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ROADKILL OCCURRENCE OF *Cerdocyon thous* (Linnaeus, 1766) AND *Lycalopex gymnocercus* (G. Fisher, 1814) IN SOUTHERN BRAZIL

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Abstract: Despite being important for the country's development, roads may have impacts on the ecosystems where they occur, as well as the wild populations that live there. Several species are at risk of being run over on the highways, including taxa considered common and abundant. Of these species Crab-eating-fox (*Cerdocyon thous*) and Pampas-fox (*Lycalopex gymnocercus*) are susceptible to the impacts of highways and as a result this study aims to evaluate the occurrence of roadkills of *C. thous* and *L. gymnocercus* in highways in the Araucaria Plateau, Rio Grande do Sul. Monthly surveys were conducted from May / 2016 to April / 2017, along eight sections of state and federal highways of Rio Grande do Sul, Brazil. The surveys were performed in a motor vehicle, searching for carcasses of the target species. 25 animals killed by running over were recorded, 18 were *C. thous* and seven *L. gymnocercus*, but no significant difference was observed between the species or sections evaluated. However, the asphalt highways with the highest traffic volume had the highest running over concentrations. The presence of crops along the roads can be attractive to many native species, and the absence of natural barriers facilitates access to the highways, increasing the risk of collision with vehicles. It is important that mitigating measures be implemented on the highways, in order to minimize the running over of wild fauna.
Keywords: Araucaria's plateau; Canidae; Crab-eating-fox; Pampas-fox.

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1 INTRODUCTION

Highways (roads) are important structures for the development of a country, allowing the traffic of passenger and cargo vehicles (VAN DER HOEVEN *et al*., 2009; OLIVEIRA; SILVA, 2012). However, the impacts of roads since the construction to its use may compromise natural ecosystems, and as a consequence, the structure of wild populations which depends on these environments, resulting in several cases of roadkill of free-living animals that passes across these roads (FORMAN; ALEXANDER, 1998; TROMBULAK; FRISSEL, 2000). Even though highways are important for economic development, its impacts are significant to wild species (FU *et al*., 2010). Vertebrates of low population densities and/or considered threatened with extinction are more susceptible to the impacts caused by roads' construction. Nevertheless, abundant native species that use roads' surrounding areas are also directly susceptible, which negatively face this barrier, modifying their trophic, breeding and territorial patterns (FORMAN; ALEXANDER, 1998; TROMBULAK; FRISSEL, 2000).

Some studies conducted in Southern Brazil evidence road impact on the wildlife, for example: Hengemühele and Cademartori (2008), Santana *et al*. (2012), Silva *et al*. (2013), Carvalho *et al*. (2014), Corrêa *et al*. (2017) and Ceron *et al*. (2017) report that generalista and opportunistic species show higher roadkill indexes. However, specialist species are also reported to be trampled by vehicles (HENGEMÜHELE; CADEMARTORI, 2008, CERON *et al*. 2017; CORRÊA *et al*., 2017). The proportion of these roadkills may vary seasonally according to fauna abundance (COELHO *et al*., 2008; SILVA *et al*., 2013), being associated with traffic intensity, which influences collisions, especially of slow moving species (MELO; SANTOS-FILHO, 2009). Though, even the most agile species, such as birds (SICK, 1997), felines and canids, of twilight and nocturnal habits (SILVA, 1994; ACHAVAL *et al*., 2007), are also susceptible considering the high speed of vehicles (TROMBULAK; FRISSEL, 2000; HENGEMÜHELE; CADEMARTORI, 2008; FU *et al*., 2010).

In these cases, vehicles' lights at night can overshadow these animals on the highway, which end up being roadkilled. However, the proximity of urbanized areas (ALVES *et al*., 2015) and the decharacterization of the matrix around the highway also influence the risk of collisions (MELO; SANTOS-FILHO, 2009; SANTANA, 2012). Several mitigating measures are described and/or proposed in the literature, in order to minimize cases of fauna roadkill according to the taxonomic group and region structure (TROMBULAK; FRISSEL, 2000; HENGEMÜHELE; CADEMARTORI, 2008; CORRÊA *et al*., 2017). Among the proposed measures, speed reduction in certain sections, especially the ones of higher roadkill incidence, is the main recommendation to reduce animal mortality (HENGEMÜHELE; CADEMARTORI, 2008; SOUSA; MIRANDA, 2010; SILVA *et al*., 2013). Wild mammal populations are constantly suffering from anthropogenic pressures that end up causing negative impacts

on these groups, which is considered one of the most impacted by the presence of roads and highways in their life areas (SOUSA ;MIRANDA, 2010; FERREIRA *et al*., 2014).

