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ROADKILL IN THE BRAZILIAN CERRADO SAVANNA: COMPARING FIVE HIGHWAYS IN SOUTHWESTERN GOIÁS

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ABSTRACT
This study described and analyzed the roadkill of native vertebrates in the southwest of the Brazilian State of Goiás, evaluating the influence of the seasonal variation in climate and the influence of highway structure (*e.g.*, two lane/one lane routes, road conditions). In this context, we collected samples each month over a one-year period on five of the region's highways, all of which originate in the town of Jataí, linking it to the neighboring towns of Acreúna, Aporé, Itajá, Doverlândia and Portelândia. We recorded 1113 individuals (0.115 individuals/km/year), including nine amphibians, 55 reptiles, 223 birds, and 826 mammals. The two-lane highway had the highest species richness and abundance, and was significantly different from the other roads. We also found significant seasonal differences in overall abundance, and the species richness and abundance of the herpetofauna, with a greater number of collisions occurring during the rainy season. Over the long term, programs of environmental education – especially during the rainy season – may help to raise the awareness of drivers.
Keywords: biodiversity; Cerrado; highways; Road Ecology.

INTRODUCTION

Highways are an essential transportation infrastructure that improve the access to remote regions and support land use, forming a complex network that fragments the landscape (Antrop 2000). As the highway network expands, the landscape becomes ever more fragmented (Coffin 2007). In the United States, for example, approximately 20% of the land is affected directly by highways (Forman & Alexander 1998).

Roads alter the abiotic and biotic components of the ecosystem (Coffin 2007) and affect the fauna in a number of different ways, acting as barriers or filters to the movement of species (Forman & Alexander 1998). It has been estimated that, if Brazil reaches the same proportion of paved highways as the United States, as many as 603 million collisions with animals may occur per year (Dornas *et al.* 2012).

Highways are one of the principal factors contributing to the loss of biodiversity (Coffin 2007, Cáceres *et al.* 2010), and the growth of the highway network reinforces the need for increasing field research on the ecology of roads (Rosa & Bager 2013). Little is known of the impact of roadkill on the fauna of Brazil (Bager *et al.* 2007), which is a fundamental problem for the protection and management of its wildlife, given the need for reliable data on which to base the development of effective conservation policies for the highway network.

The most obvious and direct impact of highways on the local fauna is collisions and roadkill (Forman & Alexander 1998, Coffin 2007), although the barrier effect may impact more species over a wider area (Forman & Alexander 1998), through the interruption of normal migration patterns and reproduction (Jaeger *et al.* 2005). Highways also have a border effect, the intensity of which will depend on the intensity of the traffic and dynamics of the local economy (Coffin 2007). All these processes may contribute to the isolation of populations and increase the probability of local extinction (Jaeger *et al.* 2005).

The Brazilian Midwest has a number of important federal highways, which link the capital, Brasília, to the country's other major urban centers (Klink & Moreira 2002), and are also used to transport agricultural produce, in particular soybean, to seaports for exportation (Correa & Ramos 2010). There is a clear need for research on the fauna of this highway network for the understanding of the effects of the impacts caused by this traffic, which will provide essential data for the development of effective management policies for the protection of the Cerrado fauna. In this context, our goal was described and analyzed the roadkill of native vertebrates in the southwest of the Brazilian state of Goiás, evaluating the influence of the seasonal variation in climate and the influence of highway structure (*e.g.*, two-lane/one-lane routes, road conditions). The analysis of seasonal patterns may provide important guidelines for the temporal distribution of conservation and educational measures, while the understanding of the influence of highway structure will help to identify the routes that require most attention from conservationists.

