



# Vertebrate Roadkill in Santa Catarina State's Plateau, Southern Brazil

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**ABSTRACT** – Everyday thousands of animals are killed on highways and several studies have recorded these deaths annually. In the present study the researcher traveled, twice a day, a 70km long stretch of a highway in the plateau region of Santa Catarina state, southern Brazil, between September 2017 and May 2018. 350 vertebrate roadkill were recorded in total, the maximum recorded was 10 dead vertebrates per day. On average 2.69 vertebrates were victims of traffic per sampling day, totaling 0.02 individuals/km/day. There was neither a significant difference in the number of roadkill per day in the number of roadkill. This fact indicates that the death rate is constant, resulting in even greater damage to biodiversity. Another environmental problem was recorded, the roadkill contained a large amount of domestic animals, indicating a high rate of abandonment of animals.

**Keywords:** Conservation; road ecology; wildlife-vehicle collision.

## Atropelamento de Vertebrados no Planalto de Santa Catarina, Sul do Brasil

**RESUMO** – Todo dia, milhares de animais são mortos em rodovias e diversos estudos têm registrado essas mortes anualmente. No presente estudo, percorri quase diariamente, duas vezes ao dia, um trecho de 70km de uma rodovia na região de planalto do estado de Santa Catarina, sul do Brasil, entre setembro de 2017 e maio de 2018. Foram registrados 350 atropelamentos de vertebrados, em média 2,69 vertebrados atropelados por dia, totalizando 0,02 indivíduos/km/dia. O maior valor registrado em um dia foi de 10 vertebrados atropelados. Não houve uma diferença estatisticamente significativa no número de atropelamentos diários. Esses dados indicam que as taxas de atropelamento são constantes, resultando em danos ainda maiores para a biodiversidade. Outro problema ambiental registrado foi a grande quantidade de animais domésticos atropelados, indicando uma alta taxa de abandono de animais.

**Palavras-chave:** Conservação; ecologia de estradas; impacto de estradas.

## Mortalidad de vertebrados por colisión vehicular en la meseta de Santa Catarina, sur de Brasil

**RESUMEN** – Cada día mueren miles de animales en las carreteras y varios estudios han registrado estas muertes anualmente. En el presente estudio, recorrí casi a diario, dos veces al día, un tramo de 70km de una carretera en la región de la meseta del estado de Santa Catarina, sur de Brasil, entre septiembre de 2017 y mayo de 2018. Se registraron 350 muertes de vertebrados por colisión vehicular, una media de 2,69 vertebrados muertos por día, con un total de 0,02 individuos/km/día. El valor más alto registrado en un día fue de 10 vertebrados muertos por colisión vehicular. No ha habido diferencias estadísticamente significativas en el número de muertes diarias en la carretera. Estos datos indican que los índices de muertes de vertebrados por colisión son constantes, lo que supone un daño aún mayor para la biodiversidad. Otro problema de carácter medioambiental registrado fue el gran número de animales domésticos atropellados, lo que indica un alto índice de abandono de estos animales.

**Palabras clave:** Conservación; ecología de carretera; impacto de carretera.

## Introduction

Brazil has a wide highway network which covers the country, and in recent years several studies have recorded the massacre of animals that occur every day on those roads (Orlandin *et al.*, 2015; Valadão *et al.*, 2018; Caires *et al.*, 2019; Miranda *et al.*, 2020). Considering Brazil's economic model, this situation tends to get worse, since it is based on the transport of cargo by road (IBGE, 2019). Allied to this fact is the reality that few roads have fauna passages, identification of critical points where animals can cross, or have appropriate signs or speed reducers for vehicles.

It is also harmful the Brazilian behavioral characteristic of disrespecting the speed limits of roads, with several drivers disrespecting the limits (DETRAN/SC, 2019). Driving vehicles at high speeds can also make it difficult to divert and brake in order to avoid the death of animals, thus increasing the chance of an incident with vertebrates (Bartonička *et al.*, 2018; Ferregueti *et al.*, 2020).