Crab-eating-fox *Cerdocyon thous* (Linnaeus, 1766) and Pampas-fox *Lycalopex gymnocercus* (G. Fisher, 1814), are abundant canids in Rio Grande do Sul, and are considered periurban animals since it tolerates high levels of anthropic modification in its habitats, and may even benefit from such human-driven habitat modification (SILVA, 1994). *C. thous* is a species of generalist and opportunistic habits, feeding on fruits, eggs, invertebrates and small vertebrates. It measures about 65 cm in length, and adults can weigh from 5 to 8 kg (SILVA, 1994; ACHAVAL *et al*., 2007). *L. gymnocercus* is also considered a generalist species, even preferring rural environments rather than urbanized ones, and it can occupy native forests and *Pinus* spp. farms in Rio Grande do Sul (SILVA, 1994). It can reach 1 m in length, weighing about 4 to 6 kg (ACHAVAL *et al*., 2007).

Although apparently stable and sympatric, populations of *C. thous* and *L. gymnocercus* are vulnerable to direct and indirect impacts of roads, as well as to conflicts with domestic dogs and diseases contracted through the interaction with these, cases of poisoning and firearm slaughter by land owners (BEISIEGEL *et al*., 2013; QUEIROLO *et al*., 2013). Overall, these factors contribute to a potential decline of these populations (SILVA, 1994; BEISIEGEL *et al*., 2013; QUEIROLO *et al*., 2013). In this study,e analyzed the occurrence of *C. thous* and *L. gymnocercus* roadkills on highways from the Araucaria Plateau region, Rio Grande do Sul, Brazil.

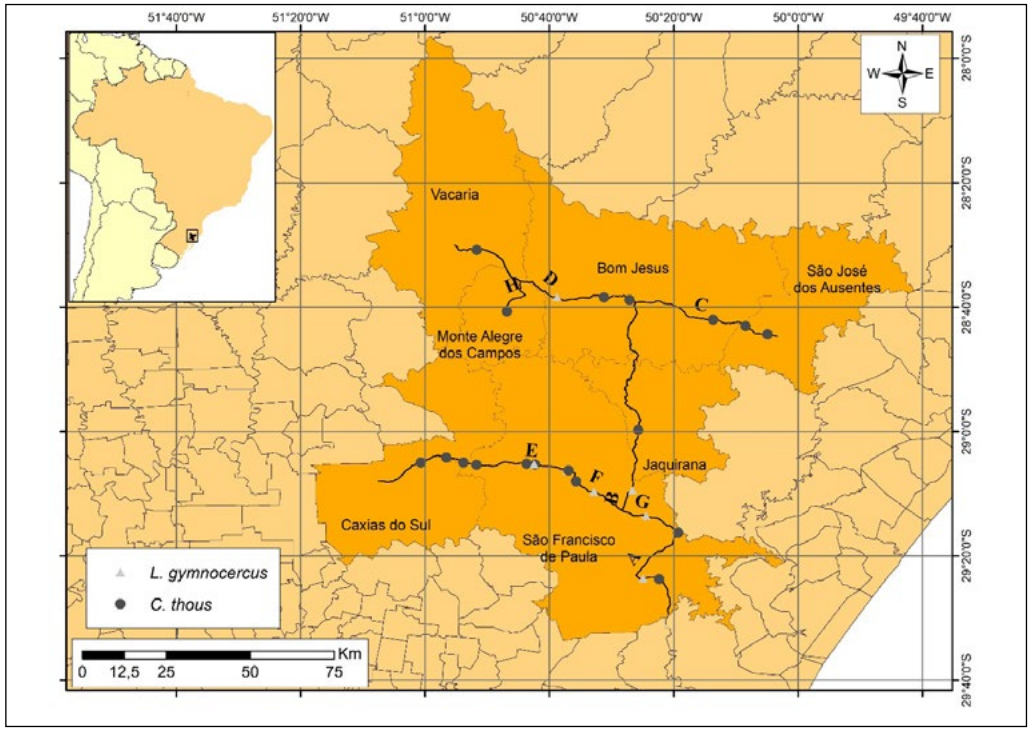
2 MATERIAL AND METHODS

This study was conducted along three stretches (eight sections) of Federal and State Highways in the Rio Grande do Sul State, Brazil (Table 1). Between the stretches of State Highways ERS-020, ERS-110, ERS-460, ERS-484; RSC-453 and Federal Highway BRS-285. These cross regions that comprise and/or connect the municipalities of Bom Jesus, Caxias do Sul, Jaquirana, Monte Alegre dos Campos, São Francisco de Paula, São José dos Ausentes and Vacaria, Rio Grande do Sul state, Brazil (Figure 1).

Table 1 - Description of eight sections of Federal and State Highways, evaluated in the Rio Grande do Sul State, Brazil, with roadklill records of Crab-eating-fox (*Cerdocyon thous*) and Pampas-fox (*Lycalopex gymnocercus*). Lenght (km) of each stretch.