MATERIAL AND METHODS

The study was conducted between January 2014 and January 2015 on five stretches of highway in southwestern Goiás, Brazil, centered on the town of Jataí (Figure 1). The region's climate is of the Aw type, with dry winters (April-September) and rainy summers (October-March) (Alvares *et al.* 2014). The five routes were (i) 170 km north to the towns of Caiapônia (via the BR158 federal highway) and Doverlândia (denominated DV here), via the GO-221 state highway, (ii) 160 km east to Acreúna (AC), via the BR-060, (iii) 142 km northwest to Mineiros (via the BR-364) and Portelândia (PO) via the GO-194 highway, (iv) 144 km southwest to Aporé (AP) via the GO-184 and BR-060 highways, and (v) 186 km south to Itajá (IT) via the BR-364, GO-206 and GO-178 highways. We surveyed a total of 9624 km of highway on these five routes over the study year.

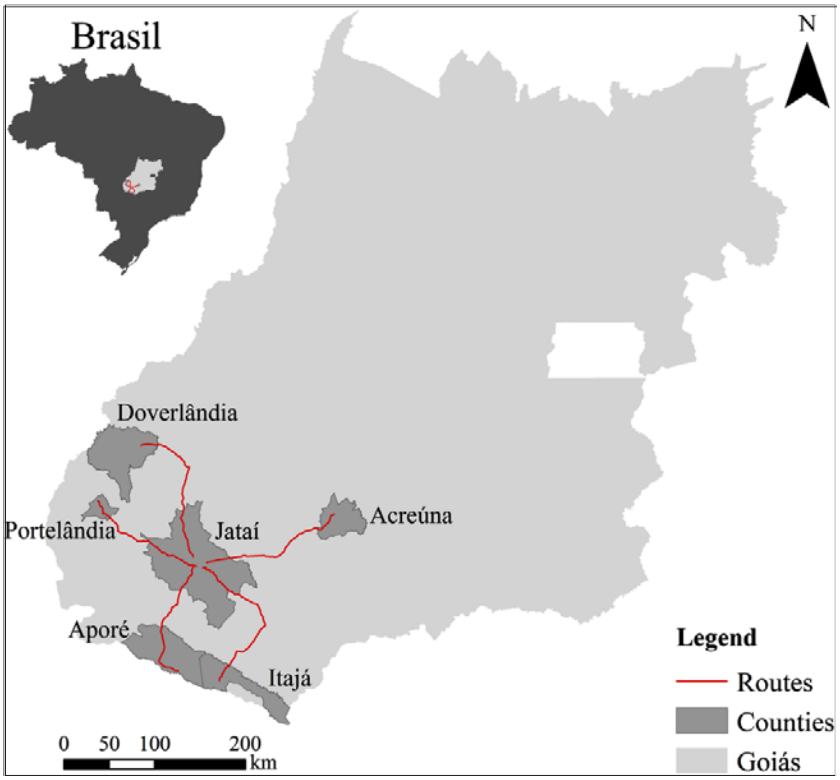

Figure 1. Map of the study area showing the five highway stretches (routes) surveyed in the Cerrado savanna of southwestern Goiás, Brazil. Routes: Acreúna (AC), Aporé (AP), Doverlândia (DO), Itajá (IT), and Portelândia (PO).

The AC route includes part of the federal BR060 highway between Jataí and Acreúna, a two-lane highway, divided by a grassy central reservation with a central drainage ditch. This highway connects southwestern Goiás with both Brasília and the Paraguayan border. The AP route also includes part of the BR-060, as well as the GO-186, which is a one-lane highway, but is an important link with southern Brazil and the country's principal seaports. The majority of the PO route is part of the BR-364 highway, which links the Brazilian states of Acre and São Paulo. This one-lane highway carries heavy cargo traffic. The DV and IT routes include state and federal highways in similar proportions. The state highways tend to have much less traffic than the federal roads, with very few trucks, which indicates that they are economically less important than the other roads for the region's economy. All the highways monitored are paved and all but AC are one-lane. Traffic statistics are available only for the federal highway, which impedes a systematic comparison of the effects of traffic levels.

