OCCURRENCE OF ROADKILLS OF *Caiman latirostris* ON ROADS IN CENTRAL-WESTERN, SOUTHEASTERN, AND SOUTHERN BRAZIL

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ABSTRACT

Brazil has an extensively large road network, with significant importance to its society. However, construction of new roads can promote the modification of the natural environment, increasing the chances of roadkills of wild animal specimens, both in protected and non-protected areas. In this sense, it is important to collect data on roadkills of native fauna specimens. Considering the scarcity of information, the main objective of this study was to collect data on roadkills of *Caiman latirostris* in Central-Western, Southeastern and Southern Brazil. Between 2010 and 2022, a total of 48 individuals of *C. latirostris* hit by vehicles were recorded, with occurrences in the Cerrado (75%), Pampa (16%), and Atlantic Forest (8%) biomes. Monitoring of wildlife roadkills may be an indicator of local biodiversity and its results can be used as an alert for implementing effective preventive measures to reduce the death of caimans from vehicular collisions.

Keywords: Collisions. Conservation. Broad-snouted caiman. Road ecology. Fauna monitoring.

INTRODUCTION

According to research data from the Ministry of Infrastructure, Brazil has a road network of 1,720,700 km (1,069,200 miles), of which 94.7% are state and municipal roads, and 5.3% are federal (IBGE, 2019). These data indicate that roads are important undertakings for society, as, by allowing the movement of people and products, they end up enabling the development of populations living in remote regions (ALAMGIR et al., 2017; PEREIRA et al., 2011). However, construction of new roads is one of the most widespread ways of modifying the landscape (BAGER et al., 2016).

The construction of highways and the traffic of vehicles are responsible for numerous direct and indirect cases of reduction in the populations of local and migratory wildlife, since they can cause a series of alterations in the associated environments, such as the damming of water courses, habitat loss, barrier effect, changes in food webs and natural ecological corridors, geographic, genetic, and population isolation, edge effects, and roadkills (BAGER et al., 2016; GRILO et al., 2020).

Roadkills have been a threat to animal species, both in protected and unprotected areas (COLLINSON et al., 2019), and are a subject of concern for environmentalists, authorities, and the scientific community, although the available data do not reveal the true statistical reality (SÁSSI et al., 2013).

Researchers suggest that collisions with automobiles may have already surpassed hunting as the main anthropic factor directly responsible for wildlife mortality on a global scale (FORMAN; ALEXANDER, 1998), and the Brazilian Center for Studies on Road Ecology (CBEE, 2019) estimates that more than 475 million animals per year are roadkilled on Brazilian highways, affecting animals of the most diverse taxonomic groups, such as amphibians (GLISTA et al, 2008), birds (ICMBIO, 2018a), mammals (CACERES, 2011; ICMBIO, 2018b), and reptiles (GONÇALVES et al., 2018).

Caiman latirostris is found in South America, and its geographic distribution extends to Brazil, Argentina, Paraguay, Uruguay, and Bolivia, at latitudes ranging from 5^{o}S to 34^{o}S and at altitudes of up to 800 m, with low-density populations dependent on ecosystems with water and vegetation, such as rivers, swamps, lakes, mangroves, among other environments in the

Atlantic Forest, Cerrado, Caatinga, and Pampa biomes, as well as in environments near cities, industries, and rural areas (COUTINHO et al., 2013). This species is considered a top predator, so any loss of individuals can lead to an impact on the balance of the local ecosystem. In Brazil, most of the geographic distribution of this species is in the remainders of the Atlantic Forest (COUTINHO et al., 2013).

Based on the wide distribution and scarcity of reports of *C. latirostris* roadkills, it is argued whether the data are underestimated or whether the species has some behavioral characteristic that minimizes the chance of death by vehicular collision on roads. In this context, the objective of this study was to collect data on roadkills of specimens of *C. latirostris* on the roads of Central-Western, Southeastern, and Southern Brazil between the years 2010 and 2022, from databases of conservation and monitoring projects of roadkilled fauna.

