficking and illegal trade, accidents, captivity, or rescued from outside their habitat [9, 10].

In Brazil, the Atlantic Rainforest is an area with relevant registers of wildlife exploitation, reflecting

the number of species under threat of extinction, corresponding to 383 out of the 633 listed in the country [11, 12]. Espírito Santo State, which initially had its entire territory covered by the Atlantic Rainforest, experienced high levels of deforestation [13, 14], contributing to the vulnerability of wildlife due to habitat loss and exposure to hunting [5]. In the State, natural areas close to urban settings and the proximity of roads contribute to many animals being determined of their habitats or involved in accidents [15]. In addition, the local culture of domesticating wildlife and the lenient legislation for wildlife protection contribute to its vulnerability [16, 17].

The present study described the trends in wildlife admission to the CETAS-ES over the past 10 years and discussed the impact of animal exploitation.

Materials and Methods

Ethical approval

The Brazilian Institute for the Environment and Renewable Natural Resources (IBAMA) approved the study. The study used secondary data; thus, no ethical approval from the Ethics Committee on Animal Use (CEUA) was necessary.

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Study period and location

This descriptive study used the database provided by CETAS-ES on wildlife admitted between 2011 and 2021. CETAS-ES is an institution that manages seized, rescued, collected, or voluntarily delivered fauna. It covers Espírito Santo State's entire territory and receives animals from other States [9, 10].

CETAS-ES has one unit in Serra municipality, located in the Metropolitan Region of Greater Vitória, Espírito Santo State, Brazil. Espírito Santo State is in the littoral of the Brazilian southeast region, with an area of 46,074.448 km², 78 municipalities, a tropical humid climate, and a biome with ecosystems encompassing mangroves, salt marshes, highlands, and marshes [18]. In 2021, the remaining Atlantic Rainforest in the State corresponded to 12.6% of the original coverage, and in 2022, 311 of the faunal species were considered endangered [19].

Study variables

The study evaluated the following data on wildlife admitted to the CETAS-ES: Admission year, origin (seizing, rescue/collection, and voluntary delivery), place of captivity (municipality and State), taxonomic category (class, order, and species), sex (male, female), life stage (cub, young, adult), and health status (alive, dead).

Seizing consisted of illegal trade and captivity for commercial purposes. Rescue/collection represented victims of accidents or animals reported out of their natural habitats. Voluntary delivery corresponded to irregular pets.

Statistical analysis

Simple and relative frequencies were calculated using Microsoft Excel (Microsoft Office, Washington, USA).

Results

Over 10 years, 23,176 animals were admitted to the CETAS-ES, with an annual average of 2,106 admissions and a standard deviation of 873.87, varying from 686 in 2016 to 3,437 in 2020, with no clear increasing trend over the years ($y = 116.18x + 1,409.8$;

$R^2 = 0.1994$). Seizing was the most frequent origin, accounting for 60.4% ($n = 13,995$), with an average of 1,272 records/year (standard deviation = 680.78), followed by rescues/collections ($n = 5,230$; 22.6%) and voluntary deliveries ($n = 2,714$; 11.7%), with annual averages of 475 (standard deviation = 213.27) and 246 (standard deviation = 91.13), respectively. Unidentified origins comprised 5.3% ($n = 1,237$). Rescues/collections slightly surpassed seizures in 2014 and 2015 (Figure-1).

Most wildlife admitted to CETAS-ES were alive (99.2%) or in adulthood (72.1%). Despite 53.0% having no sex determined, most of those who had this information were male (38.4%). Birds were predominant among the animals admitted (80.6%). Serra ($n = 7,653$; 33.0%), Cariacica ($n = 1,417$; 6.1%), Vitória ($n = 1,359$; 5.9%), and Vila Velha ($n = 839$; 3.6%), all cities in the Metropolitan Region of Great Vitória, were their principal places of origin, in addition to Cachoeiro de Itapemirim ($n = 695$; 3.0%), which is located in the south of the State (Figure-2). However, data on the place of captivity were missed in 7,571 cases (32.7%). Wildlife from bordering States, such as Bahia ($n = 721$), Rio de Janeiro ($n = 356$), and Minas Gerais ($n = 8$) were also admitted to CETAS-ES, as well as from more distant places, such as Santa Catarina State ($n = 82$), Rio Grande do Sul State ($n = 6$), Brasília ($n = 1$), and the Amazon region ($n = 2$), totaling 1,176 animals from other States (Table-1 and Figure-2).