We conducted a survey each month by car, starting at 07:00 h, traveling at the lowest speed possible (no more than 70 km/h) along the whole length of the route. The survey team included the driver and two observers, and each observer surveyed visually both sides of the highway. All the animals encountered during the survey were identified *in loco* to the lowest possible taxonomic level. We photographed all the specimens to provide a permanent record, as well as for the confirmation of the species, whenever necessary. The location of each animal was recorded using a Global Positioning System (GPS).

To evaluate the variation in the species richness and composition between seasons and among the different routes, we analyzed the data by group – mammals, birds, herpetofauna, and a general analysis including all the groups together (all vertebrates). We ran a factorial analysis of variance with a 95% confidence limit, testing the influence of the seasons and routes, with the relevant factors being confirmed using Tukey's *a posteriori* test. The analyses were run in BioEstat 5.0 (Ayres *et al*. 2007).

RESULTS

We recorded 1113 individuals (0.115 individuals/km/year), belonging to 87 species and 52 families. These records included nine amphibians, 55 reptiles, 223 birds, and 826 mammals (Table 1). The species recorded most frequently were the six-banded armadillo, *Euphractus sexcinctus* (23.5% of the records), the crab-eating fox, *Cerdocyon thous* (17.8%), the giant anteater, *Myrmecophaga tridactyla* (7.6%), collared anteater, *Tamandua tetradactyla* (6.7%) and the red-legged seriema, *Cariama cristata* (4.4%, Table 1). Some of the species – some mammals and one bird – are on the Brazilian and IUCN lists of endangered species (MMA, 2014, IUCN, 2014, BirdLife International, 2016) (see Table 1).

The road to Acreúna (AC route) had the largest number of individuals (0.191 individuals/km/year) and species killed, followed by Portelândia (0.117 individuals/km/year), Itajá (0.071 individuals/km/year), Aporé (0.122 individuals/km/year), and Doverlândia (0.084 individuals/km/year), respectively, by descending order of species richness. The AC route was clearly differentiated from all the others in terms of its species richness and the frequency of collisions (Figure 2) in all the analyses (Table 2). We found significant seasonal differences only for the general group (all vertebrates) and the herpetofauna (Table 2, Figure 2). The general (vertebrate) species richness was significantly higher ($F_{1, 50}$ = 5.168, p = 0.027) in the rainy season, while the species richness ($F_{1, 40}$ = 8.228, p = 0.006) and abundance ($F_{1, 40}$ = 6.872, p = 0.012) of the herpetofauna were also significantly higher in the rainy season (Figure 2).

DISCUSSION

The number of records collected along each route appear to have been influenced by the local economy, the width of the highway, and the intensity of its traffic (Forman & Alexander 1998, Trombulak & Frissell 2000, Jaeger *et al*. 2005, Coffin 2007), given that the highest total was obtained along the two-lane federal highway BR-060. The more intense flow of vehicles likely increases the probability of collisions, especially with scavengers such as the *Caracara plancus* (carcará), which is often found foraging along the margins of highways.

Table 1. Vertebrate species encountered as roadkill along the study routes in southwestern Goiás, Brazil, between January 2014 and January 2015. The five routes were: Acreúna (AC); Aporé (AP); Doverlândia (DV); Itajá (IT); Portelândia (PO). NI = Non identified vertebrates.

Species	Number of records collected along route					
	AC	AP	DV	IT	PO	TOTAL
ANFIBIA						
NI	1	-	-	-	-	1
Bufonidae						
Rhinella schneideri	4	1	-	-	-	5
Hylidae						
Hypsiboas albopunctatus	-	1	-	-	-	1
Leptodactylidae						
Leptodactylus labyrinthicus	-	-	-	-	1	1
Microhylidae						
Elachistocleis ovalis	-	-	-	1	-	1
Total	**5**	**2**	**0**	**1**	**1**	**9**
REPTILIA						
NI	-	-	1	-	-	1
Amphisbaenidae						
Amphisbaena alba	2	1	-	-	3	6
Boidae						
Boa constrictor	-	2	-	3	2	7
Eunectes murinus	1	-	-	-	-	1
Chelidae						
Phrynops geoffroanus	1	-	-	-	-	1
Colubridae						
Erythrolamprus sp.	1	-	-	-	-	1
Philodryas nattereri	1	-	-	-	-	1
Philodryas olfersii	1	-	-	-	-	1
Philodryas sp.	1	-	-	-	-	1
Spilotes pullatus	-	-	-	1	-	1
NI	-	1	-	-	-	1
Dipsadidae						
Oxyrhopus guibei	2	1	-	1	1	5
Simophis rhinostoma	-	-	-	-	1	1
Teiidae						
Ameiva ameiva	3	-	2	3	-	8
Salvator merianae	1	-	2	1	4	8
Viperidae						
Bothrops moojeni	3	1	-	-	1	5
Crotalus durissus	4	-	-	1	1	6
Total	**21**	**6**	**5**	**10**	**13**	**55**