MATERIAL AND METHODS

All the information obtained was collected, organized, and tabulated from data compiled by the “Projeto Caiman: Jacarés da Mata Atlântica”, the “Projeto Bandeiras e Rodovias”, and the Taim Ecological Station (“ESEC do Taim”), which met criteria such as (i) highlighted the biome where the roadkill occurred; (ii) the roadkill occurred between 2010 and 2022, throughout all seasons of the year and (iii) reported roadkill by *C. latirostris*, males and females, of all age groups, on Brazilian roads. The taxonomic identification of Broad-snouted caimans was carried out by direct observation of the carcass and natural distribution of the species.

RESULTS AND DISCUSSION

In the present study, 48 adult individuals of *C. latirostris* that were hit by a vehicle between 2010 and 2022 were surveyed (Figure 1). The data obtained from roadkills of *C. latirostris* on Brazilian roads, including the date of the vehicular accident, geographic coordinates, season of the year, phytophysiognomy of the site, and location are summarized in Table 1. According to the data compiled in this study, 75% (36 records) of the roadkills occurred in the Cerrado biome (Figure 2), 16.66% (8 records) in the Pampa biome (Figure 3), and 8.33% (4 records) in the Atlantic Forest. Overall, 81.25% of the roadkills occurred between the months of October and April, in the period of greater intensity of rains (Figure 4). The advanced state of decomposition of the carcasses made it impossible to identify the sex of the animals.

Table 1 - Roadkill records of adult *Caiman latirostris* in Central-Western, Southeastern, and Southern Brazil.

Date	Road	Coord. Y	Coord. X	Biome	Seasons
06/02/2017	BR262	-20.499587	-54.294256	Cerrado	Rainy
07/02/2017	MS040	-21.102494	-53.689944	Cerrado	Rainy
07/02/2017	MS338	-21.535861	-52.542256	Cerrado	Rainy
07/03/2017	MS040	-21.191258	-53.340765	Cerrado	Rainy
21/03/2017	MS040	-21.191313	-53.340728	Cerrado	Rainy
18/04/2017	BR267	-21.780263	-52.508069	Cerrado	Dry
18/04/2017	BR267	-21.764256	-52.492276	Cerrado	Dry
28/11/2017	MS040	-21.15103	-53.41064	Cerrado	Rainy
04/12/2017	BR262	-20.464336	-54.05244	Cerrado	Rainy
10/12/2017	MS040	-20.853191	-54.146635	Cerrado	Rainy
13/12/2017	MS040	-21.110257	-53.654244	Cerrado	Rainy
10/01/2018	BR267	-21.561165	-54.132389	Cerrado	Rainy
22/01/2018	MS040	-21.137307	-53.485871	Cerrado	Rainy
31/01/2018	BR262	-20.804017	-51.860823	Cerrado	Rainy
07/03/2018	MS338	-21.44546	-52.66519	Cerrado	Rainy
08/05/2018	BR262	-20.499706	-54.294011	Cerrado	Dry
15/05/2018	MS338	-21.452918	-52.652586	Cerrado	Dry
15/10/2018	MS338	-21.436148	-52.681866	Cerrado	Rainy
15/10/2018	MS338	-21.48012	-52.608096	Cerrado	Rainy
15/10/2018	BR267	-21.728835	-52.445227	Cerrado	Rainy
07/11/2018	BR262	-20.495129	-55.302158	Cerrado	Rainy
13/11/2018	MS040	-21.143761	-53.42077	Cerrado	Rainy
13/11/2018	BR267	-21.871049	-52.826264	Cerrado	Rainy
20/11/2018	BR262	-20.49967	-54.29432	Cerrado	Rainy
26/11/2018	MS040	-21.143653	-53.420901	Cerrado	Rainy
26/11/2018	MS040	-21.256765	-52.918425	Cerrado	Rainy
21/01/2019	MS040	-21.256733	-52.91849	Cerrado	Rainy
05/02/2019	BR267	-21.774619	-52.503689	Cerrado	Rainy
26/02/2019	BR262	-20.535761	-54.700865	Cerrado	Rainy
06/03/2019	BR267	-21.737986	-52.461144	Cerrado	Rainy
29/04/2019	MS040	-21.17286	-53.25525	Cerrado	Dry
30/09/2019	MS040	-20.979718	-54.062726	Cerrado	Dry
17/12/2019	BR262	-20.492754	-55.294971	Cerrado	Rainy
21/12/2019	BR267	-21.872622	-52.833971	Cerrado	Rainy
22/12/2019	BR267	-21.592603	-54.025823	Cerrado	Rainy
12/01/2020	BR267	-21.592566	-54.025809	Cerrado	Rainy
06/04/2010	BR 471	-32.579444	-52.561638	Pampa	Dry
15/02/2013	BR 471	-32.609833	-52.572888	Pampa	Rainy
21/02/2013	BR 471	-32.647388	-52.58625	Pampa	Rainy
24/10/2013	BR 471	-32.545111	-52.54275	Pampa	Rainy
27/12/2013	BR 471	-32.605777	-52.571416	Pampa	Rainy
30/12/2014	BR 471	-32.597416	-52.568333	Pampa	Rainy
30/01/2015	BR 471	-32.597861	-52.568555	Pampa	Rainy
06/04/2016	BR 471	-32.603083	-52.570361	Pampa	Dry
01/07/2019	ES080	-20.2314973	-40.4115996	Atlantic Forest	Dry
23/02/2020	AMT	-20.254881	-40.239097	Atlantic Forest	Rainy
11/12/2020	Urban area	-20.135555	-40.233333	Atlantic Forest	Rainy
12/01/2022	AMT	-20.217323	-40.237952	Atlantic Forest	Rainy