The seized animals were mostly alive (99.1%), adults (89.2%), and males (63.6%). Serra ($n = 4,292$; 30.7%), Cariacica ($n = 873$; 6.2%), Vila Velha ($n = 402$; 2.9%), Vitória ($n = 366$; 2.4%), and Cachoeiro de Itapemirim were the most cited places of captivity, and almost all cities in Espírito Santo had wildlife captured. In addition, 714 cases were from bordering States, 709 were from Bahia, three were from Rio de Janeiro, and two were from Minas Gerais. The place of captivity was unknown in 36.7% ($n = 5,260$) of the cases (Table-1 and Figure-2).

Concerning taxonomic classes, 97.5% ($n = 13,638$) of seized wildlife were birds, with

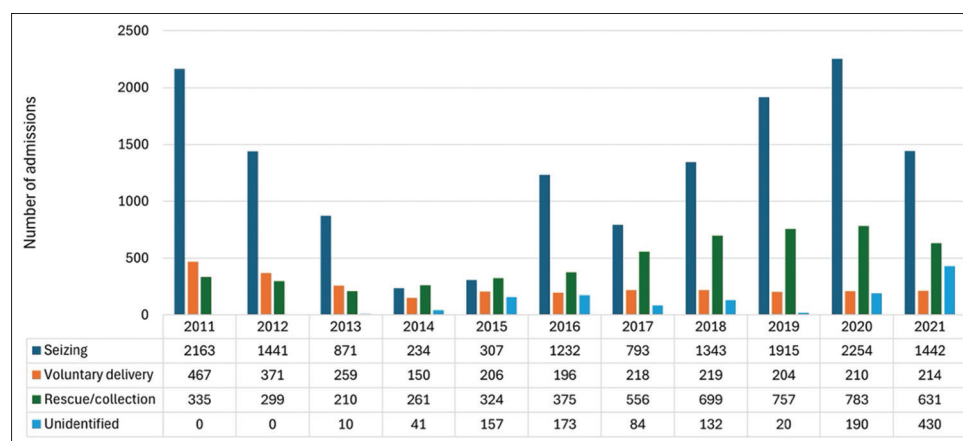


Figure-1: Annual admissions and origins of wildlife admitted to CETAS-ES, Espírito Santo State, Brazil, 2011 – 2021.

Table-1: Characteristics of wildlife admitted to CETAS-ES according to origin from 2011 to 2021.

Characteristic	Seizing N = 13,995 N (%)	Rescue/collection N = 5,230 N (%)	Voluntary delivery N = 2,713 N (%)	Total* N = 23,176 N (%)
Health status				
Alive	13,870 (99.1)	5,176 (99.0)	2,706 (99.7)	22,987 (99.2)
Dead	125 (0.9)	54 (1.0)	7 (0.3)	189 (0.8)
Sex				
Male	7,340 (52.4)	1,191 (22.8)	209 (7.7)	8,900 (38.4)
Female	141 (1.0)	1,620 (31.0)	147 (5.4)	1,998 (8.6)
Undefined	6,514 (46.5)	2,419 (46.2)	2,357 (86.9)	12,278 (53.0)
Life stage				
Cub	315 (2.3)	2,181 (41.7)	282 (10.4)	2,986 (12.9)
Young	1,833 (13.1)	819 (15.7)	301 (11.1)	2,946 (12.7)
Adult	11,594 (82.8)	2,130 (40.7)	2,070 (76.3)	16,714 (72.1)
Undefined	253 (1.8)	100 (1.9)	60 (2.2)	530 (2.3)
Class				
Birds	13,637 (97.4)	2,442 (46.7)	1,985 (73.2)	18,681 (80.6)
Mammals	43 (0.3)	2,356 (45.0)	157 (5.8)	2,678 (11.6)
Reptiles	257 (1.8)	431 (8.2)	542 (20.0)	1,729 (7.5)
Arachnids	52 (0.4)	0	0	52 (0.2)
Insects	6 (0.1)	0	0	6
Actinopterygii	0	0	26 (1.0)	26 (0.1)
Amphibians	0	0	3 (0.1)	3
Undefined	0	1	0	1