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Species	Number of records collected along route					
	AC	AP	DV	IT	PO	TOTAL
AVES						
NI	1	4	1	2	1	9
Accipitridae						
Gampsonyx swainsonii	1	-	-	-	-	1
Rupornis magnirostris	4	-	2	1	-	7
Anatidae						
Cairina moschata	-	-	1	-	-	1
Caprimulgidae						
Hydropsalis albicollis	-	-	1	-	2	3
Cariamidae						
Cariama cristata	8	7	15	8	11	49
Cathartidae						
Coragyps atratus	4	4	1	-	2	11
Charadriidae						
Vanellus chilensis	1	-	-	-	-	1
Columbidae						
Columba livia	-	-	-	-	1	1
Columbina talpacoti	-	1	-	-	1	2
Leptotila rufaxila	-	1	-	-	-	1
Leptotila verreauxi	-	-	-	1	-	1
Patagioenas cayennensis	-	-	-	-	1	1
Cracidae						
*Crax fasciolata**	-	-	2	-	-	2
Penelope superciliaris	-	-	-	1	-	1
Cuculidae						
Crotophaga ani	3	-	1	1	2	7
Guira guira	7	2	2	2	2	15
Emberizidae						
Zonotrichia capensis	-	-	-	-	1	1
Falconidae						
Caracara plancus	2	5	2	3	2	14
Milvago chimachima	1	-	-	-	-	1
Icteridae						
Molothrus bonariensis	1	-	-	-	-	1
Picidae						
Colaptes campestris	1	1	-	-	-	2
Dryocopus lineatus	-	-	-	1	-	1

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Species	Number of records collected along route					
	AC	AP	DV	IT	PO	TOTAL
Psittacidae						
Ara ararauna	2	-	-	-	-	2
Aratinga aurea	2	-	-	-	-	2
Brotogeris chiriri	-	-	-	-	1	1
Ramphastidae						
Ramphastos toco	-	-	1	-	-	1
Rheidae						
Rhea americana	-	1	1	-	1	3
Strigidae						
Asio clamator	3	-	1	-	-	4
Athene cunicularia	9	4	3	2	7	25
Megascops choliba	-	-	-	1	-	1
Thraupidae						
Volatinia jacarina	2	1	1	-	2	6
Tinamidae						
Crypturellus parvirostris	1	-	1	1	-	3
Nothura maculosa	-	-	-	1	2	3
Rhynchotus rufescens	4	-	-	5	2	11
Trochilidae						
Phaethornis pretrei	-	-	-	-	1	1
Thalurania furcata	1	-	-	-	-	1
Tyrannidae						
Pitangus sulphuratus	-	-	-	-	1	1
Xolmis Cinereus	-	-	1	-	-	1
Tytonidae						
Tyto furcata	16	1	2	1	4	24
Total	**74**	**32**	**39**	**31**	**47**	**223**
MAMMALIA						
NI	8	3	-	-	1	12
Atelidae						
Alouatta caraya	-	3	-	-	-	3
Callitrichidae						
Callithrix penicillata	-	-	-	1	-	1
Canidae						
Cerdocyon thous	100	23	23	27	25	198
*Chrysocyon brachyurus***	5	4	-	1	1	11
*Lycalopex vetulus***	2	4	4	3	-	13
*Speothos venaticus***	-	1	-	-	-	1
NI	1	-	1	1	-	3