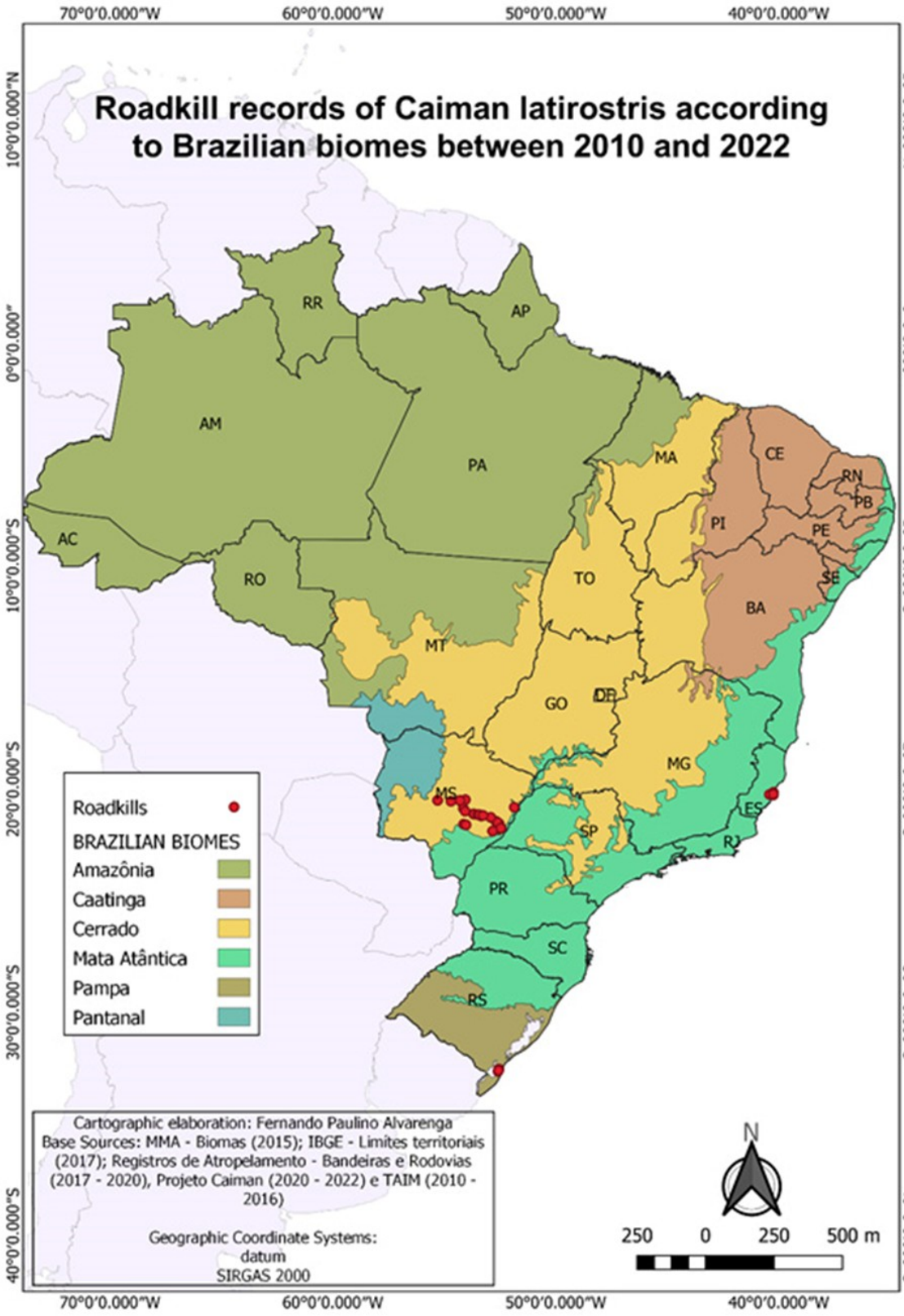

Figure 1 - Map of Brazil showing the regions and biomes where the roadkills of *Caiman latirostris* specimens occurred.

