I CONGRESSO IBEROAMERICANO DE BIODIVERSIDADE E INFRAESTRUTURA VIÁRIA

&

IV CONGRESSO DE ECOLOGIA DE ESTRADAS

UNIVERISIDADE FEDERAL DE LAVRAS – LAVRAS – MG – BRASIL

5 A 11 DE NOVEMBRO DE 2016

Alex Bager
Organizador

I CONGRESSO IBEROAMERICANO DE BIODIVERSIDADE E INFRAESTRUTURA VIÁRIA

IV ROAD ECOLOGY BRAZIL

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LAVRAS – MG – BRASIL
2016

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Sumário

Prefácio

Em 2014, durante o III Road Ecology Brazil, foi apresentada a proposta de se ampliar a escala de abrangência do Congresso Brasileiro de Ecologia de Estradas ou a realização de dois eventos, um nacional e outro internacional. Após muitos debates constatou-se que o melhor seria a realização de dois eventos, um reunindo países Iberoamericanos e outro brasileiro. O congresso brasileiro é fundamental para a manutenção de um foro de discussão nacional, com temas focados nesta escala política.

Diante disso, em novembro de 2016, foram realizados o I Congresso Iberoamericano de Biodiversidade e Infraestrutura Viária (CIBIV) e o IV Road Ecology Brazil (REB). Neste ano ambos ocorreram concomitantes, mas a partir de 2018 o CIBIV deverá ocorrer em diferentes países.

O CIBIV é o evento oficial da Rede Latinoamericana de Biodiversidade e Infraestrutura Viária (Rede BioInfra). A organização do congresso se dará por uma coordenação local, no país responsável por sediar o evento, e por membros da Diretoria e do Conselho Gestor da Rede BioInfra.

Em 2016 os eventos contaram com a participação de xxx inscritos de xx países. Tivemos um número recorde de resumos aprovados, 80, e também o maior número de palestrantes e conferencistas internacionais.

Agradecemos pelo interesse e engajamento de todos participantes, palestrantes e organizadores, os quais proporcionaram o sucesso de nossos congressos. Esperamos todos em 2018.

Organização

Pela primeira vez a organização do REB contou com uma equipe local, um comitê nacional e representantes internacionais. Além disso, contamos com um comitê técnico que colaborou na avaliação dos trabalhos técnico-científicos.

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Tathiana Bagatini
Teresa C. da Silveira Anacleto

Programa

Dia 05 | Sábado

08h00 **Abertura do credenciamento**
Local: nº 3 do mapa

Workshop: Instrução Normativa do Ibama 13/13
Coordenadores: Roger Borges da Silva (MRS Engenharia) & Giuliana Cousin Berghella (IBAMA)
Local: nº 8 do mapa

Minicurso: Ferramentas para Análise de Dados em Ecologia de Estradas
Coordenadoras: Clara Grilo e Priscila Lucas
Local: nº 3 do mapa

15h00 **Encerramento do Credenciamento**

18h00 **Encerramento do workshop e minicurso**

Dia 06 | Domingo

08h00 **Continuação do Workshop e minicurso**

14h00 **Abertura do credenciamento**
Local: nº 34 do mapa

18h00 **Encerramento do Credenciamento**

Encerramento do workshop e minicurso

Dia 07 | Segunda-feira

08h00 **Continuação do Workshop**

Abertura do credenciamento
Local: nº 34 do mapa

10h00 **Abertura oficial do I CIBIV e IV REB**
Local: nº 34 do mapa

10h30 **Conferência de abertura**
Anthony Clevenger - EUA

12h00 **Intervalo para almoço**

14h00 **Palestra**
Priscila Lucas (CBEE/UFLA)

15h00 ***Coffee break***

15h30 **Mesa Redonda:** Rede Iberoamericana de Biodiversidade e Infraestrutura Viária

17h00 **Palestra**
Luiz Paulo Ferraz (AMLD)

18h00 **Coquetel**

Dia 08 | Terça-feira

08h00 **Continuação do Workshop**

10h00 **Intervalo**

10h30 **Conferência**
Pedro Costa - Portugal

12h00 **Intervalo para almoço**

14h00 **Palestra**
Fernanda Teixeira (NERF/UFRGS)

15h00 **Apresentações orais**

16h00 ***Coffee break***

16h30 **Apresentações orais**

Dia 09 | Quarta-feira

08h00 **Continuação do Workshop**

10h00 **Intervalo**

10h30 **Vídeo conferência**
Jochen Jaeger - Canadá

12h00 **Intervalo para almoço**

14h00 **Palestra**
A confirmar

15h00 ***Coffee break***

15h30 **Mesa Redonda:** Avanços Brasileiros em Ecologia de Estradas

17h00 **Encerramento**

Apresentações Orais | Dia 08

15h00 **Trabalho:** ROAD-KILLED BATS (MAMMALIA: CHIROPTERA) FROM SOORETAMA BIOLOGICAL RESERVE- ES CROSSED BY THE HIGHWAY BR-10

15h10 **Trabalho:** LONG-TERM MONITORING OF WILDLIFE CROSSINGS STRUCTURES IN THE ATLANTIC FOREST, ARGENTINA

15h20 **Trabalho:** SURVEY OF THE VERTEBRATE FAUNA ROADKILLED, DURING A YEAR, IN THE BR 304 ROAD, IN THE CAATINGA BIOME, RN

15h30 **Trabalho:** SNAKES ROADKILL ON TWO HIGHWAYS IN "TRIANGULO MINEIRO", MINAS GERAIS: AN INTENTIONAL CONDUCT?

15h40 **Trabalho:** MOLECULAR DETECTION OF SPECIES AND GENDER IN ROAD KILLED FOXES IN URUGUAY

15h50 **Trabalho:** HOW TO DECIDE THE SAMPLING EFFORT: A CASE FROM SC-290 ROAD, SANTA CATARINA, BRAZIL

16h00 ***Coffee break***

16h30 **Trabalho:** ASSESSING VEHICLE TRAFFIC VOLUME EFFECTS ON MAMMALIAN PERSISTENCE: A THEORETICAL APPROACH

16h40 **Trabalho:** MAINTENANCE AND EFFECTIVINESS OF MITIGATION MEASURES CONCERNING ROADKILLS: THE CASE OF SP 322

16h50 **Trabalho:** ENVIRONMENTAL PRESSURE BY ROADS ON STREAMS OF SOUTHERN BRAZIL

17h00 **Trabalho:** WHICH AND HOW ROAD EFFECTS ON WILDLIFE ARE CONSIDERED IN ENVIRONMENTAL IMPACT ASSESSMENTS

17h10 **Trabalho:** WILDLIFE ROADKILL ON A ROUTE BETWEEN THE BRS 070 AND 174 IN MATO GROSSO'S PANTANAL: DEFINITION OF HOTSPOTS

17h20 **Trabalho:** ARE PARKWAYS REALLY GOOD FOR WILDLIFE? THE FIRST CASE STUDY OF THE RIO DE JANEIRO STATE

17h30 **Trabalho:** ASSESSMENT OF THE IMPACTS BY ROAD INFRASTRUCTURE OVER THE MORTALITY OF VERTEBRATES IN THE CENTRAL ANDES OF ANTIOQUIA, COLOMBIA