*The total includes 1,237 animals with unidentified origin. CETAS-ES=Wild Animal Screening Center in Espírito Santo State

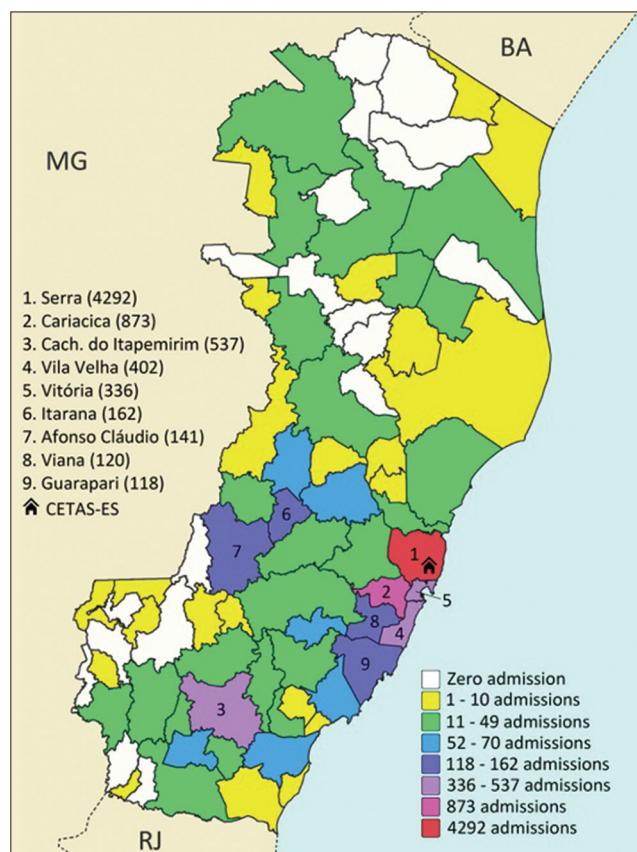


Figure-2: Places of captive wildlife admitted to CETAS-ES, Espírito Santo State, Brazil, 2011–2021 [Source: Wild Animal Screening Center in Espírito Santo State (CETAS-ES)].

a predominance of Passeriformes (n = 13,089; 96.0%), followed by Psittaciformes (n = 469; 3.4%), Columbiformes (n = 35; 0.3%), Galliformes (n = 10; 0.1%), Falconiformes (n = 9; 0.1%), Anseriformes

(n = 8; 0.1%), Piciformes (n = 7; 0.1%), Strigiformes (n = 5), Accipitriformes (n = 2), Gruiformes (n = 2), and Cathartiformes (n = 1). The order Passeriformes predominated among the 16 most frequently seized species admitted to CETAS-ES, and only one species of the order Psittaciformes was included in this ranking (Tables-1 and 2).

Seized reptiles were of the order Testudinata (n = 178; 69.3%), Squamata (n = 65; 25.3%), and Crocodyla (n = 14; 5.4%), while Arachnids were of the Order Araneae (n = 50; 96.2%) and Scorpiones (n = 2; 3.8%). Regarding mammals, 46.5% (n = 20) were of the order Didelphimorphia, 23.3% (n = 10) Primates, 14.0% (n = 6) Rodentia, 7.0% (n = 3) Cingulate, 4.7% (n = 2) Artiodactyla, 2.3% (n = 1) Carnivora, and 2.3% (n = 1) Pilosa. Insects belonged to the Order Blattodea (n = 5; 83.3%) and Coleoptera (n = 1; 16.7%).