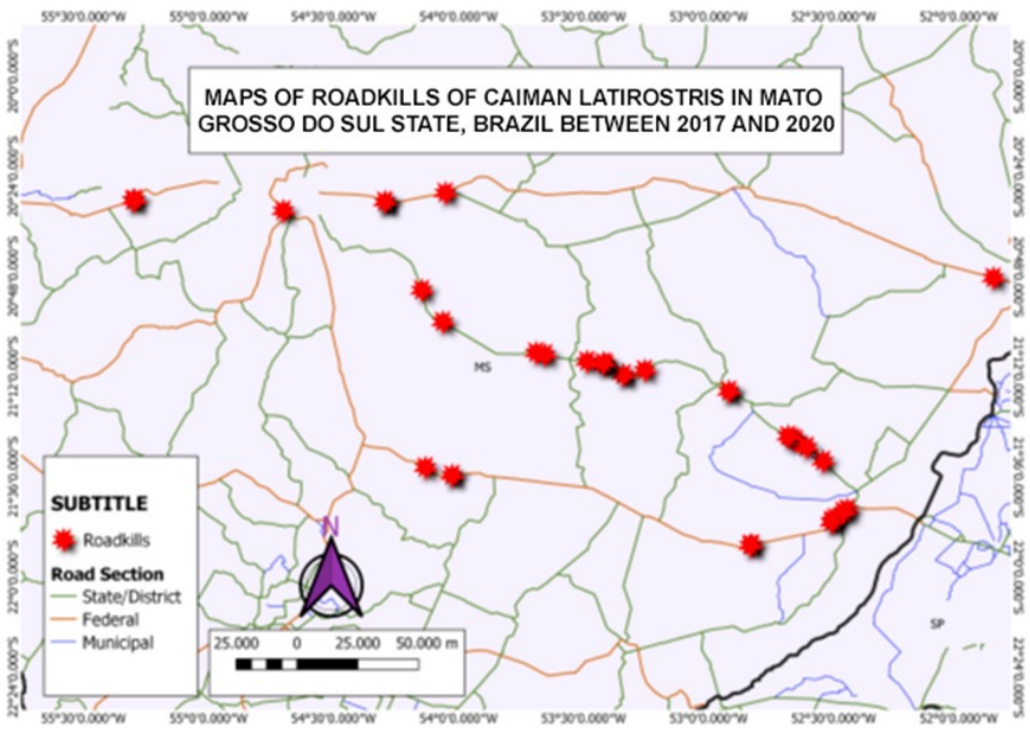

Figure 2 - Map of the state of Mato Grosso do Sul, highlighting the occurrence of roadkill of specimens of *Caiman latirostris* in the Central-Western Region.

