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Wildlife Vehicle Strikes on the Toluviejo Highway-Colosó, Sucre, Colombia

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Abstract

Objective: Wildlife vehicle strikes were determined on a road that passes through the northwestern portion of Montes de María, a relictual area of a tropical dry forest in the Department of Sucre, Caribbean, and Colombia. **Methods/statistical analysis**: The study area was located between the Pechelín Bridge (9° 26'12'' N - 75° 26'20'' W) and Colosó (9° 29'10''N - 75° 21' 18''O), Sucre, Colombia, an alternating tropical zonobioma. The study was carried out for 6 continuous months, from October, 2016 to March, 2017, with two routes/week, between 05:00 and 08:00, at an average speed of 15 km/hour. The samples were identified *in situ*. Duncan's multiple range tests was applied for the analysis. **Findings**: Vehicle strikes of 66 amphibians (35.9%), 76 reptiles (41.3%), 12 birds (6.5%) and 30 mammals (16.3%) were recorded. There was no significant difference between the two analyzed seasons. The daily roadkill rate (TA) was 0.35 ind/day/km. According to the Duncan's multiple range tests, the amphibian and reptile groups suffered significantly more roadkills; on the other hand, the species with the greater number of collisions were: *Rhinella marina, Iguana iguana* and *Didelphis marsupialis.* The roadkill rate in the present study was relatively high when compared with rates established in other studies. The proximity of the dry forest present with its relict landscape resulted in the high calculated value. **Application**: Wildlife vehicle strikes form a type of environmental deterioration that requires special attention. The results showed that preventive measures and corrective steps must be taken to avoid the negative impact of anthropic actions.

Keywords: Caribbean, Colombia, Dry Forest, Environmental Impact, Roadkill

1. Introduction

Between habitats, wildlife uses connectivity to occupy various areas that are necessary for survival[1]; roadways are barriers that prevent connectivity and, at the same time, prevent many wildlife species from moving through separated areas [1,2]. In addition, they are a dynamic source of risk for animals that need to cross them, being a source of human accidents consisting of vehicle strikes [3,4].

Roads and transport interact with the environmental systems they pass through[5], with correlations between transport, development and economic growth of a region or country[6]. However, roadways are a factor of great importance for development and economies and are usually harmful because they fragment habitat and generate negative impacts on the natural dynamics of the ecosystems immersed within the infrastructure[2,5,7-9].

Roadways have a broad social and economic connotation and involve political decisions related to land use; in essence, roads and transportation are products of culture that interact with the natural systems they pass through[5].

Roads impact the abiotic components of natural ecosystems, including changes in hydrological dynamics and mechanisms of sedimentation, deposits and water currents; in addition, they can alter the chemical composition of water and soil covers, vary microclimates[10], and even produce erosion in some cases or other harmful sedimentation, factors that affect ecosystem dynamics in general, with pollution being the most frequent impact[5].

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In terms of biotic components that are directly impacted, such as flora and fauna that are suppressed in ecosystems, it should be noted that, although for certain species the disappearance of small portions of habitat is not relatively important, other species, such as small mammals with high fidelity to road sites, habitat loss can be very harmful. Indirectly or secondarily, the transit of vehicles can introduce contaminants to exotic species, which affects local fauna through disease and competition[5,11].

Research conducted in South America, Europe and the United States has shown worrisome figures for the number of roadkill animals and the threat this represents for some threatened species[12-14]. Vehicle strikes show patterns related to the type of vegetation, climatic conditions and behavior of the species, with a higher incidence of roadkill animals in generalist and opportunistic habits [15]. Vehicular collisions with wildlife are related to the climatic period of the year and, in many cases, coincide with reproductive periods and availability of food sources, which increase the possibilities of mobilization of wild fauna between areas separated by roads, consequently increasing the probability of being run over[16-19].

In Colombia, studies measuring the frequency of roadkills in road areas close to protected natural systems or surrounding forests are recent[4,20-24].

In the present study, a complementary method was used for a highway in the Department of Sucre, Colombia to determine wildlife vehicle strikes on the road that surrounds the northwestern portion of Montes de María, the largest relictual zone of tropical dry forest in the Colombian Caribbean.