The plateau region of Santa Catarina has agriculture and timber farming as its main economic activities, and presents a constant flow of vehicles between its municipalities and as well as the portuary and capital regions, especially in periods of agricultural harvesting (Rochadelli *et al.*, 2008; Mattei *et al.*, 2012). This pattern results in a strong degradation of its original vegetation types and a wide fragmentation of natural areas (Medeiros & Saleh, 2009).

Animals need to move more frequently between different fragments of natural areas to look for the resources on which they depend, be it food or shelter. This can result in a larger flow of animals in highway areas and by consequence, their death (Guimarães *et al.*, 2018; Plante *et al.*, 2019).

Given this situation, the present work aimed to analyze the vertebrate roadkill for nine months in a stretch of highway in the plateau region of Santa Catarina state, southern Brazil.

## Materials and Methods

The present work was conducted on a 70km stretch of the BR-470 highway, on the plateau region of Santa Catarina state, between the municipalities of Curitibaanos (c. 27° 18' 46" S, 50° 34' 38" W – 1,010 m a.s.l.) and Campos Novos (c. 27° 24' 17" S, 51° 12' 20" W – 900 m a.s.l.), southern Brazil (Figure 1). The route was traveled twice a day, between 5:30-6:30 a.m. and between 13:00-14:00 p.m., in a total sampling of 140km per day, between September 11, 2017 and May 24, 2018. The road crosses mainly areas used for farming purposes, interspersed with fragments of natural vegetation types known as Araucaria Forest and Natural Grasslands (both part of the Brazilian Atlantic Rainforest biome) as well as areas utilized for forestry.

A total of 130 sampling days were performed, ranging from seven to 22 sample days per month. At the end of the study, 18,200km were traveled. All vertebrate animals that were dead and visible from inside the vehicle were recorded, when possible coordinates of the placement of the roadkill and the time for disappearance of the carcass were also recorded.

In order to test if there was a significant difference in the abundance of vertebrate roadkill between the different sampling days, the test of Kruskal-Wallis was used, after the Shapiro-Wilk test for normality. These test were made on the software Past, version 4.05 (Hammer *et al.*, 2001).

## Results

During the sampling period 350 vertebrate roadkill were recorded, on average 2.69 vertebrates per sampling day, in a total of 0.02 individuals/km/day. The date with the highest amount of roadkill in this study was in January 15, 2018, when 10 dead vertebrates were recorded. There were days when no vertebrate roadkill was recorded (Table 1).