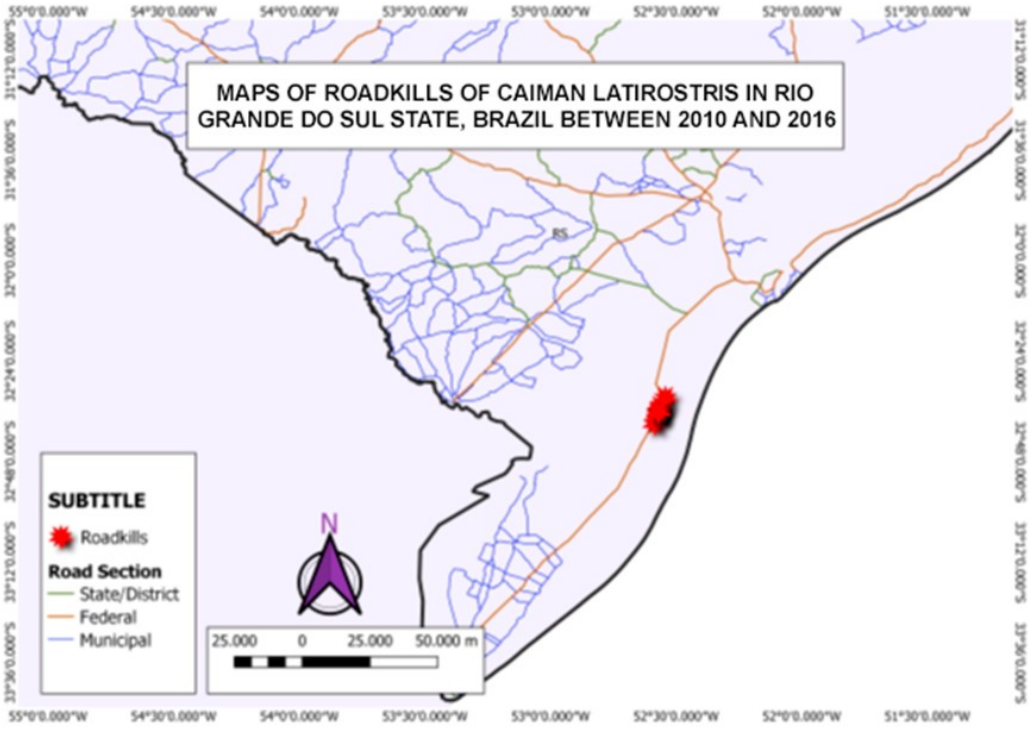

Figure 3 - Map of the state of Rio Grande do Sul, highlighting the occurrence of roadkill of specimens of *Caiman latirostris* in the Southern Region.