17h40 **Trabalho:** IS MOVEMENT OF STREAM FISH DISTURBED BY ROAD CROSSINGS? A CASE STUDY USING OF PHOTO-IDENTIFICATION

17h50 **Trabalho:** USING OPEN SOURCE GIS SOFTWARE TO ASSESS RUN OVER WILDLIFE IN THE CENTRAL ANDES OF ANTIOQUIA, COLOMBIA

Pôsteres

No dia designado, os pôsteres devem ser colocados pela manhã até às 09h00, permanecendo expostos durante o dia inteiro. Os responsáveis devem ficar disponíveis para questionamentos durante os intervalos do café

Dia 07 I Segunda-feira

1. WILD VERTEBRATES ROADKILL ON THE HIGHWAY BR 050, SECTION UBERLÂNDIA-UBERABA-MG, BRAZIL
2. EATING BY THE EDGES – ROAD PROJETCS AND VEGETATION SUPPRESSION IN SÃO PAULO STATE
3. EVALUATION OF THE RABIES VIRUS IN CERDOCYON THOUS (LINNAEUS, 1766) FROM THE FOREST THE ATLANTIC IN ESPÍRITO SANTO
4. FISH PASSAGE AT THE NORTE-SUL RAILROAD, BOIS RIVER- CASE STUDY
5. CAN DIET AND HABITAT USE INFLUENCE BIRDS ROADKILL?
6. RELATIONSHIP BETWEEN ROAD DENSITY AND RICHNESS OF BIRD SPECIES IN SÃO PAULO STATE
7. SISTEMA URUBU: A TWO-YEAR BACKGROUND
8. INFORMATION AS THE KEY TO REDUCE ROADKILLS
9. INFLUENCE OF SEASONALITY ON WILD VERTEBRATES ROADKILL IN AN AREA OF CERRADO, MINAS GERAIS, BRAZIL
10. MORPHOMETRY OF CRAB-EATING FOXES (CERDOCYON THOUS) FOUND ROADKILLED IN THE SEMIARID REAGION NORTHEASTERN BRAZIL
11. ROADKILL ANIMALS IN TIJUCA NATIONAL PARK (RIO DE JANEIRO, BRAZIL): MONITORING AND EDUCATIONAL CAMPAIGNS
12. CRIMINALIZED SPACES OF ROADKILLS VICTIMS IN ROADS OF THE "PANTANOS DE CENTLA BIOSPHERE RESERVE".
13. STATE OF THE ART ON WILDLIFE RUN OVER IN COLOMBIA
14. WILD BIRD AFFECTED BY ROADKILLS ON HIGHWAYS IN THE SOUTHERN OF SANTA CATARINA STATE, BRAZIL, DUE TO SEASANALITY
15. GEOGRAPHICAL DISTRIBUTION OF MAMMAL ROAD-KILL IN BRAZIL
16. ROADKILLS OF VERTEBRATES ON SC-290 ROAD, SOUTHERN BRAZIL
17. INCORPORATING THE RESULTS OF WILDLIFE MONITORING ON ROADS IN RECOMMENDING MEASURES FOR REDUCING THE IMPACT OF ROAD DEVELOPMENT : ROUTE 32, LIMON, COSTA RICA.
18. WILDCATS, MUSTELIDS AND OTHER LARGE MAMMALS IN COSTA RICAN ROADS
19. ROAD KILLED MAMMALS FROM THE MUSEUM OF NATURAL HISTORY OF CAPÃO DA IMBUIA, CURITIBA, PARANÁ, SOUTHERN BRASIL
20. SPATIAL PATTERNS OF GIANT-ANTEATER (MYRMECOPHAGA TRIDACTYLA) PERSISTENCE: ANALYSIS WITH OBSERVED ROAD-KILL RATES AND ROAD DENSITY IN ITS DISTRIBUTION RANGE
21. WILDLIFE ROADKILL MONITORING ON MGC-455 HIGHWAY, UBERLÂNDIA-RIO DO PEIXE, UBERLÂNDIA-MG
22. SURVEY OF DEAD VERTEBRATES BY VEHICLE HIT IN BR-158, PARANÁ - BRASIL

Dia 08 I Terça-feira

1. INFLUENCE OF CLIMATE VARIABLES ON WILD VERTEBRATES ROADKILL IN AN AREA OF CERRADO, MINAS GERAIS, BRAZIL
2. ASSESSING THE ROADKILL IMPACT ON BATS (MAMMALIA, CHIROPTERA): A CASE STUDY FROM SOUTHEASTERN BRAZIL
3. ENVIRONMENTAL GUIDE: WILDLIFE FRIENDLY ROADS
4. SPECIES TRAITS EXPLAIN ROAD MORTALITY RISK FOR BIRDS AND MAMMALS IN BRAZIL
5. INVISIBLE DEATH IN OUR DAILY LIVES
6. RELATIONSHIP BETWEEN ROAD DISTANCE AND FIRE EVENTS IN ATLANTIC FOREST
7. TROPICAL FOREST FRAGMENTATION IN ROADED LANDSCAPES: EFFECTS ON THE OCCURRENCE OF BLACK-TUFTED-EAR MARMOSET CALLITHRIX PENICILLATA
8. PRELIMINARY STUDY ON THE DIET OF CORAGYPS ATRATUS (BLACK VULTURE) FOUND ROADKILLED IN THE SEMIARID REGION OF NORTHEASTERN BRAZIL.
9. ROAD KILLS IMPACT IN URUGUAYAN MAMMALIAN FAUNA.
10. WHY DO WE REALLY NEED TO ACCOUNT FOR CARCASS REMOVAL AND DETECTION ON ROAD-KILL ESTIMATES?
11. MONITORING WILDLIFE RUN OVER DURING THE IMPLANTATION AND PAVING OF BR - 235, NORTH STATE OF BAHIA
12. MORTALITY RATE OF WILD ANIMALS IN THE HIGHWAYS PR-407 AND PR-508, COAST OF PARANÁ.
13. MONITORING OF WILDLIFE ROAD-KILL IN HIGHWAY RJ-149, CUNHAMBEBE STATE PARK (RIO DE JANEIRO - BRAZIL)
14. EXPANSION OF ROAD NETWORK AND BIODIVERSITY: A CASE STUDY ABOUT WILDLIFE ROADKILL ON THE BA-099 HIGHWAY, NORTH COAST OF BAHIA
15. A MODEL TO DETERMINE FAUNA PASSAGES ON THE ROAD CROSSING THE CONSERVATION AREA GUANACASTE, COSTA RICA
16. SURVEY OF FLATTENED WILDLIFE SPECIES ON THE NORTHERN STRETCH OF HIGHWAY BR-101 IN UBATUBA CITY, SÃO PAULO, BRAZIL.
17. MAMMALIAN LOSS BY ROADKILLS IN ROADS OF THE PLAIN TABASQUEÑA
18. LONG-TERM MONITORING OF ROAD MORTALITY IN ATLANTIC FOREST
19. ENVIRONMENTAL BIOETHICS POINT OF VIEW OF ROADKILLS
20. THE OPHIDIAN ROADKILLS ON A STRETCH OF BR-040: ANALYSIS OF LOCAL ROADKILL
21. SEASONALITY IN THE ROADKILL RATES ON MGC-455, UBERLÂNDIA-RIO DO PEIXE SECTION, UBERLÂNDIA-MG.
22. ANALYSIS OF SPATIOTEMPORAL FACTORS RELATED TO WILD ANIMALS ROADKILL IN THE NORTHERN STRETCH OF HIGHWAY BR-101, UBATUBA, SP, BRAZIL.