2. Materials and Methods

2.1 Study area

A secondary asphalt road, 10.9 km in length and over 50 years old, runs through a ravine, Pechelín and a strip of wooded hills, separated from both formations by an average of 456 m (259-1324). m), located between the Esperanza Bridge (9°26'12" N - 75°26'20" W) and Colosó (9°29'10"N - 75°21'18"W), Sucre, Colombia (Figure 1). In environmental terms, this area is an alternating tropical zonobioma [25], identified as a tropical dry forest [26] with a marked relictual characteristic and a landscape matrix that is mainly agricultural.

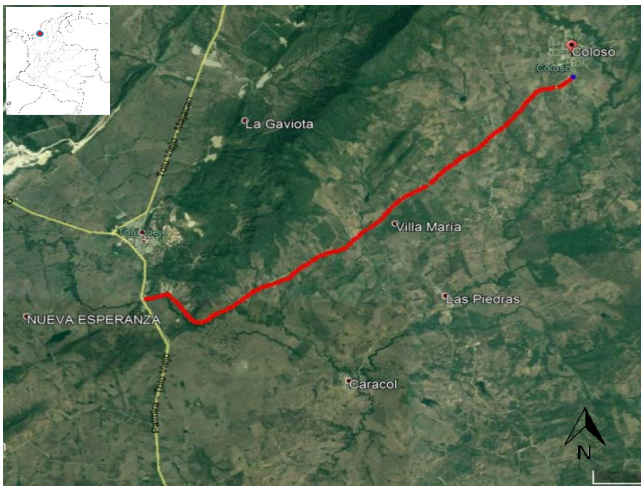

Figure 1. Map of the study area. Source: Google earth, free version 5.

2.2 Sampling

This study was carried out 6 continuous months: dry season (January-April 2017) and rainy season (May-August 2017), with two routes/week, between 05:00 and 08:00, and an average speed of 15 km/hour on a motorcycle with two observers. The two weekly routes included one from the Pechelín Bridge to the Colosó Bridge and one in the opposite direction[4,22].

The detected samples were identified *in situ* using the following sources of information: for amphibians, Darrel Frost's proposal of the American Museum of Natural History-AMNH (version 5.2, July 15, 2008); for reptiles, the proposal in The Reptile Database by Peter Uetz (October 15, 2008); and, for birds, the proposal of the South American Classification Committee, American Ornithologist Union (version 11, December 2008) along with the relevant documents for birds and mammals [27,28]. The common names used in this study are local.

Data analysis: Contingency tables and Duncan's multiple range tests were used to analyze the data. Likewise, nonparametric statistics were applied to analyze the number of run-over species [29]; the roadkill rate (TA) was determined directly [30].

3. Results

The results for the roadkills by group and by species are shown in Table 1 according to the analyzed time of the year. The total roadkills included 66 amphibians (35.9%),

76 reptiles (41.3%), 12 birds (6.5%) and 30 mammals (16.3%) for the entirety of this study.

Table 1. Roadkills by group and by species according to the time of year

Run over	Dry season	%	Rainy season	%
Amphibians				
Rhinella marina	10	47.6	42	49.4
*Scinax*sp.	0	0	4	4.7
*Leptodactylus*sp.	3	14.3	7	8.3
Amphibians (unidentified)	8	38.1	32	37.6
Subtotal Amphibians	**21**	100	**85**	100
Reptiles				
Leptodeiraseptentrionalis	5	11.2	2	5.3
Pseudoboaneuwiedii	0	0	3	7.9
Epicrates cenchria	1	2.2	3	7.9
Imantodes cenchoa	1	2.2	5	13.1
Oxyrhopuspetola	0	0	2	5.3
Liophislineatus	1	2.2	4	10.5
Boa constrictor	1	2,2	4	10.5
Leptodeiraannulata	0	0	3	7.9
Snakes (unidentified)	1	2.2	6	15.8
Iguana iguana	34	75.6	2	5.3
Ameivaameiva	1	2.2	4	10,5
Subtotal Reptiles	**45**	100	**38**	100
Birds				
Coragyps atratus	2	25	1	25
Cathartes aura	3	37.5	1	25
Milvago chimachima	1	12.5	0	0
Tyrannusmelancholicus	2	25	2	50
Subtotal birds	**8**	100	**4**	100
Mammals				
Didelphys marsupialis	8	57.2	14	87.6
Cerdocyonthous	1	7.1	0	0
Tamandua mexicana	5	35.7	1	6.2
Conepatussemistriatus	0	0	1	6.2
Subtotal mammals	**14**	100	**16**	100

Of the total number of detected roadkills, the dry season saw 88 (38.1%), and the rainy season had 143 (61.9%). No significant differences were determined when applying the Duncan test (Table 2).