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Species	Number of records collected along route					
	AC	AP	DV	IT	PO	TOTAL
Caviidae						
Hydrochoerus hydrochaeris	12	1	-	3	3	19
Cebidae						
Sapajus libidinosus	-	1	-	1	1	3
Cervidae						
Mazama gouazoubira	-	-	1	-	-	1
Dasypodidae						
Cabassous unicinctus	1	1	1	1	1	5
Dasypus novemcinctus	8	5	1	11	7	32
Euphractus sexcinctus	46	79	50	27	60	262
NI	1	1	-	-	-	2
Didelphidae						
Didelphis albiventris	4	-	-	1	-	5
Erethizontidae						
Coendou prehensilis	1	2	-	3	1	7
Felidae						
*Leopardus pardalis***	1	-	-	-	-	1
*Leopardus wiedii***	-	-	-	-	1	1
*Puma yagouaroundi***	-	1	-	-	-	1
Mephitidae						
Conepatus semistriatus	-	-	-	-	1	1
Muridae						
Rattus rattus	1	-	-	-	-	1
Mustelidae						
Eira barbara	1	-	-	1	-	2
Galictis cuja	5	1	-	-	-	6
Myrmecophagidae						
*Myrmecophaga tridactyla****	24	14	16	18	13	85
Tamandua tetradactyla	23	17	9	10	16	75
Phyllostomidae						
Artibeus sp.	-	-	-	-	1	1
NI	1	-	-	-	-	1
Procyonidae						
Nasua nasua	4	4	13	4	1	26
Potos flavus	-	-	-	-	1	1
Procyon cancrivorus	18	7	8	4	5	42

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Species	Number of records collected along route					
	AC	**AP**	**DV**	**IT**	**PO**	**TOTAL**
Tapiridae						
*Tapirus terrestris****	1	-	1	1	-	3
Tayassuidae						
Pecari tajacu	-	-	-	-	1	1
Total	**268**	**172**	**128**	**118**	**140**	**826**
TOTAL (all taxa)	**368**	**212**	**172**	**160**	**201**	**1113**

* BirdLife International (2016); ** Brazilian Redlist (MMA 2014); *** Brazilian and IUCN Redlist (MMA 2014, IUCN 2014).

Table 2. Variation in species richness and abundance of vertebrate species encountered as roadkill among the different study routes in southwestern Goiás, Brazil, between January 2014 and January 2015.

Group	**Species richness**		**Abundance**	
All vertebrates	$F_{(4, 50)} = 9.555$	$p < 0.001$	$F_{(4, 50)} = 10.148$	$p < 0.001$
Birds	$F_{(4, 50)} = 5.612$	$p < 0.001$	$F_{(4, 50)} = 7.128$	$p < 0.001$
Herpetofauna	$F_{(4, 40)} = 4.304$	$p = 0.006$	$F_{(4, 40)} = 4.381$	$p = 0.005$
Mammals	$F_{(4, 50)} = 4.021$	$p = 0.007$	$F_{(4, 50)} = 6.436$	$p < 0.001$

The one-lane federal highways followed closely behind the two-lane route in term of both species richness and the number of collisions recorded. The width of the highway is almost certainly an important factor here, given that the animals must take much longer to cross a two-lane highway than a one-lane highway. The two-lane highways also have higher speed limits, which mean that the traffic tends to travel much faster.

Our observations are consistent with the findings of previous studies, which have shown that mortality increases with the increasing flow of traffic (Jaeger *et al*. 2005, Coelho *et al*. 2008, Beaudry *et al*. 2010), as well as being influenced by the speed limit (Rosa & Bager 2013), given that two-lane highways tend to have higher limits than undivided roads. We believe that the frequency of collisions is also influenced by the quality of the highway, given that no roadkill was encountered along the most precarious stretches of road (on routes IT and DV). This may have been related to the lower speeds of the vehicles traveling along these routes. The landscape surrounding the study route may have influenced the species richness recorded (Forman & Alexander 1998, Coffin 2007, Grilo *et al*. 2009), although this does not necessarily mean that the roads with more similar species richness and composition are located within similar landscapes.