Dia 09 I Quarta-feira

1. USE OF CUVERTS AS FAUNA PASSAGES FOR VERTEBRATES IN THE PAN AMERICAN HIGHWAY CROSSING THE CONSERVATION AREA GUANACASTE, COSTA RICA
2. SEASONAL DIVERSITY AND ASPECTS OF ROADKILLED CHIROPTERA ON A STRETCH OF BR-040, RIO DE JANEIRO/JUIZ DE FORA
3. DIFFERENCES IN ROADKILL RATES IN THE BIOLOGICAL RESERVES OF SOORETAMA AND ITS SURROUNDING IN BR-101.
4. COMPARISON OF TWO METHODS OF MONITORING FAUNA RAIL-KILL AT RIO GRANDE DO SUL STATE RAILWAY
5. CITIZEN SCIENCE FOR WILDLIFE CONSERVATION IN THE COLOMBIAN ROADS
6. WILD VERTEBRATE FAUNA ROADKILL IN ARARIPE PLATEAU, CAATINGA, NORTHEAST REGION OF BRAZIL
7. CAN WILDLIFE-VEHICLE-COLLISIONS BE USED AS AN INDICATOR OF POPULATION HEALTH?
8. ASSESSING THE ROLE OF ENVIRONMENTAL VARIABLES TO EXPLAIN ROAD-KILL LIKELIHOOD ACROSS MULTIPLE SCALES
9. THE USE OF FAUNA UNDERPASSAGES ALONG THE RAILWAY BETWEEN APARECIDA DO TABOADO/MS AND RONDONÓPOLIS/MT
10. FELIDS AND ROADS INTERACTION IN BRAZIL: TEMPORAL AND SPATIAL PATTERNS OF ROAD-KILLS
11. DISTRIBUTION MODELS OF SIX CARNIVORES SPECIES ALONG THE BR-290 IN RIO GRANDE DO SUL STATE, BRAZIL
12. EVALUATING MAMMAL OCCURRENCE AND VEHICLE TRAFFIC EFFECT IN ROADSIDE PATCHES IN SOUTHEASTERN, BRAZIL
13. ROAD ECOLOGY IN THE VISION OF ENVIRONMENTAL BIOETHICS
14. MONITORING THE ROAD KILLED FAUNA IN ROADS SC -487 AND SC- 100 IN SANTA CATARINA
15. CARCASS PERSISTENCE TIME ON THE ROADS: MORE THAN MEETS THE EYE
16. MOVEMENT OF TARANTULAS ON A BRAZILIAN RAILROAD
17. WILDLIFE THREATENED BY COLLISIONS IN THE AREA OF COAST OF TABASCO,
18. ROADKILL MAMMALS BEFORE AND AFTER DOUBLING THE HIGHWAY BR101-SOUTH, SOUTHERN BRAZIL
19. ROAD-KILL VERTEBRATE ALONG THE "COSTANERA SUR" ROAD, COSTA RICA
20. CASE STUDY: EVENT RECORD ANURANS MORTALITY IN BR-448, RIO GRANDE DO SUL, BRAZIL
21. ROADKILLS OF VERTEBRATES ON STATE HIGHWAY BA-120

Patrocínios e Apoios

Trabalhos Técnico-Científicos

Atropelamento de Fauna Selvagem

WILD VERTEBRATE FAUNA ROADKILL IN ARARIPE PLATEAU, CAATINGA, NORTHEAST REGION OF BRAZIL

Paulo Fernando Maier Souza[1], Flavia Regina Domingos[1], Rose Mary Feitosa Macedo[2], Weber Andrade Girão e Silva[3], José Gonçalves Neto[1], Marciano Soares e Silva[2], Raimundo Macedo Leite[1]

[1]Área de Proteção Ambiental Chapada do Araripe - ICMBio – Ceará, [2]Parque Estadual Sítio Fundão – Secretaria Estadual do Meio Ambiente – Ceará, [3]Associação de Pesquisa e Preservação de Ecossistemas Aquáticos – Aquasis – Ceará. Paulo Fernando Maier Souza: paulo.maier@icmbio.gov.br – APA Chapada do Araripe, Praça Joaquim Fernandes Teles, s/nº, Pimenta, Crato, CE, CEP 63105-030

The Araripe Plateau is located in the Caatinga biome between the states of Ceará, Pernambuco and Piauí and contains sixteen Protected Areas forming a mosaic. It has territory in Caatinga and Mata Atlântica Biosphere Reserves, including core areas. It shelters the Araripe Geopark, first of its kind in the American Continent, with nine geosites. This study, SISBIO authorization number 43324-1, presents preliminary outcomes of a year of wildlife run over monitoring on paved state roads in the interior and around the Área de Proteção Ambiental Chapada do Araripe, the Floresta Nacional Araripe-Apodi, the Reserva Particular do Patrimônio Natural Araçá, the Reserva Particular do Patrimônio Natural Oásis Araripe, the Monumento Natural Estadual Riacho do Meio, the Parque Estadual Sítio Fundão and Parque Natural Municipal Luis Roberto Correia, as well as Batateira Geosites, Ponte de Pedra and Riacho do Meio. The work was conducted in 109.5 km, by paved road, being 51.1 km on the road CE 060, between Barbalha and Jardim, 34.9 km on the road CE 292, between Crato and Nova Olinda and 23.5 km on the road CE 494 in Crato. The method chosen is the one proposed by the Centro Brasileiro de Estudos em Ecologia de Estradas of the Universidade Federal de Lavras (CBEE) with campaign in fourteen day intervals, totalizing 26 sampling days per year, carried out by an observer and a driver with vehicle pickup truck at the speed of 40 $km.h^{-1}$. All animals detected were registered, those sighted by the observer with the vehicle in movement were counted as systematic collection and the others as an eventual collection. The registered animals were taken

off the road to avoid recount. The average pluvial rainfall accumulated in periods of fourteen days between the samples was calculated based on Fundação Cearense de Meteorologia e Recursos Hídricos (Funceme) data. They traveled 2847 kilometers from July, 14 in 2014 to June, 29 in 2015 counting 677 wild animals run over (Figure 1). However, during a single campaign in April 2016 were detected 718 animals, probably due to the rainiest year, although for the analyzed period significant association had not existed between the number of animals run over and rainfall for the period by the Spearman's correlation coefficient. Most amphibians were registered in an eventual collection. The general roadkills rate was 0.238 animals / km, ranging from 0.436 animals / km on the road CE 060, 0.093 animals / km on the road CE 292 and 0,023 animals / km on the road CE 494. The rate of general roadkills was and road CE 060 are far superior to those found in studies carried out in other biomes in Brazil, possibly the great detection of amphibians, mainly *Rhinella jimi*. The threatened species detected were *Leopardus tigrinus*, the *Puma yagouarondi* and the *Licalopex vetulus*. Work carried out in the surroundings of Parque Nacional Serra da Itabaiana, also in the Caatinga biome, it allowed us to calculate a roadkill rate of 0.375 animals / km, superior than the general roadkill rate of this current study and lower than the road CE 060. The greatest number registered of animals run over was the Anfibia class with 72.8% of detected cases, followed by the class Reptilia with 9.4% of cases, Ave with 8.8% and 7.4% Mammalia.