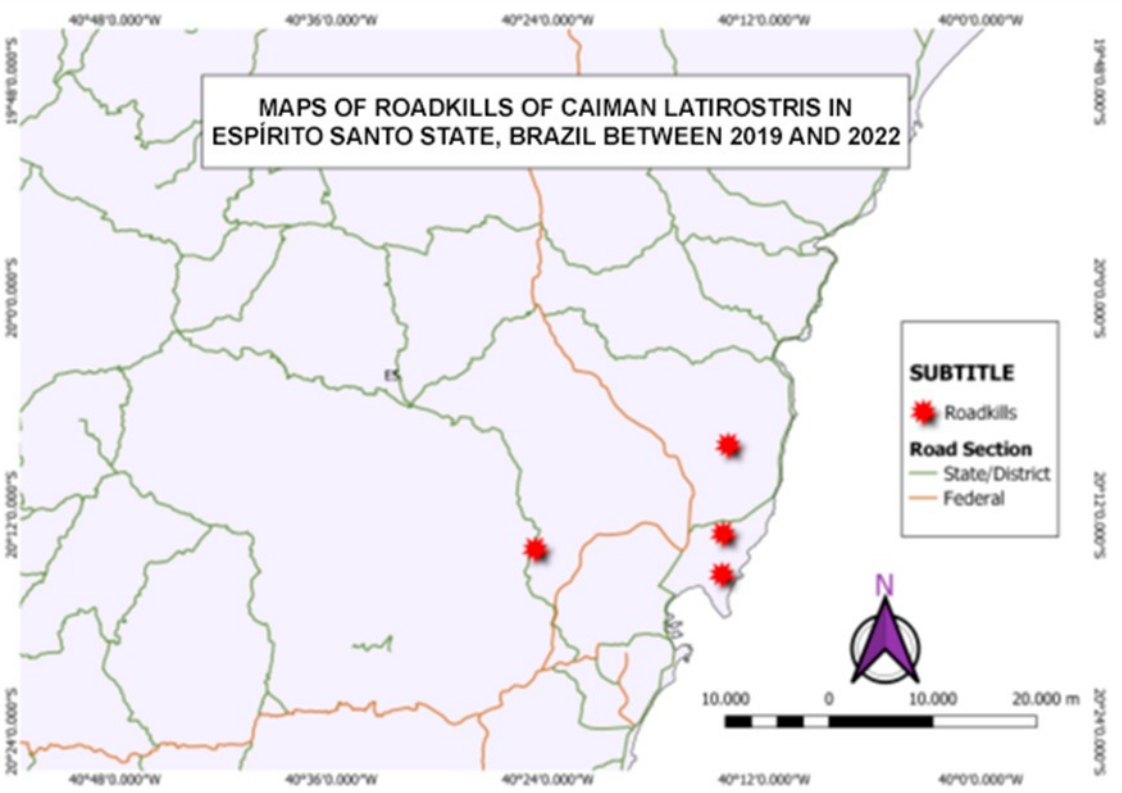

Figure 4 - Map of the state of Espírito Santo, highlighting the occurrence of roadkill of specimens of *Caiman latirostris* in the Southeastern Region.

Studies show that wildlife roadkills have patterns determined by the surroundings of the roadkill area, with reference to vegetation, climate, type of highway and the habits of different species (BAGER; ROSA, 2010; CLEVENGER et al., 2003; CURVO et al., 2021).

In the central corridor of the Atlantic Forest, *C. latirostris* populations have decreased in natural areas and are concentrated in urban areas (COUTINHO et al., 2013), where the risks of crossing roads and streets are greater, increasing the risk of roadkill as a threat to the conservation of the species. In the Central-Western region, contrariwise, in the last three years, 36 occurrences of roadkill of *C. latirostris* were recorded; 11 in 2017, 15 in 2018, and 10 in 2019. The vehicular accidents occurred in Campo Grande and in the Eastern cities surrounding it, in areas of pasture, plantations or riparian forest. In the Southern region, between the years 2010 to 2016, eight occurrences of roadkill of *C. latirostris* were recorded, and 2013 was the year of the highest incidence of records, with four occurrences. The

recordings were carried out on the stretch of road that crosses the Taim Ecological Station. After 2016, the Taim Ecological Station did not record any other cases of trampling.

The obtained data show a relationship between the roadkill rate and the rainy season, as well as the reproductive period of these animals, since the majority of roadkills (81.25%) occurred during the wettest months of these years. Nóbrega et al. (2017) suggest that for *C. latirostris* there is a greater movement of individuals due to the reproductive period, which preferably takes place between the months of October to March.

The low population density of *C. latirostris* may be one of the reasons for the few reported roadkills, when compared to the species *Caiman yacare*, for example, which has a vigorous population, with a density of approximately 100 individuals/km^2 (FARIAS et al., 2013; PRIMACK; RODRIGUES, 2001). Even in the Atlantic Forest, the biome that concentrates the largest population of these species, the number of road accidents with *C. latirostris* may be underestimated, since it presented the lowest number of occurrences of collisions, as well as a high existence number of anecdotal reports of *C. latirostris* roadkills, found on the internet and in personal communications. Furthermore, carcasses can also be quickly removed by scavenger species (TEIXEIRA et al., 2013).

Research carried out abroad evaluates roadkill events by fauna through analysis of hotspots (DIAZ-VARELA et al., 2011) and, although several studies present reports of the use of structures to reduce mortality on highways, few have measured the success of such structures (GLISTA et al., 2009).