Evaluated Highways	Lenght (km)
A - Entrance ERS-484 (Morrinhos) – West access to Rincão dos Kroeff	36.48
B - Entrance RSC-453 (Várzea do Cedro) - Entrance BRS-285 (Bom Jesus)	73.18
C - Entrance ERS-020 (São José dos Ausentes) - Entrance ERS-110 (Bom Jesus)	44.37
D - Entrance ERS-110 (Bom Jesus) - Entrance BRS-116 (Vacaria)	57.25
F - Entrance ERS-476 (Lajeado Grande) - Entrance ERS-110 (Várzea do Cedro)	22.49
G - Entrance ERS-110 (Varzea do Cedro) - Entrance ERS-020 (Tainhas)	16.96
H - Entrance BRS-285 - Monte Alegre dos Campos	13.97
Total	**317.12**

Figure 1- Distribution map of the evaluated stretches during the study, with the record points of Crab-eating-fox (*Cerdocyon thous*) and Pampas-fox (*Lycalopex gymnocercus*), in the State of Rio Grande do Sul, Brazil.



Roads are inserted in regions under the domain of Atlantic Forest Biome, comprising forests of Seasonal Deciduous and Mixed Ombrophylous domains, with the presence of grasslands, steppe and savanna vegetation around some stretches. The region is popularly known as Araucaria Plateau, and suffers from intense anthropic pressure resulting from urban and agriculture activities (IBGE, 2004). The relief is wavy, with many slopes of elevations varying from 700 to 1000 m. The climate is considered temperate, with average annual temperature lower than 17°C and e annual rainfall of ~1800mm (BRASIL, 1973; ALVARES *et al*., 2013).

The surveyed stretches totaled 317.12 km which was crossed between May 2016 and April 2017. Surveys were conducted monthly, during morning after sunrise (SILVA *et al*., 2013) and, at total, we covered 3.805,44 km along 12 excursions. We covered the highways using a motor vehicle at an average speed of 40 km/h (MELO; SANTOS-FILHO, 2007), where two observers searched for *C. thous* and *L. gymnocercus* carcasses along the roads. Records of both species was georeferenced using a hand-held GPS, reported in the field spreadsheet. Then, we removed each animal from the road, in order to avoid recounting and to reduce the risk of other scavenger animals (ZANDONADI *et al*., 2014; DEFFACI *et al*., 2016).

In order to determine na index for foxes' roadkill along 12 months, we calculated the ratio between total roadkill and the total distance covered. The significance of the each species roadkill rate in each stretch was tested through the Kruskall-Wallis test. In order to verify if there is a relation between stretches' length and the number of roadkills, we calculated a Linear Regression between these variables. The analyzes were performed in the R software, considering $p \leq 0.05$ as the critical value.