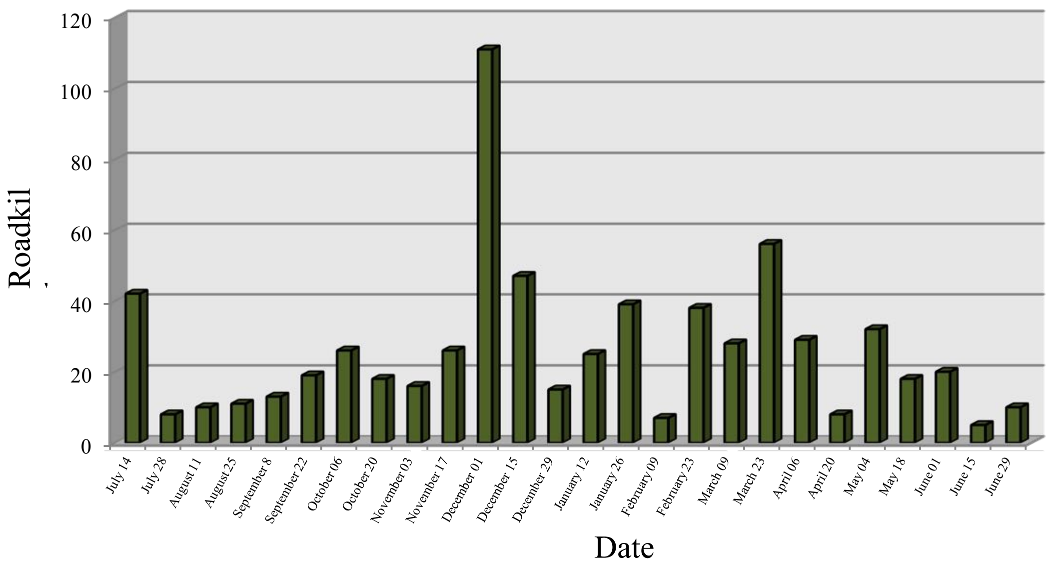

Figure 1: Number of records of vertebrate wild animals run over.

The analyzed so far we can say that: (a) most small animals, especially amphibians, is not detected by the observer with the vehicle in movement at 40 km.h^{-1}; (b) there was no significant relationship between the number of detected roadkills and pluvial rainfall; (c) there is a high rate of roadkills in the studied area, mainly on the road CE 060; (D) most roadkill are in the Anfibia class; (E) analysis of taxonomic groups and road stretches are necessary for verification of mitigation eventual measures to be proposed, improving the environmental licensing processes of roads.

WILD VERTEBRATES ROADKILL ON THE HIGHWAY BR 050, SECTION UBERLÂNDIA-UBERABA-MG, BRAZIL

Aline Carneiro Veloso[1], Ana Elizabeth Iannini Custódio[1, 2, 3], Carine Firmino Carvalho[1, 2], Wanessa Gomes Pereira[1], Jasmine de Resende Assis[1]

[1]Laboratório de Ecologia de Mamíferos (LEMA), Universidade Federal de Uberlândia, Instituto de Biologia – Uberlândia; MG. [2]Programa de Pós-graduação em Ecologia e Conservação de Recursos Naturais – MG. [3]Instituto de Biologia, UFU – MG. Aline Carneiro Veloso: veloso.ac14@gmail.com – Universidade Federal de Uberlândia, Instituto de Biologia, C. Postal 593, Uberlândia, MG, CEP 38400-902, Brasil.

Currently, linear developments are among the most important environmental changes, because of the fragmentation of natural environments and the wildlife roadkill. The wild vertebrates roadkill has been regarded as one of the main causes of biodiversity loss. Estimations indicate that more than 475 million of wild animals collisions happen on Brazilian roads every year, with an average of 90 animals killed per minute. In addition, with the increase of the road network with heavy vehicles flow in the country, this impact has been increasingly aggravated. Thus, this study aimed to list the species killed in vehicle collisions in the section Uberlândia-Uberaba of the highway BR-050 and to calculate their respective roadkill rates. This section is a dual carriageway, approximately 96 km long, it has an intense vehicles traffic with an average volume of 12.000 vehicles per day. The monitoring was performed weekly from April 2013 to March 2014. The trips were executed by car in the morning, starting at 08:00 h, during the necessary time to go through all the section, at an average speed of 60km/h. Thirty-nine trips were made, covering 192 km per week, totaling 7488 km at the end of one year of data collection. During the trips, two observers were present in the vehicle. When visualizing a roadkill, one observer registered in a spreadsheet the identification of the taxa at the lowest possible taxonomic level, and photographic records of carcasses were made to confirm the identification of the taxa by specialists. In order to avoid counting the same carcass later and the scavengers roadkill, the carcasses were removed from the highway and deposited on the roadside. For the categories wild vertebrates, wild mammals, birds and reptiles (Lepidosauria), roadkill rates were

calculated as individual/km/day. During the monitoring activities, 412 wild animals roadkill were found, distributed as follows: 258 (62.6%) mammals, 103 (25%) birds e 51 (12.4%) reptiles; 139 domestic animals that were not counted as systematized records and 60 undetermined individuals. We identified 21 mammal species, 33 birds species and 12 reptiles species. The rates were calculated only for systematized wildlife roadkill, for wildlife animals it was 0.055 ind./km/day, on average 10.564 ind./day. The wild mammals roadkill rate was 0.034 ind./km/day, on average 6.615 wild mammals/day. The bird roadkill rate was 0.014 ind./km/day, on average 2.641 birds/day. For reptiles, the roadkill rate was 0.007 ind./km/day, on average 3.308 reptiles/day. Among the registered classes, the mammal group was the most affected by roadkill, followed by birds and reptiles. The mammal species most recorded during the study were *Cerdocyon thous, Conepatus semistriatus* and *Euphractus sexcinctus.* Among the bird species, they were *Cariama cristata* and *Caracara plancus*. For reptiles, the species that suffered more roadkill were *Boa constrictor amarali*, *Crotalus durissus collilineatus* and *Bothrops moojeni*. We found species recorded as vulnerable to extinction: *Chrysocyon brachyurus*, *Myrmecophaga tridactyla, Lycalopex vetulus* and *Puma yagouaroundi.* This study shows a significant number of wild vertebrates roadkill, including species target as vulnerable to extinction. These results reinforce the need to develop more studies in the area, thus contributing to the preservation of local wildlife through the implementation of mitigation measures.