Excepting BR 471, which covers an extension of approximately 15 km of the ESEC Taim and has 19 tunnels under the highway, road signs for drivers, screens adjacent to the shoulder in part of the stretch, in addition to two speed controllers (60 km/h) installed close to the access portals to the Station area in both directions, the other roads with occurrence of *C. latirostris* roadkill have not any mitigation measure to reduce the rate of accidents involving these animals. Noteworthy, the devices for reducing collisions with wildlife at ESEC Taim started operating in March of 2012 (BORGES; COLARES, 2007).

The present study did not aim to relate the characteristics of the landscape or the roads, nor the speed and flow of vehicles, with the roadkill rates of *C. latirostris*. Such an inference can

only be measured when landscape and traffic studies are included in the analysis. However, regardless of the causes or potentiating effects for roadkills, the data found suggests that areas modified by anthropic activities may expose caimans to the risk of collisions with vehicles. Since they enter roads while seeking a more preserved environment, whose abundance of resources was not compromised, or are feasible for their reproductive period (BAGER; ROSA, 2010).

CONCLUSION

The monitoring of roadkill fauna serves as an indicator of local biodiversity, revealing aspects about the form of displacement and seasonal dynamics of some populations of species present in a community. Databases have been created to gather, systematize, and make available information on wildlife mortality on highways, in order to assist the government and highway concessionaires in making decisions to reduce these impacts. In addition, there are effective measures that can be taken to reduce the death of wild animals by roadkill, such as improving road signs, implementing speed reducers in areas with higher levels of roadkill, fauna underpasses, directional fences, and environmental education. Therefore, this study may contribute to the compilation of new data that can support future actions for the conservation of *C. latirostris*.

OCORRÊNCIA DE ATROPELAMENTOS DE *Caiman latirostris* NAS ESTRADAS DAS REGIÕES CENTRO-OESTE, SUL E SUDESTE BRASILEIRAS

RESUMO

O Brasil apresenta uma malha viária extensivamente grande, com importância significativa para a sociedade. No entanto, a abertura de estradas pode promover a modificação da paisagem natural, aumentando as chances de atropelamentos de espécimes de animais silvestres, tanto em áreas protegidas quanto não protegidas. Nesse sentido, nota-se a importância em levantar dados de atropelamento de espécimes da fauna nativa. Considerando a escassez de informações, o principal objetivo deste trabalho foi levantar dados de atropelamentos de *Caiman latirostris* nas estradas do centro-oeste, sudeste e sul brasileiro. Um total de 48 indivíduos de *C. latirostris* atropelados, entre os anos

de 2010 e 2022, com ocorrências de atropelamento nos biomas Cerrado (75%), Pampas (16%) e Mata Atlântica (8%) foram registrados. O monitoramento da fauna atropelada pode ser um indicador da biodiversidade local e seus resultados como um alerta para implementar medidas efetivas a serem tomadas para reduzir a morte de jacarés por atropelamentos.

Palavras-chave: Colisões. Conservação. Jacaré-do-papo-amarelo. Ecologia de estradas. Monitoramento de fauna.

OCURRENCIA DE ATROPELLOS DE *Caiman latirostris* EN CARRETERAS DE LAS REGIONES CENTRO-OESTE, SUR Y SURESTE DE BRASIL

RESUMEN

Brasil tiene una extensa red de carreteras que es de gran importancia para la sociedad. Sin embargo, la apertura de caminos puede favorecer la modificación del paisaje natural, aumentando las posibilidades de atropellar ejemplares de animales salvajes, tanto en espacios protegidos como no protegidos. En este sentido, es importante recopilar datos sobre el pisoteo de ejemplares de fauna autóctona. Teniendo en cuenta la escasez de información, el objetivo principal de este trabajo fue recopilar datos sobre los atropellos de *Caiman latirostris* en las carreteras del centro-oeste, sureste y sur de Brasil. Se registró un total de 48 individuos de *C. latirostris* atropellados entre los años 2010 y 2022, con ocurrencias de atropellos en los biomas Cerrado (75%), Pampa (16%) y Mata Atlántica (8%). El monitoreo de la fauna atropellada puede ser un indicador de la biodiversidad local y sus resultados como una advertencia para implementar medidas efectivas a tomar para reducir la muerte de caimanes por atropellamientos.

Palabras clave: Colisiones. Conservación. Caimán de hocico ancho. Ecología vial. Seguimiento de fauna.

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