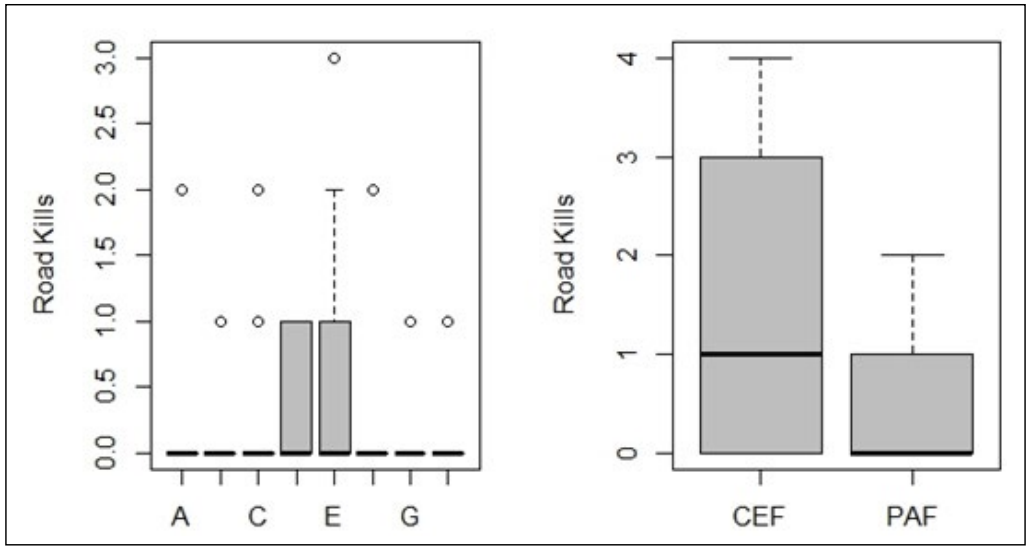
3 RESULTS AND DISCUSSION

During surveys, we found 25 roadkilled foxes, of which 18 individuals were *C. thous* and 7 were *L. gymnocercus*. The stretch in which most roadkills occurred was the E (n=7), followed by D and F (n=4), C (n=3), A, B e G (n=2), and finally H (n=1) (Table 2). The roadkill indexes were 0.002 for *L. gymnocercus* and 0.005 for *C. thous*. For the two species, it was 0.007. Furthermore, the Kruskall-Wallis showed no significant difference between the species (χ^2=3,22,6435, dF=1, p=0.104), and the analysis between stretches also showed no significant differences (χ^2=4.96, dF=7, p=0.66) (Figure 2). The linear regression between stretches was also not significant (R^2 0.15, p=0.104), showing the occurrence of roadkills is not dependent on the extension of the sampled stretches (Figure 3).

Table 2 - Number of *C. thous* (Crab-eating-fox - CEF) and *L. gymnocercus* (Pampas-fox - PAF) found dead in each survey and in each sampled stretch.

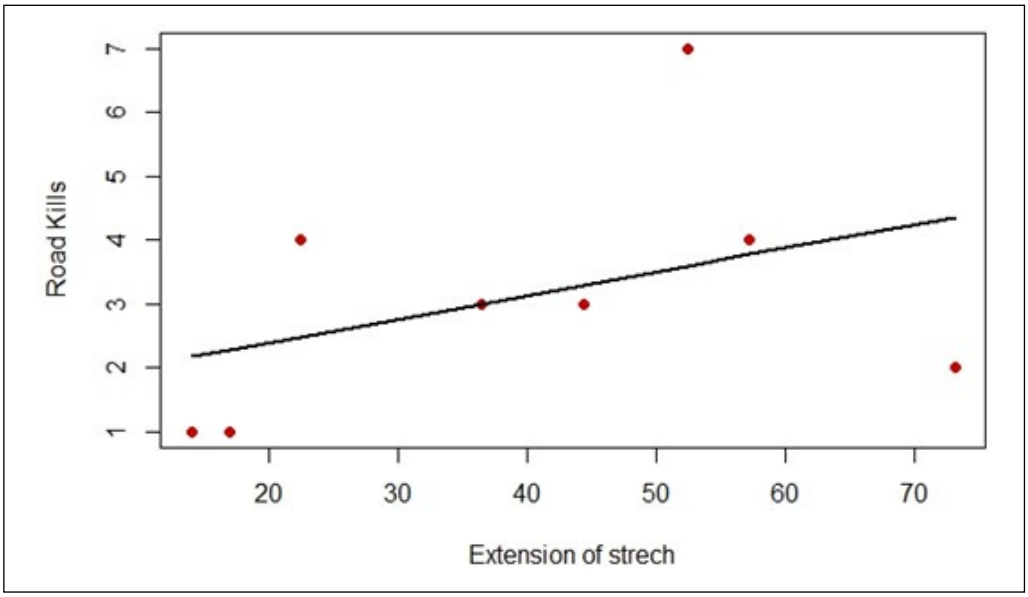
Strech	Lenght (km)	Road-kills	CET	PAF
A	36,48	3	2	1
B	73,18	2	1	1
C	44,37	3	3	0
D	57,25	4	3	1
E	52,42	7	6	1
F	22,49	4	2	2
G	16,96	1	0	1
H	13,97	1	1	0
TOTAL	**317,12**	**25**	**18**	**7**

Figure 2 - Boxplot of the evaluated roadkills in this study. On the left, the comparison between stretches, and on the right, between species. CEF - *C. thous* and PAF - *L. gymnocercus*.



The highways surveyed in this study are characterized by the flow of raw materials from the region, for processing in other locations, besides serving as a connection between metropolitan cities and the coastal areas of the state. Also, roads are essential for providing access to basic services for the human population (VAN DER HOEVEN *et al*., 2009; OLIVEIRA; SILVA, 2012) and also for industry and commerce, as it enable the transport of resources between producers and consumers (OLIVEIRA; SILVA, 2012; COLLINSON, 2013).

Figure 3 - Linear regression of stretch extension and the number of roadkills found, R^2 0.1581. y = 0.03x + 1.656.



While roads are extremely important structures for urban development, the installation of these along natural areas, especially for connecting cities, becomes one of the causes of the fragmentation of large areas, and consequently affects the natural populations that inhabit these areas (SANTOS; TABARELLI, 2002; MORELLI *et al*., 2014). Also, roads can directly affect animals by colliding with vehicles (BARTHELMESS; BROOKS, 2010). Since highways generally interrupt natural areas, many animals are forced to cross these structures almost daily in order to forage, rest and breed. In addition, roads can provide resources such as grains from transport losses, and the carcasses of roadkilled animals themselves, increasing the volume of road-going organisms (BENÍTEZ-LÓPEZ *et al*., 2010; MORELLI *et al*., 2014). As expected, roadkills distribution along the study area concentrates in paved highways with higher traffic volumes. As already suggested in several studies (TROMBULAK; FRISSEL, 2000; CLEVENGER *et al*., 2003; MALO *et al*., 2004; SAEKI; MACDONALD, 2004; COELHO *et al*., 2008; CÁCERES *et al*., 2010; CÁCERES *et al*., 2012; SILVA *et al*., 2013) there is a direct relationship between the characteristics of highways such as road pavement, number of vehicles, speed, as well as the structure of the environment.