WILDCATS, MUSTELIDS AND OTHER LARGE MAMMALS IN COSTA RICAN ROADS

Esther Pomareda García[1,] Daniela Araya Gamboa[2] y Esmeralda Arévalo Huezo[3],

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Research has shown that there are vulnerable and important species due to their condition as wildcats and larger species such as tapirs, are being affected by roads. Las Pumas Rescue Center and Panthera Corporation had individually a database of wildcats; but since 2012 because of a initiative of both organization and other institutions to mitigate the impact of roads on wildlife, the information was set in a unique database. An intense search of information of these species was realized and completed with sources as the National Museum of Costa Rica and La Salle, the Hospital Smalls and Wild Species, Schools of Biology of the National University and University of Costa Rica, Rescue Centers, Veterinary Clinics and staff of the National System of Conservation Areas (Ministry of Environment and Energy) and people that has independent reports. The database has records of wildcats, mustelids and larger mammals such as tapir, peccaries, and deers. The data include animal salive crossing the road or the has been roadkill or hit by a car and stay alive. The oldest records are from 1989 with a puma (*Puma concolor*) when the Route 32 in the Braulio Carrillo National Park was recently opened ,and in 1996 a jaguar (*Panthera onca*) in Salitral Bagaces. A total of 238 individuals reported of which 20% are animals crossing the roads and the rest (80%) animals killed or hit by a car. The ocelot (*Leopardus pardalis*), is the specie with the highest records, represent the 50% of the whole base; with and average of two deaths ocurring per month. This data collection help us to visualize how vulnerable are these endangered species to the road networks and their negative impacts. It is important to now that this information is a snapshot of the animal son the roads, but there are several individuals suchs as wildcats that are stolen to take out the skin or the deers for the meat. The database support the decision making for future research and provide recommendations for environmental measures to prevent and mitigate the impact of roads on the wildlife, that in the medium and long term may eventually disappear.

Table 1. Database resume of wildcats, mistelids and other large mammals in Costa Rican roads, 2016

Specie	Common Name	Number
Leopardus tigrinus	Oncilla	2
Leopardus wiedii	Margay	8
Leopardus pardalis	Ocelot	117
Puma yaguaroundi	Jaguarundi	21
Puma concolor	Puma	16
Panthera onca	Jaguar	24
Tapirus bairdii	Tapir	15
Odocoileus virginianus	Whitetailed Deer	8
Mazama americana	Red Brocket Deer	3
Tayassu tajacu	Peccary	4
Lontra longicaudis	Otter	5
Galictis vittata	Grison	5
Eira barbara	Tayra	9
Mustela frenata	Weassel	1
May-16	**Total**	**238**

WILDLIFE ROADKILL MONITORING ON MGC-455 HIGHWAY, UBERLÂNDIA-RIO DO PEIXE, UBERLÂNDIA-MG.

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Roads are necessary and essential to human life, they allow the movement of people and products. However, they bring negative effects to the environment, being the wildlife roadkill the most significant. It is estimated that, on Brazilian roads, approximately 475 million of animals die every year, victims of roadkill. The number of wild animals roadkill suffers increase in sections near to preserved areas. A preserved area in the city of Uberlândia, Minas Gerais, is the Ecological Station of Panga (EEP), RPPN (Private Natural Heritage Reserve) belonging to the Federal University of Uberlândia. It borders the Panga stream in the north, and the state highway MGC-455, Uberlândia-Campo Florido in the east. The highway is single laned, two-way, 137.3 km long and it is currently being paved. Thus, the objectives of this study were to relate the animal species victims of roadkill in the 80-km-long section of Uberlândia-Rio do Peixe and to calculate their respective roadkill rates. Therefore, biweekly monitoring was performed, always starting at 07: 30 a.m. lasting the time needed to complete the trip, during the period from April 2012 to April 2015. The monitoring was carried out by two observers, by car, at an average speed of 50 km/h. Animals found victims of roadkill were photographed for later taxonomic identification using identification guides. When the identification had raised doubts, the photos were sent to specialists for confirmation. The identification was done at the lowest possible taxonomic level. Only animals found in the outward path were systematized, the other ones were accounted as occasional records. At the end of the data collection, the animals were removed from the road. We found 134 animals, of which 87 were wild and 47 domestic. Among the

wild animals, 38 individuals (43.7%) were birds, 24 (27.6%), reptiles, 17 (19.5%), mammals and eight (9.2%), amphibians. We identified 39 species, 17 species of birds, 11 species of reptiles, nine species of mammals and two species of amphibians. The rates were calculated only for systematized wildlife roadkill, for wildlife animals it was 0,008 animals/km/day. The birds roadkill rate was 0.003 animals/km/day, for reptiles, 0.002 animals/km/day, for wild mammals, 0.001 animals/km/day and for amphibians, 0001 animals/km/day. When comparing our results with other studies conducted in several regions of Brazil, we found that the diversity, abundance and roadkill rates vary greatly in each research. Some of the causes of these differences may be related to the features associated with roads, as surrounding landscape, traffic flow, number of lanes, among others. Others factors responsible for this are differences in methodology, such as sampling effort, the monitoring frequency, vehicle speed and extension of the monitored section. It is noteworthy that roadkill rates are often underestimated, because there are animals that do not die at the time of the collision, and some carcasses are removed from the road, whether by traffic, environmental factors or by scavenger animals. The values found in this study were low, compared with other studies. Nevertheless, we should take into account the characteristics of the highway, with half of its length being recently paved and the rest of the highway has not received the pavement yet, so it is in a precarious situation, thus forcing vehicles to transit at a lower speed. We believe that with the finalization of the paving process, the vehicles flow and the speed adopted by the drivers will increase, raising the roadkill rates. Endangered animals were found such as *Myrmecophaga tridactyla* and *Lycalopex vetulus. Cariama cristata* was the most recorded bird and wild animal in this study. As for reptiles, *Crotalus durissus*, *Erythrolamprus aescapulappi* and *Amphisbaena alba*, were the most affected species. The most affected mammal was *Cerdocyon thous*. The presence of endangered animals in the area proves the importance to preserve Cerrado remnants as the EEP, still present in the study area for the conservation of these species. Protected areas crossed by roads should be urgently target for implementing and constant monitoring of mitigation measures.