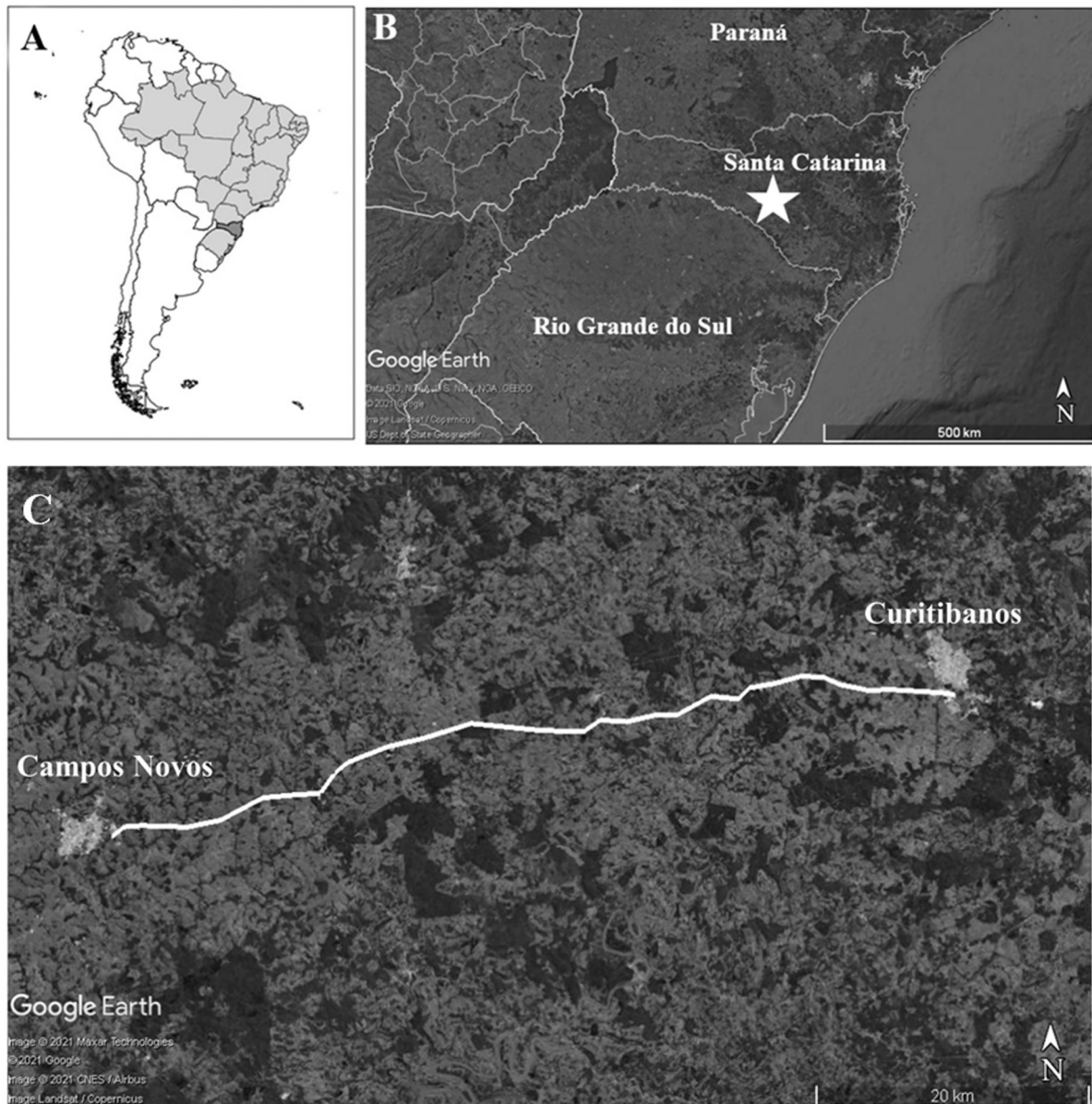


Figure 1 – Location of the sampling site in South America and Brazil (A) and in Santa Catarina state (B). Detail of the road covered in the present study, between the municipalities of Campos Novos and Curitibanos, Santa Catarina state, southern Brazil (C). Source: Google Earth (2021).

Table 1 – Number of roadkill specimens recorded per taxon in the present study in Santa Catarina state's plateau, Southern Brazil.

Taxon	Abundance
Not identified	198
Birds not identified	27
<i>Canis familiaris</i>	18
<i>Didelphis albiventris</i>	14



<b>Taxon</b>	<b>Abundance</b>
Dasypodidae	13
<i>Cerdocyon thous</i>	11
<i>Salvator merianae</i>	11
<i>Coendou spinosus</i>	9
<i>Tamandua tetradactyla</i>	6
<i>Hydrochoerus hydrochaeris</i>	5
<i>Galictis cuja</i>	4
<i>Tyto furcata</i>	4
<i>Alouatta guariba clamitans</i>	4
<i>Lepus europaeus</i>	3
<i>Procyon cancrivorus</i>	3
<i>Nasua nasua</i>	2
<i>Cariama cristata</i>	2
<i>Felis catus</i>	2
<i>Lycalopex gymnocercus</i>	1
<i>Aramides saracura</i>	1
<i>Eira barbara</i>	1
<i>Leopardus sp.</i>	1
Strigidae	1
<i>Coragyps atratus</i>	1
<i>Gallus gallus</i>	1
<i>Caracara plancus</i>	1
<i>Milvago chimachima</i>	1
<i>Ramphastos dicolorus</i>	1
<i>Penelope obscura</i>	1
<i>Sicalis flaveola</i>	1
<i>Guira guira</i>	1
<i>Rhynchotus rufescens</i>	1