The impact and influence of highways on vertebrates, especially mammals, has been documented in different regions of the world (PINOWSKI, 2005; SMITH-PATTEN; PATTEN, 2008; TAYLOR; GOLDINGAY, 2004; ATTADEMO *et al*., 2011). Medium size (1 to 10kg) animals and omnivores, such

as the target species of this study, present higher roadkill rates (BARTHELMESS; BROOKS, 2010).

When comparing the target species of this study, no significant differences were found between roadkill rates along the surveyed period, thus, both species are equally vulnerable to damages caused by the contact with roads. Different studies have confirmed *C. thous* and *L. gymnocercus* as roadkill victims (PINOWSKI, 2005; MELO; SANTOS-FILHO, 2009; ATTADEMO *et al*., 2011; HEGEL *et al*., 2012; OLIVEIRA; SILVA, 2012; CUYCKENS *et al*., 2016; CORRÊA *et al*., 2017). Even though both species are considered generalist, *C. thous* is more adapted to modified environments, and this opportunistic habit may enhance the chance of roadkill, thus justifying a higher number of cases for this species (SILVA, 1994; ACHAVAL *et al*., 2007). In addition, *C.thous* has been reported in other studies as a species of high roadkill rates, often being the most mentioned mammal in roadkill studies (PINOWSKI, 2005; MELO; SANTOS-FILHO, 2009). This fact can be explained since this species, more than L. gymnocercus, usually uses roads for displacements, but also, its feeding amplitude allows it to consume carcasses on the highways (MELO; SANTOS-FILHO, 2009).

4 CONCLUSION

Roads are an important source for vehicles to move, but from their implementation to continuous use, they cause several impacts on wildlife, and it is important to carry out studies reporting information on these impacts. Our study reports information on records of road kills by *C. thous* and *L. gymnocercus* in different stretches of highways (roads) in the extreme northeast of the state. But no significant difference was observed between the species or sections evaluated. However, the asphalt highways with the highest traffic volume had the highest running over concentrations. The presence of crops along the roads can be attractive to many native species, and the absence of natural barriers facilitates access to the highways, increasing the risk of collision with vehicles. Also, on large stretches of these roads, it was possible to observe rotating crops of different plant species, which can serve as attractive to various wildlife organisms, often target preys of *C. thous* and *L. gymonocercus*. As mentioned in the literature, these investigative studies at local levels can serve as a basis for future studies, aiming to alert and reduce roadkills in wild animals on highways. Finally, we recommend that all studies related to the ecology of roads should be published in indexed journals, presenting the impacted species and reporting this problem.

REFERENCES

ACHAVAL, F. *et al*. Mamíferos de la República Oriental del Uruguay, guia fotográfica. 2.ed. Montevideo: Zonalibro Indústria Gráfica, 2007. 216p.

ALVARES, C.A. *et al*. Köppen's climate classification map for Brazil. **Meteorologische Zeitschrift**, Gebrüder Borntraeger, v.22, n. 6, p. 711–728, jan. 2013. Available in: http://www.lerf.eco.br/img/publicacoes/Alvares_etal_2014.pdf. Access at:14 jan. 2022.

ALVES, D. M. D. *et al*. Levantamento de vertebrados silvestres atropelados com enfoque em indivíduos da Ordem Chiroptera: estudo de caso da rodovia MGC-354, Minas Gerais, Brasil. **Revista Perquirere**, Patos de Minas, v.**12**, n.1, 176–193, jul. 2015. Available in: https://docplayer.com.br/76594313-Perquirere-12-1-jul-centro-universitario-de-patos-de-minas.html. Access at:16 jan. 2022.

ATTADEMO, A. M. *et al*.. Wildlife vertebrate mortality in roads from Santa Fe Province, Argentina. **Revista Mexicana de Biodiversidad**, México, v. 82, n. 3, p. 915-925, set. 2011. Available in: https://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S1870-34532011000300018. Access at: 10 jan. 2022.

BARTHELMESS, E. L.; BROOKS, M. S. The influence of body-size and diet on road-kill trends in mammals. **Biodiversity and Conservation**, México, v.19, n. 6, p. 1611-1629, fev. 2010. Available in: https://www.semanticscholar.org/paper/The-influence-of-body-size-and-diet-on-road-kill-in-Barthelmess-Brooks/2d242e88a854abf39681a2c56fb9f160e2c55480. Access at: 29 jan. 2022.