WILDLIFE THREATENED BY COLLISIONS IN THE AREA OF COAST OF TABASCO

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Coastal areas are complex systems of great importance for conservation because the protection they provide to a wide variety of species and habitats however it is considered vulnerable due to the effects of climate change and human-induced activities like communication routes. Roads negatively affect populations of wildlife primarily due to collisions that occur between wildlife and vehicles ("Roadkill"), this impact is influenced by biological characteristics of species and structure of tracks. In order to know the impact of roads on the diversity of vertebrate monitoring were performed on a section of roads located in the coastal area, with the aim to identify the most vulnerable species. The tours were conducted over a period of three years (2013, 2014, 2015) on a road section with a length of 81.76 km (covered by federal highway 180 and 187). Each year a tour was conducted by season (dry, rain) on a schedule of 6:00 a.m. to 11:00 a.m. making use of vehicles, maintaining a constant speed of 20 km/hrs. During the three years of monitoring six samplings were obtained with a total of 215 records of roadkill, of which 58.79% were obtained in the rainy season. Due to the high state of decomposition eleven records could not be identified to species level. Analyzing mortality by seasons we found that greater abundance and richness of species was present in dry season compared to the rainy season. Mammals were the most affected group in both seasons being the Opossum family the most vulnerable to the impacts (specially *Didelphis marsupialis* and *Didelphis virginiana*). The second most affected class was amphibians being highly vulnerable *Rhinella marina*, *Lithobates*

berlandieri and *Lithobates Vaillanti.* We located eight species subject to protection by the Official Mexican Standard NOM-059-SEMARNAT-2010 (*Lithobates berlandieri, Sphiggurus mexicanus, Tamandua mexicana, Boa constrictor, Claudius angustatus, Iguana iguana, Kinosternon acutum, Lampropeltis triangulum*). Although the class of mammals were sampled in two seasons they had the highest mortality rate in both seasons, this may be due to the abundance of the species or as indicated by other studies like in the case of the gender Didelphis and the adaptability they have performed in this area about urbanized areas (because in these areas a high density of population is present). As for the class of amphibians mortality it may be related to the biological needs of the organisms concerning its habitat requirements (presence of waterbodies around the roads). The high mortality of individuals in this area had already been reported in 2014 where it was determined that the roadkill are mainly influenced by the high speeds allowed in the area because they are federal roads. So far there are no measures that mitigate the impact in the coastal zone, necessary for the protection of biodiversity in the State, since it is located close to the largest reserve in the State of Tabasco (Reserva de la Biosfera Pantanos de Centla) and is considered internationally as a RAMSAR area an AICA.

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WILDLIFE ROADKILL ON A ROUTE BETWEEN THE BRS 070 AND 174 IN MATO GROSSO'S PANTANAL: DEFINITION OF HOTSPOTS

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The highways are present in the routine of most human beings currently, positioning as one of the most important motivators of society's development. Allied with the benefits provided by the highways, there are, also, the impacts, seeing that the highways implementation do not attend to the technical aspects of environmental conservation, which provides negative impacts, leading to damage such as pollution, soil erosion, silting of water's course, higher risks of fires, and even risks of wild animals roadkills. Concerning to the last topic, the damage caused by the roads exert a negative pressure on the fauna, forcing it to make a larger displacement, either to obtain food and shelter, or reproduction. This situation is a result of the fragmentation and degradation caused on the natural habitat. In conjunction with this larger movement, there is the presence of the road that acts as a barrier, however, many species are in danger by crossing it, and they end up being hit. In view of the above stated, this paper has as objective to conduct a survey of roadkills at Pantanal, in Cáceres - Mato Grosso, indicating the current conditions of animals roadkills over the studied course, and pointing out the main spots of the collisions' occurrences (HotSpots). The studied route takes a path of 51 km of the BRs 070 and 174, which are continuous highways. The data collection was done for a year, from February 2015 to February 2016. Then, until the middle of July, the collections had weekly frequency, and from this date were held fortnightly. The data collection was performed with motor vehicles, driven at 60 km/h. Thus, the geographic coordinates were gathered from each point of collisions with the animals, and it was made a photographic record of road-killed animals – which had theirs carcasses removed from the highway to avoid crushes with the fauna that are

attracted to feed themselves with the dead animals on the road; and also to avoid the count of the same animal that has been already hit. The analysis of HotSpots was conducted on Siriema 2.0 software, through HotSpots 2D test, using 500 meter radius with 54 divisions; there were made 1000 repetitions, and the reliability level was 95%. 36 samples were made and 616 animals were found hit, these results showed an average of 17.11 records for sampling, and 0.336 animals.km-1.day-1. Among the classes, the one that presented the highest occurrence was the mammals, with 490 specimens, followed by 76 reptiles, 43 birds and 7 amphibians. The most victimized species were: (110) Yellow Armadillo (*Euphractus sexcinctus*), (91) Capybara (*Hydrochoerus hydrochaeris*), (84) Crab-eating Fox (*Cerdocyon thous*), (81) Nine-banded Armadillo (*Dasypus novemcinctus*), (47) Collared Anteater (*Tamandua tetradactyla*) and (31) Pantanal Alligator (*Caiman yacare*). There was also the occurrence of species at risk of extinction, such as Giant Ateater (*Myrmecophaga tridactyla*), Southern Three-banded Armadillo (*Tolypeutes matacus*) Giant Otter (*Pteronura brasiliensis*) and Hooded Capuchin (*Sapajus cay*). The HotSpots analysis scored 12 points of higher concentration of records (Figure 1), these include stretches of 961 meters each, and in three places the spots were presented continuously.

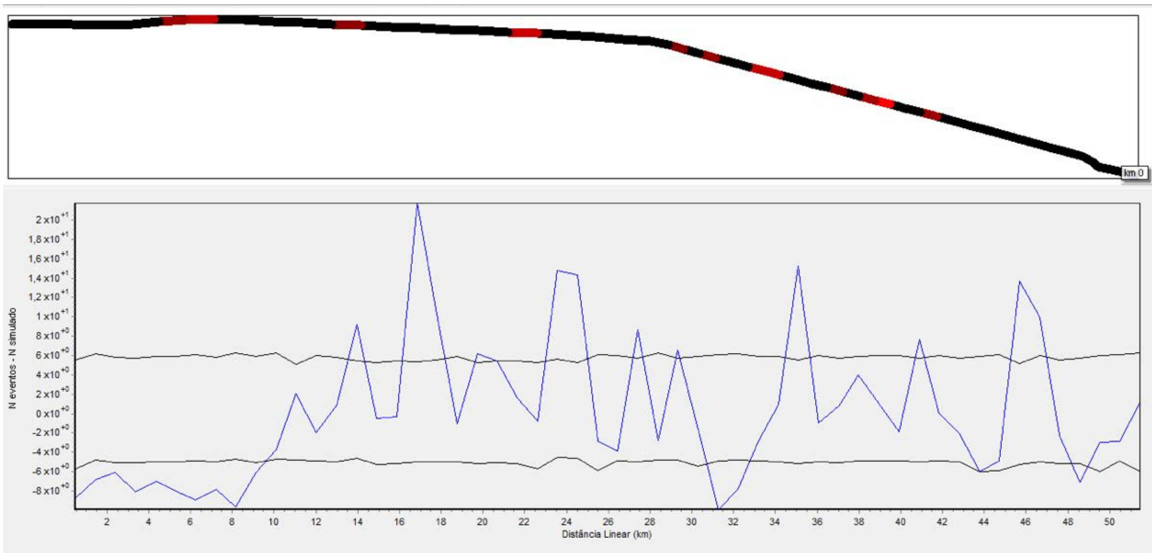

Figure 1 – HotSpots analysis obtained on Siriema 2.0 software.