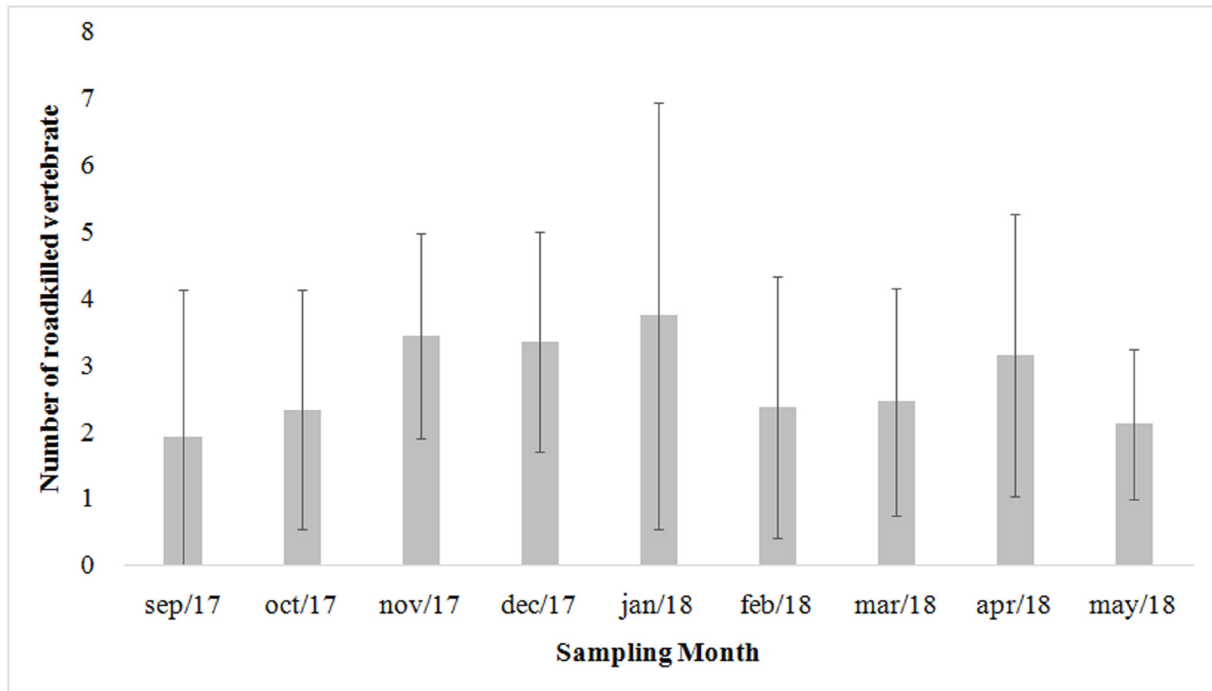


Figure 2 – Average and standard deviation of the number of animal road kills during the sampling period on a stretch of highway in Santa Catarina State, southern Brazil.

It is notable that the month of January 2018, despite the low number of sampling days ( $n = 8$ ), presented the highest average number of recorded vertebrate roadkill, 3.75 ( $\pm 3.20$ ) vertebrates per day. The lowest average number of vertebrate roadkill recorded per day was in September 2017, with 1.94 ( $\pm 2.21$ ) vertebrates per day (Figure 2).

For the total abundance of roadkill, the month of November 2017 presented most of the records, 62 vertebrates in 18 sampling days, and the lowest number of recorded roadkill was in the month of May 2018, with 17 vertebrates in eight sampling days. In comparison, in the month of January 2018, mentioned above, there were also eight sampling days, but with a total of 30 vertebrates roadkill recorded. However, there was no significant difference in the amount of roadkill recorded between sampling days, indicating that the deaths may be constant (Kruskal-Wallis:  $H = 19.18$ ,  $p = 0.67$ ).