BEISIEGEL, B. M. *et al*. Avaliação do risco de extinção do Cachorro-do-mato *Cerdocyon thous* (Linnaeus, 1766) no Brasil. **Biodiversidade Brasileira**, Brasilia, v.3, n. 1, p.138-145, out. 2013. Available in: https://revistaeletronica.icmbio.gov.br/BioBR/article/view/380. Access at: 15 jan. 2022.

BENÍTEZ-LÓPEZ, A. *et al*.. The impacts of roads and other infrastructure on mammal and bird populations: a meta-analysis. **Biological Conservation**, Montpellier, v.143, n. 6, p. 1307-1316, jun. 2010. Available in: https://www.sciencedirect.com/science/article/abs/pii/S0006320710000480. Access at: 14 jan. 2022.

BRASIL. Ministério da Agricultura. Departamento Nacional de Pesquisa Agropecuária. Levantamento de reconhecimento dos solos do Estado do Rio Grande do Sul. Recife: MA/DPPSA/DRNR/ INCRA/RS-MA/DPP-AS/DRNR. Boletim técnico, n. 30, 1973. 429p. Available in: https://www.infoteca.cnptia.embrapa.br/handle/doc/331173. Access at: 19 jan. 2022.

CÁCERES, N. C. *et al*. Mammal occurrence and roadkill in two adjacent ecoregions (Atlantic Forest and Cerrado) in south-western Brazil. **Zoologia**, Curitiba, v.27, n. 5, p. 709-717, out. 2010. Available in: https://www.scielo.br/j/zool/a/jxqMkLzsjfSFcBGyshnRZtz/?lang=en. Access at: 14 jan. 2022.

CÁCERES, N. C. *et al*. Variação espacial e sazonal de atropelamentos de mamíferos no bioma cerrado, rodovia BR 262, Sudoeste do Brasil. **Mastozoología neotropical**, Buenos Aires, v.19, n. 1, p. 21-33, jun. 2012. Available in: http://www.scielo.org.ar/scielo.php?script=sci_arttext&pid=S0327-93832012000100003. Access at: 15 jan. 2022.

CARVALHO, N. C. *et al*.. Fast and furious: a look at the death of animals on the highway MS-080, Southwestern Brazil. **Iheringia,** Porto Alegre, v. 104, n.1, p. 43-49, mar. 2014. Available in: https://www.scielo.br/j/isz/a/Q75TtN74SjCSjSG8yXDxXpH/abstract/?lang=en. Access at: 14 jan. 2022.

CERON, K. *et al*. Roadkilled bats (Mammalia: Chiroptera) in two highways of Santa Catarina state, Southern Brazil. **Oecologia Australis**, Rio de Janeiro, v.21, n. 2, p. 207-212, mar. 2017. Available in: https://revistas.ufrj.br/index.php/oa/article/view/11922. Access at: 18 jan. 2022.

CLEVENGER, A. P. *et al*. Spatial patterns and factors influencing small vertebrate fauna road-kill aggregations. **Biological conservation**, v.109, n.1, p. 15-26, jan. 2003. Available in: https://www.sciencedirect.com/science/article/abs/pii/S0006320702001271. Access at:14 jan. 2022.

COELHO, I. P. *et al*. Roadkills of vertebrate species on two highways through the Atlantic Forest Biosphere Reserve, southern Brazil. **European Journal of Wildlife Research**, Ciudad Real, v.54, n. 4, p. 689-699, jul. 2008. Available in: https://link.springer.com/article/10.1007/s10344-008-0197-4. Access at: 20 jan. 2022.

COLLINSON, W. J. A standardised protocol for roadkill detection and the determinants of roadkill in the Greater Mapungubwe Transfrontier Conservation Area, Limpopo Province, South Africa. Master Thesis. Rhodes University. Grahamstown. South Africa, 2013. 230p. Available in: http://vital.seals.ac.za:8080/vital/access/manager/Repository/vital:5606?site_name=GlobalView&view=null&f0=sm_subject%3A%22Roadkill+--+South+Africa+--+Mapungubwe+Site%22&sort=null. Access at: 19 jan. 2022.

CORRÊA, L. L. C. *et al*. Vertebrate road kill survey on a highway in southern Brazil. **Acta Scientiarum. Biological Sciences**, Maringa, v. 39, n. 2, p. 219-225, jun. 2017. Available in:https://periodicos.uem.br/ojs/index.php/ActaSciBiolSci/article/view/33788. Access at:17 jan. 2022.