The route studied showed a high number of roadkills which makes necessary the adoption of measures that attenuate the roadkills. Therefore, the 12 aggregation points of the registers, attained as result on this study, must be taken in consideration to the installation of structures that aim to mitigate the impacts of the vehicles upon the fauna.

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COMPARISON OF TWO METHODS OF MONITORING FAUNA RAIL-KILL AT RIO GRANDE DO SUL STATE RAILWAY

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Roadways and railways along with their implantation and operation cause several environmental impacts, among them fauna running over. In order to find forms of mitigation to reduce the rail-kills, RUMO ALL Logistic does the fauna run over monitoring along the railway extension. The monitoring method was adapted from roadways studies about road-kills. For the monitoring two methods are used: on foot and on railway motor car, these different approaches are used to complement each other and to compare their efficiency. The present work aims to compare the detectability efficiency of the two methods used to monitor fauna rail-kill at Rio Grande do Sul railway. We collected data between October 2014 and April 2015, 42 samplings, 21 from railway motor car and 21 from method on foot. On monitoring by railway motor car we went through all the railway extension (3,102 km) at 40 km/h, and on monitoring by foot we walked seven patches of 15 km, chosen randomly along the railway. For fair methods efficiency comparison we considered the rail-kills registered by railway motor car within the limit of on foot patch. There was a significant difference (p=0.009) between the methods applied, the carcass detectability was higher by foot (N=112) when compared to detectability by railway motor car (N=29). Among rail-kills registered by railway motor car 93.1% are mammals and 6.9% reptiles, classified by body size as big (72.4%), median (24.1%) and small (3.5%). Rail-kills registered by foot were 64.3% mammals, 21.4% reptiles, 12.5% birds and 1.8% amphibians, classified by body size as big (51%), median (32.3%) and small (16.7%). We noticed that the number of rail-kills is underestimated when monitored from a moving vehicle, besides taxonomic group and animal body size, which is directly correlated to time of carcass

removal, might also influence detectability. Even though the detectability of small animals was low for both methods, we observed that the registers of different body sizes were more evenly distributed among sampling by foot, considering that median and small body sized animals could be easily removed. Although diversity index was low for both methods, on foot method showed higher diversity (H'=1.832) than by railway motor car (H'=1.792). The most affected group for both methods was mammals, probably because generally they have bigger body sizes than the other groups. The patch MS-21 showed higher rail-kill rate for both sampling methods, 32 animals by foot and 20 by railway motor car (Fig. 1). This railway segment is near Bagé-RS, this area is characterized by agriculture activities and steppe vegetation, and the high rail-kill rate could be related to the natural occupation of this kind of environment.

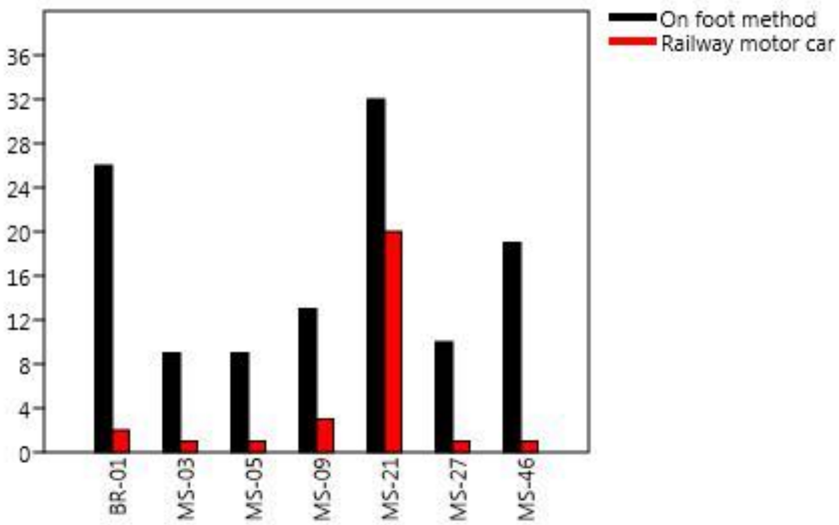

Figure 1: Number of rail-kills for sampled patches by foot and by railway motor car.

It can observed that the method by foot was more efficient at rail-kill detectability when compared to the method by railway motor car. This monitoring accuracy is related to motion velocity, related to carcass removal by scavengers and carcass persistence directly associated with taxonomic group and related to animal body size.

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CRIMINALIZED SPACES OF ROADKILLS VICTIMS IN ROADS OF THE "PANTANOS DE CENTLA BIOSPHERE RESERVE"

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In the last years the roads have been exposed as one of the greatest threats to biodiversity due to the negative effects caused on the environment. These effects can be mentioned fragmentation of ecosystems, changes in hydrological cycles, pollution and microclimatic changes, in addition to indirect effects such as the conversion of land use, loss and habitat reduction. The most visible effect of the roads to wildlife is the "roadkills ". This site becomes a crime scene. As a crime space structure and degradation, they are related to most collisions. This type of crimes in natural protected areas (ANP) is a threat to biodiversity. The ANP have continually increased their traffic flow by the volume of visitors they receive, and by increasing human settlements and related services. In the particular case of the state of Tabasco, the the "Pantanos de Centla Biosphere Reserve"; (RBPC) for its acronym in Spanish, is considered as a key site for conservation because it has about 454 species of terrestrial vertebrates and reservoir 12% of aquatic vegetation underwater state and also has a high density of Mayas - Chontales communities. However despite its importance the construction and expansion of roads has not been planned and measures to avoid the negative effects of roads. The study was conducted with a database of records of vertebrates carcasses, detected between 2014 and 2015. So determine criminalized sites. The surveys were in the first 4 hours from dawn, with a motor vehicle, was performed at a constant speed of 20 km/hr, on a stretch of 27 km. Six courses in total over 27 km were performed. A database was integrated. With the georeferenced basis collision black spots, which are

sites where there is greater density outrages were identified. For this, estimator "Kernel Density" in ArcGIS® 9.3 program was used. A total of 562 individuals of 64 species were recorded run over. Birds obtained the greatest wealth with 30 amphibian species and the highest abundance with 270 individuals. The structure is 19 orders and 36 families. The most abundant species were, *marine Rhinella* with 211 individuals, followed by *Lithobates berlandieri* with 35 individuals. Amphibians are the most vulnerable class in RBPC. This group is considered fragile due to its slow movement and its lack of response to threats as they are unable to feel the danger to vehicles and tend to freeze. 15 unions were registered. Carnivores are the best represented with 18 species, followed by Omnivores with 11. According to the abundance of Omnivores are the most abundant with 321 individuals followed by insectivorous / Invertebrates with 55 individuals. In the dry season it is the increased presence of species, requiring move to find food in the rain. A total of 14 roadkill hotspots were obtained. Two roadkill hotspots of all species. They separated groups, amphibians, reptiles, birds and mammals, three roadkill hotspots found in each. 79% of the points are distant from urban settlements. 43% are less than 200 meters from a water body. 86% is not dominated by natural hedges. 86% of the points are located in areas mainly straight roads. So we can conclude that the effects are influencing collisions is high speed, crossing open sites that are frequented by generalist species habits.