It was possible to identify 30 taxa among 152 records (class, family, genus or species), while the other roadkill records were not identified. The taxa with the highest number of roadkill were birds, with 27 specimens, followed by 18 specimens of domestic dogs *Canis familiaris* Linnaeus,

1758, 14 specimens of White-Eared Opossum *Didelphis albiventris* Lund, 1840, 13 specimens of armadillos (Dasypodidae), 11 specimens of Crab-Eating Foxes *Cerdocyon thous* (Linnaeus, 1766), 11 Black-and-White Tegu *Salvator merianae* (Duméril & Bibron, 1839) and 9 Hairy Dwarf Porcupines *Coendou spinosus* (Cuvier, 1823). The other species or families recorded had less than seven specimens.

It was not possible to identify the species of 198 roadkill records, and those were generally animals whose bodies remained on the road after the roadkill. The non-identification occurred due to the destruction of the animal's carcass, often consisting of an amorphous mass of meat spread on the asphalt due to the constant flow of vehicles over it.

Regarding the time for the carcasses to disappear from the road, 116 vertebrate roadkill were assessed, 40% ( $n = 47$ ) of carcasses disappear in approximately 24 hours (until the following day of the record) and 25% ( $n = 29$ ) disappear on the same day. Only one carcass took more than 30 days to disappear, this was a specimen of Black Vulture (*Coragyps atratus*) (Figure 3).

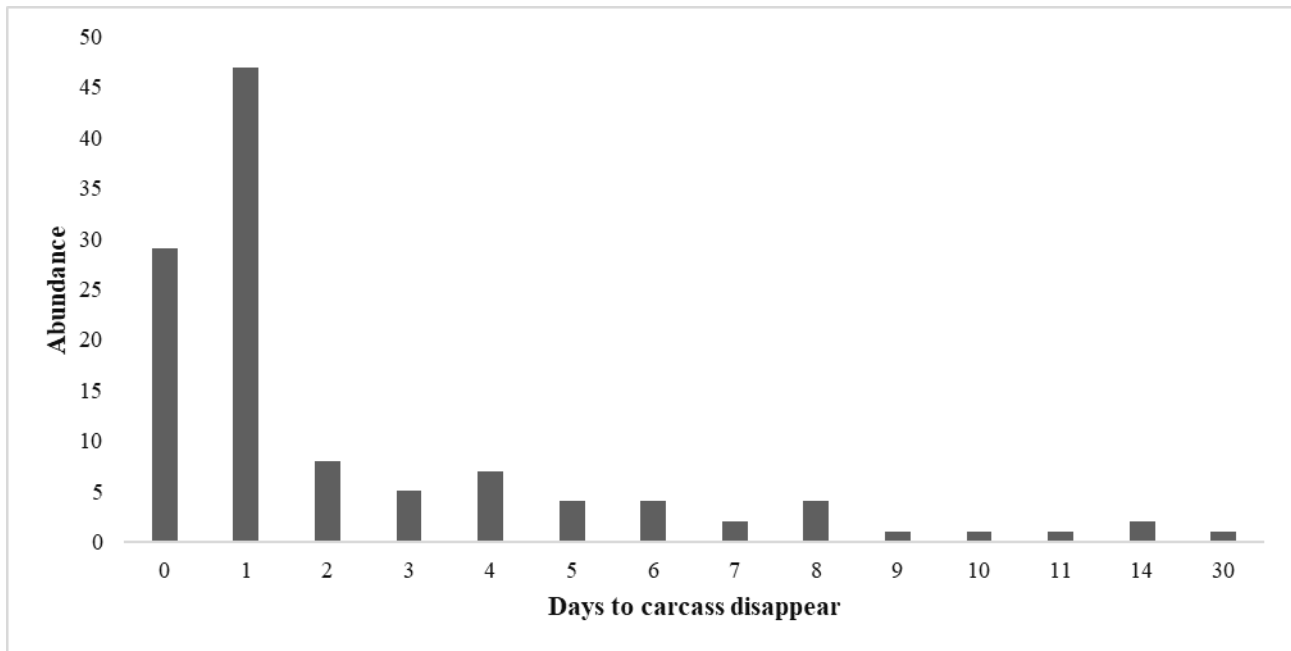


Figure 3 – Days for the vertebrate carcasses to disappear from the road in the present study.