CUYCKENS, G. A. E. *et al*. Patterns and Composition of Road-Killed Wildlife in Northwest Argentina. **Environmental management**, v.58, n. 5, p. 810-820, set. 2016. Available in: https://pubmed.ncbi.nlm.nih.gov/27619944/. Access at: 19 jan. 2022.

DEFFACI, A. C. *et al*. Diversidade de aves, mamíferos e répteis atropelados em região de floresta subtropical no sul do Brasil. **Ciência e Natura**, Santa Maria, v. 38, n. 3, p.1205-1216, set. 2016. Available in: https://periodicos.ufsm.br/cienciaenatura/article/view/22020/pdf. Access at: 15 jan. 2022.

FERREIRA, C. M. M. *et al*. Variação espacial de atropelamentos de mamíferos em área de restinga no estado do Espírito Santo, Brasil. **Neotropical Biology and Conservation**, São Leopoldo, v.9, n. 3, p. 125-133, set/dec. 2014. Available in: https://revistas.unisinos.br/index.php/neotropical/article/view/nbc.2014.93.02/4431. Access at:14 jan. 2022.

FORMAN; R. T. T.; ALEXANDER, L. E. Roads and Their Major Ecological Effects. **Annual Review of Ecology and Systematics,** v.29, p. 207-231, nov. 1998. Available in: https://www.annualreviews.org/doi/pdf/10.1146/annurev.ecolsys.29.1.207. Access at:15 jan. 2022.

FU, W. *et al*. Landscape pattern changes under the disturbance of road networks. **Procedia Environmental Sciences**, v. 2, p.859-867, 2010. Available in: https://www.sciencedirect.com/science/article/pii/S1878029610001301. Access at:15 jan. 2022.

HEGEL, C. G. Z. *et al*. Mamíferos silvestres astropelados na rodovia RS-135, norte do Estado do Rio Grande do Sul. **Biotemas**, Florianópolis, v.25, n. 2, p.165-170, jan. 2012. Available in: https://periodicos.ufsc.br/index.php/biotemas/article/view/2175-7925.2012v25n2p165/21821. Access at: 14 jan. 2022.

HENGEMÜHELE, A.; CADEMARTORI, C. V. Levantamento e mortes de vertebrados silvestres devido a atropelamento em um trecho da estrada do mar (RS-389). **Biodiversidade Pampeana**, Uruguaiana, v.6, n. 2, p. 4-10, dez. 2008. Available in: https://docplayer.com.br/37623352-Levantamento-de-mortes-de-vertebrados-silvestres-devido-a-atropelamento-em-um-trecho-da-estrada-do-mar-rs-389.html. Access at: 20 jan. 2022.

IBGE - Instituto Brasileiro de Geografia e Estatística. Mapa de Biomas e Vegetação do Brasil. Brasília, IBGE e Ministério do Meio Ambiente, 2004. Available in: <http://www.ibge.gov.br/Cartas_e_Mapas/Mapas_Murais/. Access at: 28 jan. 2022.

MALO, J. E. *et al*. Can we mitigate animal–vehicle accidents using predictive models?. **Journal of Applied Ecology**, London, v. 41, n. 4, p. 701-710, jul. 2004. Available in: https://besjournals.onlinelibrary.wiley.com/doi/10.1111/j.0021-8901.2004.00929.x. Access at: 17 jan. 2022.

MELO, E. S.; SANTOS-FILHO, M. Efeitos da BR-070 na Província Serrana de Cáceres, Mato Grosso, sobre a comunidade de vertebrados silvestres. **Revista Brasileira de Zoociências**, Juiz de Fora, v.9, n. 2, p. 185-192, dez. 2009. Available in: https://periodicos.ufjf.br/index.php/zoociencias/issue/view/1146. Access at: 15 jan. 2022.

MORELLI, F. *et al*. Can roads, railways and related structures have positive effects on birds?–A review. **Transportation Research Part D: Transport and Environment**, v.30, p. 21-31, jul. 2014. Available in: https://www.sciencedirect.com/science/article/abs/pii/S1361920914000327. Access at: 28 jan. 2022.

OLIVEIRA, D. S.; SILVA, V. M. Vertebrados silvestres atropelados na BR 158, RS, Brasil. **Biotemas**, Florianópolis, v.25, n.4, p. 229-235, set. 2012. Available in: https://periodicos.ufsc.br/index.php/biotemas/article/view/2175-7925.2012v25n4p229/0. Access at: 19 jan. 2022.

PINOWSKI, J. Roadkills of vertebrates in Venezuela. **Revista Brasileira de Zoologia**, Paraná, v.22, n.1, p. 191-196, mar. 2005. Available in: https://www.scielo.br/j/rbzool/a/G8mX5FCyBf63YLgBk4kLZ7s/?lang=en. Access at: 15 jan. 2022.