The herpetofauna was the only taxonomic group that varied significantly between seasons. This may reflect seasonal differences in the volume of traffic, which in turn, influences collision rates (Beaudry *et al*. 2010). Many studies have recorded higher mortality during hotter and rainier periods (Clevenger *et al*. 2003, Coelho *et al*. 2008, Beaudry *et al*. 2010), and indicate that the seasonal pattern is linked to life history processes such as breeding seasons, dispersal, and migration (Coelho *et al*. 2008, Grilo *et al*. 2009, Beaudry *et a*l. 2010, Costa *et al*. 2015).

The pattern observed in the herpetofauna was as expected according to the results of previous studies, and probably also influenced the seasonal difference in general vertebrate species richness. This pattern is almost certainly related to the heat-seeking behavior and reproductive migrations of reptiles and amphibians (Martins-Hatano *et al*. 2012). The more intense traffic of heavy vehicles observed during the harvest period may also have contributed to the higher rates of collision recorded during the rainy season, given that the study area is dominated by farmland. We were unable to quantify this effect, however, due to the lack of traffic data.

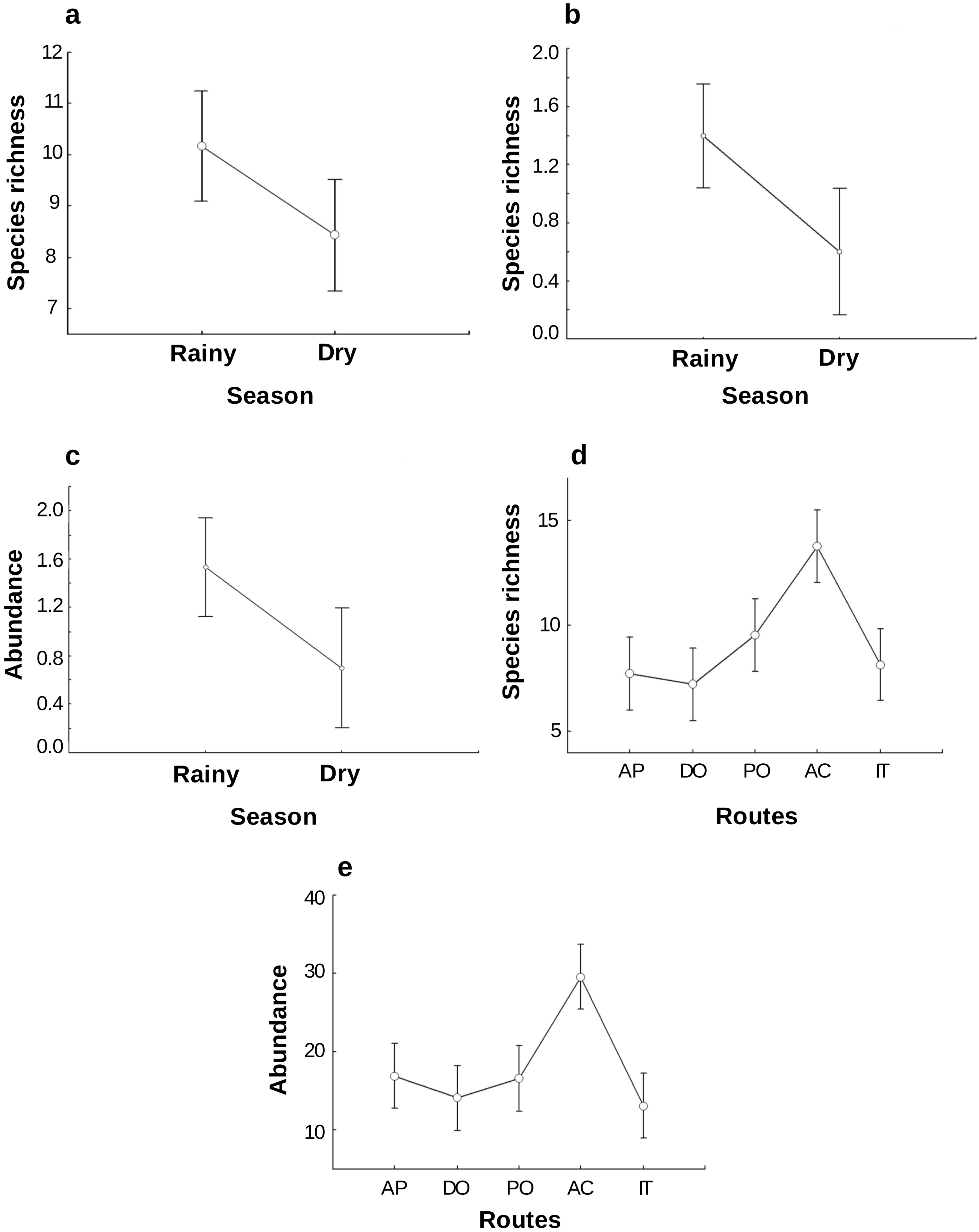

Figure 2. (a) Seasonal difference in the mean species richness of vertebrates recorded in the study area ($F_{1,50}$= 5.168, $p < 0.05$), seasonal difference in the (b) species richness ($F_{1,40}$= 8.228, $p < 0.05$) and (c) abundance ($F_{1,40}$= 6.872, $p = 0.05$) of the herpetofauna. Variation among the study routes in (d) species richness ($F_{4,50}$= 9.555, $p < 0.05$) and (e) mean vertebrate abundance ($F_{4,50}$= 10.148, $p < 0.05$). Routes: Acreúna (AC), Aporé (AP), Doverlândia (DO), Itajá (IT), and Portelândia (PO).