Table 2. Duncan's test for the two analyzed seasons

Duncan Grouping	Mean	N	Season
A	3.762	21	Dry
A	5.000	21	Rainy

Means with the same letter are not significantly different

The total roadkill rate (TA) was 0.441 ind/day/km. The calculations, by group and by time, are shown in Table 3.

Table 3. Roadkill rate by group and by time of year (TA=daily roadkill rate)

Group	Dry season	TA	Rainy season	TA
Amphibians	21	0.004	85	0.0162
Reptiles	45	0.086	38	0.072
Birds	8	0.015	4	0.007
Mammals	14	0.026	16	0.03
Total	88	0.168	143	0.273

According to the Duncan's multiple range tests, the amphibian and reptile groups suffered significantly more roadkills (Table 4); on the other hand, the species with a greater number of collisions included *Rhinella marina, Iguana iguana* and *Didelphis marsupialis*.

Table 4. Duncan test to determine differences between roadkills per group

Duncan Grouping		Means	N	Group
	A	11.000	6	Amphibians
	A			
B	A	3.800	20	Reptiles
B	A			
B	A	3.750	8	Mammals
B				
B		1.500	8	Birds

4. Discussion

By percentage, the taxa with the greater number of roadkills included reptiles, followed by amphibians; the herpetofauna was most affected by vehicle strikes[4,30-33]. The results for *Rhinella marina* agree with those from other studies, being a species that has been detected as one of the more harassed in similar studies carried out in Brazil, Mexico [34] and Colombia[4].

The fact that amphibians and reptiles had more roadkills in this study coincides with that reported for Tehuantepec, Mexico[35], but differs from that found for the Amazon in Brazil, where the greatest proportion was represented by birds and mammals with a lesser expression from amphibians and reptiles [33]; similar results were found for Colombia on a road close to the study area[23].

The high proportion of collisions found for *Iguana iguana* was determined in the dry season, which coincides with the reproductive season[30-31], when iguanas usually cross roads in search of areas to nest[4].

Within the group of mammals, *Didelphis marsupialis*, an omnivorous and opportunistic species, has stood out as a species that is commonly run over on the roads of Antioquia, Colombia[20] and roads that surround Montes de María, Sucre, Colombia [4,21-24]. This high frequency of raodkills is related to their abundance [20,22]. This species was identified in the Brazilian Amazon as the most struck within the general fauna [33].

According to different studies, the time of year influences the number of collisions [23,30,32]; however, in this study, no significant differences were found, coinciding with the results established in the Brazilian Amazon[33] and with those found for a Caribbean zone in Colombia[4]. In general, vehicle strikes are also influenced by the edge effect because species colonize border areas, usually attracted by the favorability of prey and changes in the trophic dynamics of the system[36], which increases their population and, therefore, their exposure to the effects of roads[4].

It is clear that the road has fragmented the ecosystem, leaving an isolated forest on the Pechelín stream and forested hills in a dry forest. The natural tree cover is minimal, typical of an agricultural landscape, in which the dominant groups of wildlife are amphibians and reptiles, as reflected in the roadkill percentages by zoological group.

The TA determined in this study, 0.441 ind/day/km, is relatively high when compared with that established for Portuguesa, Venezuela, which is between 0.1178 ind/day/km[37] and 0.1393 ind/day/km[30]. It is also higher than the rates found in similar studies carried out in the Montes de María area, Sucre, Colombia: 0.328 ind/km/day[4] and 0.320 ind./km/day[23]. A logical explanation for these differences can be found in the relative proximity between the road and the Pechelín stream and the dry forest hills, which are divided by the road.

Perhaps the results underestimate the magnitude of the problem; it must be borne in mind that variables such as the influence of scavenger birds and carnivorous mammals, as well as human activity and vehicular flow, can displace animal remains[32], lowering the number of observable vehicle struck specimens[4]. Finally, the mortality of fauna on roads affects natural populations, controls for which or applications of protective measures that minimize this impact are difficult to carry out, as is increasing awareness in people of the damage they can cause with their vehicles and inappropriate driving [1,38-39].

5. Conclusions

The studied road requires signage and infrastructure that provides protection for wildlife; otherwise, the current situation could put many species that inhabit these dry forest relicts at risk.

On the other hand, it is necessary to conduct further studies because these results provide valuable data on possible population deterioration and for conservation.

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