QUEIROLO, D. *et al*. 2013. Avaliação do risco de extinção do graxaim-do-campo *Lycalopex gymnocercus* (G. Fischer, 1814) no Brasil. **Biodiversidade Brasileira**, Brasilia, v.3, n.1, p. 172-178. out. 2013. Available in: file:///C:/Users/Usuario/Downloads/383-Texto%20do%20Artigo-1554-1-10-20131007-1.pdf. Access at: 15 jan. 2022.

SAEKI, M.; MACDONALD, D. W. The effects of traffic on the raccoon dog (*Nyctereutes procyonoides viverrinus*) and other mammals in Japan. **Biological conservation**, v.118, n. 5, p. 559-571, ago. 2004. Available in: https://www.sciencedirect.com/science/article/abs/pii/S0006320703004026. Access at: 14 jan. 2022.

SANTANA, G. S. Fatores influentes sobre atropelamentos de vertebrados na região central do Rio Grande do Sul, Brasil. **Neotropical Biology and Conservation**, São Leopoldo, v.7, n. 1, p. 26-40, jan/abr. 2012. Available in: https://revistas.unisinos.br/index.php/neotropical/article/view/nbc.2012.71.05/811. Access at: 16 jan. 2022.

SANTOS, A. M.; TABARELLI, M. Distance from roads and cities as a predictor of habitat loss and fragmentation in the Caatinga vegetation of Brazil. **Brazilian Journal of Biology**, São Paulo, v. 62, n. 4, p. 897–905, nov. 2002. Available in: https://www.scielo.br/j/bjb/a/CyHqkYNbYz94y6hKWVTfwfH/?lang=en. Access at: 28 jan. 2022.

SICK, H. 1997. Ornitologia Brasileira. Rio de Janeiro: Nova Fronteira, 1997. 912p.

SILVA, D. E. *et al*. Monitoramento de vertebrados atropelados em dois trechos de rodovias na região central do Rio Grande do Sul, Brasil. **Revista de Ciências Ambientais,** Canoas, v.7, n. 1, p.27-36, jul. 2013. Available in: https://revistas.unilasalle.edu.br/index.php/Rbca/article/view/406/879

https://silo.tips/download/mamiferos-terrestres-encontrados-atropelados-na-rodovia-br-230-pb-entre-campina. Access at: 15 jan. 2022.

SILVA, F. 1994. Mamíferos silvestres do Rio Grande do Sul. 2.ed. Fundação Zoobotânica do Rio Grande do Sul: Porto Alegre, 1994. 244p.

SMITH-PATTEN, B. D.; PATTEN, M. A. Diversity, seasonality, and context of mammalian roadkills in the southern Great Plains. **Environmental Management**, v. 41, n. 6, p. 844-852, jun. 2008. Available in: https://pubmed.ncbi.nlm.nih.gov/18299918/. Access at: 28 jan. 2022.

SOUSA, M. A. N. D.; MIRANDA, P. C. D. Mamíferos terrestres atropelados na rodovia BR-230/PB entre Campina Grande e João Pessoa. **Revista de Biologia e Farmácia**, Paraiba, v.4, n. 2, p. 72-82, 2010. Available in: https://silo.tips/download/mamiferos-terrestres-encontrados-atropelados-na-rodovia-br-230-pb-entre-campina. Access at: 20 jan. 2022.

TAYLOR, B. D.; GOLDINGAY, R. L. Wildlife road-kills on three major roads in north-eastern New South Wales. **Wildlife Research**, v.31, n. 1, p. 83-91, mar. 2004. Available in: https://www.publish.csiro.au/WR/WR01110. Access at: 14 jan. 2022.

TROMBULAK, S. C.; FRISSELL, C. A. Review of ecological effects of roads on terrestrial and aquatic communities. **Conservation Biology**,v.14, p.18-30, fev. 2000. Available in: https://conbio.onlinelibrary.wiley.com/doi/pdf/10.1046/j.1523-1739.2000.99084.x. Access at: 16 jan. 2022.

VAN DER HOEVEN, C. A. *et al*. Roadside conditions as predictor for wildlife crossing probability in a Central African rainforest. **African Journal of Ecology**, v.48, n.2, p.368-377, mai. 2010. Available in: https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1365-2028.2009.01122.x. Access at: 15 jan. 2022.

ZANDONADI, A. P. *et al*. Vertebrados atropelados na BR-429 eixo Alvorada d Oeste - São Miguel do Guaporé, Rondônia, Brasil. **Revista Científica da Unesc**, Criciúma, v.12, n. 15, p. 1-11, 2014. Available in: https://docplayer.com.br/37623351-Vertebrados-atropelados-na-br-429-eixo-alvorada-d-oeste-sao-miguel-do-guapore-rondonia-brasil.html. Access at: 15 jan. 2022.