As in the present study, previous studies such as that of Souza & Anacleto (2012) have also failed to confirm a seasonal pattern in the distribution of some groups. This may be accounted for, at least in part, by the fact that many larger species disperse regularly along highways (Coffin 2007), and that others are commonly found in the habitats typically located along the margins of roads, and often disperse among fragments (Cunha *et al*. 2010). In addition, some of the more common species recorded in the present study, such as *E. sexcinctus* and *C. thous*, are relatively abundant in impacted environments and will often feed on carrion, including roadkill (Souza & Anacleto 2012). This means that these species are almost invariably found on or near highways, throughout the year.

The ample distribution of the mammals that occur in the Cerrado, and the diversity of habitats they exploit (Marinho-Filho *et al*. 2002), contribute to the higher rates of collisions involving these vertebrates recorded in the present study. The relatively large size of most of the mammal species recorded in this study also means that their carcasses are less easily dragged away by scavengers (Melo & Santos-Filho 2007). A number of different factors influence the removal of carcasses, including climatic conditions, and the presence of scavengers (Slater 2002, Coelho *et al*. 2008, Santos *et al*. 2011). Given this, some groups of animals, such as mammals, have a greater chance of being encountered. As birds and amphibians are much smaller, they tend to be less easily detected, and are more likely to be removed by scavengers (Teixeira *et al*. 2013).

Species such as *C. thous*, *E. sexcinctus*, *M. tridactyla*, and *T. tetradactyla* are among the most common mammal species observed along Cerrado highways (Prado *et al*. 2006, Cáceres *et al*. 2010, Silva *et al*. 2011, Carvalho *et al*. 2015). Although these species tend to be more common in forest patches, they will frequently cross the open matrix to move between habitats (Cáceres *et al*. 2010). In this case, the records of roadkill in the Cerrado may be associated at least as much with the permeability of the matrix (Cunha *et al*. 2010, Freitas *et al*. 2015, Ascensão *et al*. 2017), as the matrix itself, as in the case of *M. tridactyla*, which was associated with pasture (Ascensão *et al*. 2017).