Similarly to the other origins, most of the rescued or collected wildlife were alive (99.1%), but slight differences were observed according to sex, life stage, and class of these animals. Most of the animals were female (31.0%), and the proportions of cubs (41.7%) and adults (40.7%) were similar, as were the percentages of birds (46.7%) and mammals (45.0%). Among rescued/collected birds, the main orders were Strigiformes (n = 621; 11.9%), Passeriformes (n = 598; 11.4%), Psittaciformes (n = 268; 5.1%), Falconiformes (n = 194; 3.7%), Columbiformes (n = 153; 2.9%), and Accipitriformes (n = 110; 2.1%). The principal order of rescued/collected mammals was Didelphimorphia (n = 1,843; 35.2%), mainly of the species *Didelphis aurita* (n = 1,803). Regarding rescued/collected Primates (n = 340; 6.5%), they were mostly of the species *Callithrix geoffroyi* (n = 315).

Table-2: Frequently seized wildlife species admitted to CETAS-ES, Espírito Santo State, Brazil, 2011–2021.

Rank	Class	Order	Species	n (%)
1	Birds	Passeriformes	<i>Sporophila caerulescens</i>	4,659 (33.3)
2	Birds	Passeriformes	<i>Sicalis flaveola</i>	2,345 (16.8)
3	Birds	Passeriformes	<i>Saltator similis</i>	1,556 (11.1)
4	Birds	Passeriformes	<i>Sporophila nigricollis</i>	822 (5.9)
5	Birds	Passeriformes	<i>Sporophila frontalis</i>	355 (2.5)
6	Birds	Passeriformes	<i>Paroaria dominicana</i>	325 (2.3)
7	Birds	Passeriformes	<i>Zonotrichia capensis</i>	240 (1.7)
8	Birds	Passeriformes	<i>Turdus rufiventris</i>	238 (1.7)
9	Birds	Passeriformes	<i>Tangara sayaca</i>	231 (1.7)
10	Birds	Passeriformes	<i>Gnorimopsar chopi</i>	222 (1.6)
11	Birds	Passeriformes	<i>Sporophila angolensis</i>	220 (1.6)
12	Birds	Psittaciformes	<i>Amazona rhodocorytha</i>	206 (1.5)
13	Birds	Passeriformes	<i>Sporophila ardesiaca</i>	198 (1.4)
14	Birds	Passeriformes	<i>Volatinia jacarina</i>	130 (0.9)
15	Birds	Passeriformes	<i>Sporophila lineola</i>	125 (0.9)
16	Birds	Passeriformes	<i>Icterus jamaicai</i>	121 (0.9)

**Sporophila* spp. (Birds, Passeriformes) comprised 363 (2.6%) individuals. The other species had < 100 individuals admitted. CETAS-ES=Wild Animal Screening Center in Espírito Santo State

Reptiles of the order Testudinata (n = 235; 4.5%) and Squamata (n = 175; 3.3%) were also among the most rescued/collected animals (Table-1). The main places of rescued/collected wildlife were Serra (n = 2,633), Vitória (n = 830), Cariacica (n = 328), Vila Velha (n = 325), Guarapari (n = 101), and Cachoeiro de Itapemirim (n = 58), with 572 (10.9%) unidentified places.