## Discussion

The total number of vertebrate roadkill recorded here was larger than that recorded by Orlandin *et al.* (2015), who also researched roadkill in the west of Santa Catarina state. However, the rate of 0.02 individuals/km/day recorded here is lower than that recorded on other roads sampled by the aforementioned study (0.05 individuals/km/day – Orlandin *et al.*, 2015), and lower than that recorded in other biomes and states (Cunha *et al.*, 2015: 0.13 individuals/km/day; Bauni *et al.*, 2017: 0.037 individuals/km/day; Ferregueti *et al.*, 2020: 0.062 individuals/km/day).

Although there were variations in the mean number of sampling per day (highest in January 2018 and lowest in September 2017) and in total abundance of recorded roadkill per month (highest in November 2017 and lowest in May 2018), there was no statistically significant difference that would indicate daily variation, this absence of a temporal pattern was also recorded in other Brazilian states, such as Paraná (Ramos *et al.*, 2011) and Rio Grande do Sul (Oliveira & Silva, 2012). However, a recent study indicating that the number of road kills of mammals is higher in the rainy months, and that there are fewer road kills on stretches of road with traffic calming device used to reduce vehicle speed (Ferregueti *et al.*, 2020).

Thus, it is possible that on the studied stretch of road, vertebrate roadkill occurs constantly. Oscillations seem to occur mainly in periods of greater flow of vehicles on the road, such as vacation and summer periods (December and January). Other oscillations may be the result of periods of greater flow of vehicles, such as the agricultural harvest season, considering that the surroundings of the sample area are mainly used for such purpose (Ramos *et al.*, 2011). An important factor for these recorded oscillations may also be characteristics inherent to the habits of the species, such as periods of increased displacement of animals in times of search for reproductive partners or dispersal upon reaching maturity (González-Calderón, 2020; Bianchini *et al.*, 2020).

However, the absence of a temporal pattern for the roadkill may only be a result of the fact that some of the most commonly recorded species, such as *Didelphis albiventris* and *Cercopithecus thous*, do not have temporal variations in their movements (Lemos & Facure, 2011; Bianchini *et al.*, 2020). This causes them to be exposed to the roads continuously, that is, mortality and population reduction are constant, with no recovery periods, which may result in a continuous reduction in the populations of these animals (Cunha *et al.*, 2015). A fact that is even more worrisome considering



that some of the species with the highest number of recorded deaths are also among those most recorded in other similar study in the western region of Santa Catarina state (Orlandin *et al.*, 2015).

The present study was conducted on a daily basis, which made it possible to follow the time of disappearance of the carcasses of the recorded animals. Despite the low number of individuals/kilometer/day recorded, the data found here demonstrates that the absence of daily monitoring on highways can result in an underestimated number for roadkills.

In the present study 40% of the carcasses of dead animals disappeared from the site within 24 hours and 25% disappeared within the same day. Whether this disappearance is a result of other scavenging animals or people passing by the site is uncertain. A similar pattern of disappearance of carcasses of animals (in this case, snakes) was recorded by Enge & Wood (2002), in Florida (USA), where 70.5% of the carcasses had disappeared in the day after being killed.

Another problem identified in the present study is the large amount of roadkill which were domestic animals, such as dogs. This result reinforces not only the issue of animal abandonment, but also the issue that the release of these animals in areas far from human habitations, may result in predation on native animals (Galetti & Sazima, 2006; Rangel & Neiva, 2013; Vilela & Lamim-Guedes, 2014; Costa *et al.*, 2020), further increasing negative impacts on native animals.

## Conclusion

In Brazil, it is common for both citizens and political leaders to claim that it would be necessary to allow the hunting of native animals for population control purposes, to prevent them from becoming “plagues”. However, one aspect that these data shows is that any form of population control of native animals would be totally unnecessary. Considering the enormous number of animal deaths that occur every day on Brazilian highways, these deaths alone are responsible for the silent and continuous massacre of thousands of specimens of the Brazilian fauna, unprotected by the absence of a public environmental policy that involves the planning and maintenance of highways.

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