Like some of the mammal species, a number of birds may also be attracted to the sources of food, including roadkill, found along the margins of the highway (Forman & Alexander 1998), increasing the risk of collisions. Some bird species, such as falconiforms and passeriforms, may be relatively tolerant of the presence of highways (Bager & Rosa 2012), and are not disturbed by the traffic, even when intense (see Rosa and Bager 2013). Even so, traffic noise may disturb the reproduction and dispersal of some birds and anurans, altering behavior patterns, such as the frequency of vocalization (Helldin *et al*. 2013).

Except for *Lycalopex vetulus* (hoary fox), the other six species on the list of threatened species are amply distributed in Brazil, where they are threatened primarily by the loss of habitat (Medici *et al*. 2012, Beisiegel *et al*. 2013, Jorge *et al*. 2013, Lemos *et al*. 2013, Paula *et al*. 2013, Tortato *et al*. 2013). *Speothos venaticus* (bush dog) and *Puma yagouaroundi* (jaguarundi) occur at low densities (Almeida *et al.* 2013, Jorge *et al*. 2013) and our study may provide important evidence for the identification of new populations in the Cerrado, as in the case of *Leopardus wiedii* (margay), for which there is no established conservation program (Tortato *et al*. 2013) or *L. vetulus*, which is endemic to the region (Lemos *et al*. 2013). As *Tapirus terrestris* (tapir) is only found in preserved areas of the Cerrado and/or in the vicinity of permanent sources of water (Medici *et al*. 2012), our records may indicate potential areas for the conservation of the species in a region dominated by farmland and ranching. We thus believe that these records of *T. terrestris* should be investigated in more detail.

Chrysocyon brachyurus (maned wolf) and *M. tridactyla* are known to suffer impacts from highways, principally from collisions (Paula *et al*. 2013, Miranda *et al*. 2014). A number of factors contribute to this pattern. The collision rate of *M. tridactyla*, for example, was influenced by the sex and age of the individual, given that the adult males tend to migrate more than females and juveniles (Freitas *et al*. 2014). *Chrysocyon brachyurus* is highly mobile, especially in open areas, such as pasture (Dietz 1985, Massara *et al*. 2012), and collisions have been recorded in urban areas (Freitas *et al*. 2015), which may have contributed to the high collision rate recorded for this species.

Records of roadkill can provide important data on the occurrence of species within a given area, even though the data may be limited for some species (Souza & Anacleto 2012). We not only provide a list of the vertebrate species found in the study region, but we have also identified areas that demand attention from conservationists and other scientists interested in the study of the populations of certain species, such as the *S. venaticus* and the *P. yagouaroundi*. This is especially important because the roads may have a direct, negative effect on the genetic variation of these populations (Jackson & Fahrig 2011).

We also determined the species most vulnerable to traffic collisions in the Cerrado, which is fundamentally important for the development of studies that will guarantee the maintenance of the populations associated with highways. Endangered species such as *M. tridactyla* and *C. brachyurus*, which are commonly found as roadkill, require urgent attention for the development of mitigating measures for the conservation of the populations associated with highways. In addition, larger animals, like these two species, may provoke serious accidents, which mean that the investment in measures that guarantee the safe crossing of these animals will also have benefits for road safety (Huijser *et al.* 2009, Huijser *et al*. 2013). Overall, the benefits accruing to measures that prevent collisions with wild animals may be far greater than the financial investment required (Huijser *et al*. 2013), although it is important not to cut costs, to ensure the effectiveness of the measures adopted (Huijser *et al*. 2009).

Ultimately, we believe that long-term programs of environmental education may be a promising approach to the development of public awareness of the economic and social costs of collisions with wildlife, and their effects on a region's biodiversity. More specific strategies may also be effective during the rainy season for herpetofauna. One potentially useful alternative may be to include environmental education in the preparatory courses given by driving schools.

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