Wildlife voluntarily delivered accounted for a higher proportion of life individuals (99.7%), mainly with undefined sex (86.9%). The majority of them were adults (76.3%), and the main genera were birds (73.2%) and reptiles (n = 515; 19.0%) (Table-1). Most of the birds were Passeriformes (n = 1,247, 46.0%) of *Sporophila caerulescens* (n = 387), *Sicalis flaveola* (n = 197), *Saltator similis* (n = 158), and Psittaciformes (n = 577; 21.3%) of *Amazona rhodocorytha* (n = 241). Most of the reptiles were of the order Testudinata (n = 515; 19.0%), particularly *Chelonoidis carbonaria* (n = 257) and *Trachemys dorbigni* (n = 116). In addition, similar places were cited as predominant among wildlife voluntarily delivered: Serra (n = 684), Vitória (n = 183), Vila Velha (n = 105), Cariacica (n = 97), and Cachoeiro de Itapemirim (n = 81). However, 1,388 (50.2%) individuals had unidentified places.

Discussion

The animals admitted to CETAS-ES and identified in this study illustrate a vulnerable scenario for wildlife in the Brazilian Atlantic Rainforest, particularly in Espírito Santo State. The predominance of seizing shows the permanence of illegal trade and traffic in this territory, with IBAMA and police authorities playing a significant role in preventing these crimes. The considerable number of animals rescued or collected reinforces the need for strategies to avoid accidents involving wildlife, especially collisions on highways crossing areas with natural reserves. In addition, voluntary deliveries must be encouraged among pet owners through educational

campaigns that address the risks and impacts of keeping wildlife out of their habitats.

The main places of captivity for admitted animals were cities crossed by recognized land routes for wildlife trafficking, like national and State highways [20]. These roads also cross natural areas and cause accidents with wildlife, which are often fatal. The municipalities of the Metropolitan Region of Great Vitória have markets selling animals. At the same time, Cachoeiro de Itapemirim is close to the Rio de Janeiro State border, where many wildlife markets are located [20]. This also partially explains the number of wildlife pets in these locations. Nonetheless, imprecise reporting of the locations of animal origin is expected, as evidenced by the outstanding numbers of reports in Serra municipality, where CETAS-ES is located. This is also evidenced by the low number of animals in the Linhares and Sooretama municipalities in the north of the State, as both are known as areas for hunting and selling wildlife [20]. These cities also have the Biological Reserve of Sooretama, a protected area crossed by the highway BR-101, which has a high incidence of wildlife being hit by cars, especially mammals crossing the road [15].

Most of the wildlife admitted were alive, which partially explains the preponderance of adult males. Estimations indicate that one in ten animals exploited for illegal trade and traffic survive [17]. Therefore, more vulnerable individuals, such as cubs and young animals, could not be admitted to CETAS-ES due to premature death.

In CETAS-ES, birds were the predominant wildlife admitted in all types of origin. International databases indicate that birds represent the leading group illegally traded [21]. In Brazil, granivorous and songbirds are illegally traded, and they are the most frequent animals in legal wildlife breeding, demonstrating the commercial interest in this group [22, 23]. Moreover, the use of birds as pets is a culture in some areas of

Brazil [16, 23]. Similarly to CETAS from the Bahia State, CETAS-ES had Passeriforms as the predominant seized birds admitted [24, 25], and similar species were observed among those most common, such as *S. flaveola*, *Sporophila nigricollis*, *Paroaria dominicana*, and *S. caerulescens*. These species and *S. similis*, *Sporophila angolensis*, *Gnorimopsar chopi*, *Turdus rufiventris*, and *Sporophila lineola* are also among the more seized in other areas of the Atlantic Rainforest and in CETAS-ES [23]. In addition, CETAS-ES admitted endangered bird species, such as *Sporophila frontalis*, *S. angolensis*, *S. similis*, and *A. rhodocorytha*, among the most frequent animals, highlighting the risk of loss of biodiversity in the Atlantic Rainforest [19].

The captivity of birds has consequences for their well-being, leading to stress, injury, and undernourishment due to violence and entrapment in crowded and small places. Therefore, beyond ecological imbalance, captivity favors pathogen transmission [26]. In addition, it may contribute to pathogen spillover to poultry, other domestic animals, and humans because birds are pathogen hosts, vectors, and amplifiers [27, 28]. Infectious diseases were reported as the leading cause of death in seized birds, varying from 51.7% to 78.6% [26, 29]. Pathogens were isolated from seized animals in recovery centers, such as viruses (avian influenza), parasites, fungi, and bacteria such as *Salmonella* spp., *Klebsiella pneumoniae*, and *Escherichia coli* [30–37]. In addition, birds are potential reservoirs of multidrug-resistant pathogens, which the World Health Organization lists as priorities for new antibiotic development [38]. Therefore, the captivity of wild birds may have consequences for plant reproduction, insect control, food safety, and public health, with economic and social impacts.

Accidents or rescues out of their habitats significantly impacted mammals, including the admission of opossums and monkeys. However, it was not possible to identify the specific cause of admission. Previous reports of animals killed on Brazilian roads show several accidents with opossums, also indicating *D. aurita* as one of the most affected, with 22,488 road kills estimated per year. Nonetheless, the same study reported a low number of monkeys affected by road accidents but heavily impacted by habitat loss, contributing to their being found outside their natural territories [39].

Species of the order Testudinata were among the animals that were delivered voluntarily. Their long lifespan increases the possibility of them being no longer wanted as pets. Therefore, actions that contribute to wild pets' well-being, promote environmental education, and enforce the law should be pursued to prevent the abandonment of unwanted wildlife pets, avoid their death, and avert negative impacts on natural populations, especially in non-endemic areas, such as pathogen introduction or unbalance in the food chain and reproduction [40].

CETAS-ES provides a vital service to protect fauna. Nevertheless, investments are necessary to increase the capacity of the center to identify and control health risks. Of the rescued animals admitted to triage centers in Brazil, approximately 78% returned to their natural habitat without undergoing preventive health checks [41]. Some reasons for this include a lack of professional training and insufficient infrastructure to meet the high demand for such services [42]. In addition, 60% of pathogens found in trafficked animals have zoonotic potential, and workers dealing with them must undergo follow-up and evaluation periodically [7].

CETAS-ES is a sentinel for evaluating wildlife risk, but it is limited for capturing other types of animal exploitation, such as slaughtering for human consumption. In addition, deaths from illegal activities with wildlife are underestimated if only the present data are considered. Another limitation was using secondary data, which are prone to information bias. Therefore, further studies, including different data sources, are necessary to deepen our understanding of wildlife risks in Espírito Santo State.

Behavior change must be pursued to address wildlife exploitation, with interdisciplinary and inter-institutional involvement and governmental and civil society engagement [43, 44]. Thus, it will be possible to diminish the risks associated with wildlife exploitation in the Atlantic Rainforest.

Conclusion

Wildlife admissions in CETAS-ES over 10 years revealed a vulnerable scenario for the fauna of the Atlantic Rainforest in Espírito Santo, with no reduction during the study period. Seizing was a common occurrence, reinforcing the necessity of actions to prevent wildlife trafficking and illegal trade. Birds were the principal group affected, but mammals appeared to be commonly rescued/collected, and reptiles were frequently voluntarily delivered. Actions are necessary to prevent and respond to wildlife exploitation, improve animal well-being, protect biodiversity, diminish risks, and promote behavioral changes toward wildlife abuse.

Authors' Contributions

HADS, JCT, and CRV: Conception and design. HADS and JCT: Data collection. HADS and CRV: Analyzed the data. CRV, JCT, RAM, CPB, and BF: Data interpretation. HADS, RAM, and CRV: Drafted the manuscript. JCT, CPB, and BF: Reviewed the manuscript. All authors have read and approved the final manuscript and are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Acknowledgments

The authors thank the Brazilian Institute for the Environment and Renewable Natural Resources (IBAMA) for approving the research. CRV received

a grant (number: 442106/2023-8) from the National Council for Scientific and Technological Development (CNPq), Brazil.

Competing Interests

The authors declare that they have no competing interests.

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