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ENVIRONMENTAL BIOETHICS POINT OF VIEW OF ROADKILLS

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The roads have a social, economic and environmental importance by interconnect regions, influence the development of jobs and promote tourism. In addition to these benefits, it is necessary to point out the negative impacts that these roads cause to biodiversity, such as fragmentation and loss of habitats of many wild species, which also brings problems to human environment. By proving to be an ethical, complex and global relevance problem, it demonstrates a need to understand the overview of research on the topic, in order to propose a discussion on the impact, possible knowledge gaps and ethical flaws. Were analyzed, to date, 166 publications, including articles, abstracts, technical reports, monographs and dissertations, with highlights to the Brazil and USA with respectively 54.8% (N=91) and 16.2% (N=27) published works. In Brazil, 85% (N=22) of states have developed studies related to road ecology; with Rio Grande do Sul with 15% (N=25) of the publications, Minas Gerais 13% (N=21) and São Paulo 4% (N=8). However, the subject acquired prominence in the scientific community since 2009, focusing primarily on federal highways 38% (N=63), 93% (N =155) in regions with little urbanization or near areas of environmental conservation. As the for the data collection, 71% (N=117) showed to be selective for vertebrates and 85% (N = 141) performed works only with roadkill. Regarding the classes of animal that most suffer from the environmental impacts of roads, the groups that excel are mammals with 42% (N =834), birds with 34% (N=667), reptiles 18% (N=363) and amphibians 6% (N=108) (Fig 1).

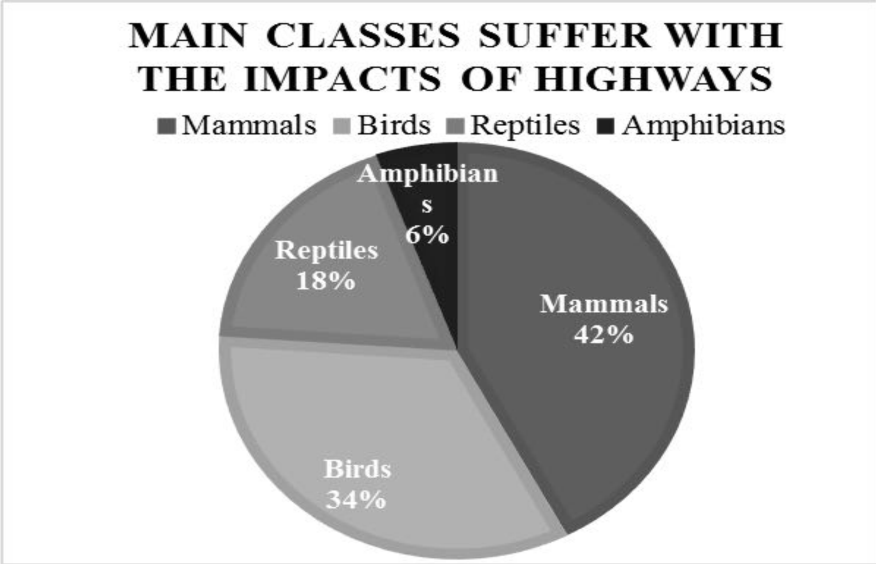

Figure 1. Classes of animals that are most impacted by roads

Among the ethical questions raised in the review, biodiversity loss, habitat fragmentation and edge effect were pointed as the primary consequences of the impacts of roads, and it is valid to point out that 44% (N=73) of the publications describe the need to develop more studies assessing the impacts motivated by highways. It may be also noted, the responsibility of the roads, the anthropic pressure mentioned by 41% (N = 68) of the publications and the lack of road infrastructure to reduce the impact of roads on the involved biome, such as the collision of vehicles with wild animals and introduction of exotic species of both fauna and flora. Over 23.4% (N=39) of the publications observed failures in environmental education strategies. The analysis revealed, as the main gap in the evolution of road ecology research, a methodological deficiency plus a low sampling effort presented in 44% (N=73) of the studies, with a serious ethical problem, which highlights the need for development of a standardized protocol for further research. To reduce environmental impacts, 76% (N=126) of the works suggest mitigation measures, such as wildlife upper and lower crossings (60%; N=100), speed reducers (12%; N=20) and light signals indicating passage of wild animals (3.6%; N=6). Therefore, it is concluded that the focus of the evaluation of wildlife roadkill occurs in environmental conservation areas, which is limiting the hotspots that end up eliminating other variables promoting biodiversity loss and fragmentation of habitats, such as urban areas and coldspots. The issue of methodological deficiency has an extremely ethical importance ethical and should be discussed often aiming in the promotion of the standardization of research methods directed to the ecology of roads, thus acquiring more reliable results and accurate diagnoses, related to the main damage caused by roads.

DIFFERENCES IN ROADKILL RATES IN THE BIOLOGICAL RESERVES OF SOORETAMA AND ITS SURROUNDING IN BR-101.

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The roadkills reduce the population size, limit gene flow and reduce the genetic diversity of wild animal populations. However, the effects of roadkill vary according to the characteristics of highway, landscape highway that intersects and the affected species. Roadkills on highway stretches intercepting Conservation Units (CU) is an environmental impact even more worrying, because of a conflict with the purpose of conservation of the species in the area. The largest continuous Atlantic forest board is located in Espírito Santo (ES). It is a forest complex, involving Sooretama Biological Reserve (SBR), the Vale Nature Reserve (VNR), the Private Natural Heritage Reserve (PNHR) Mutum Preto and PNHR Recanto das Antas, located in the municipalities of Linhares, Sooretama, Jaguaré and Vila Valério, in the north of the state of ES, with approximately 50 thousand hectares. This forest complex is intercepted by a stretch of about 25 km of the BR-101 federal highway, whereas 5,1 km cuts directly to SRB, which is a Federal Conservation Unit, and the rest tangency other protected areas, especially the VNR, which although it is a protected area, it is a private area that is not included in any category of Conservation Unit. The aim of this study was to compare roadkill rates in a stretch of 5.1 km of the BR-101 that cuts SRB with another stretch of 6 km that tangent to the VNR. The running over data in the stretch that cuts SRB were provided by Roadkill Monitoring Team. The collections in this section were performed in August 2010 to October 2014, carried out by a technician on weekdays. In the stretch of 6 km

that tangent to the VNR, the data collection was performed in this study, from July 2014 to July 2015. Data collection in SRB and VNR were performed by an observer, the route taken on foot in the morning, between 7:30 and 11:30 am, in both highway lane directions, one direction at a time. Specimens found run over were photographed and had their data registered in a spreadsheet containing taxonomic group, time, date, geographic coordinates, location on the road and the track direction. The roadkill rates were calculated by dividing the number of specimens found run over by kilometer per day survey (animals/km/day). Thus, independent of the sampling effort carried out in different parts, it was possible to compare the data. Comparison of roadkill rates between the BR-101 stretches in SRB and VNR was performed considering the data by seasonal, dry season (May to September) and rainy (October to April). In addition, roadkill rates were compared in the months in which there was data collection overlap in the two sections. In all, an effort was made 415 days of collection in SBR and 30 days in VNR. In the stretch of 5.1 kilometers of SRB were recorded in 1772 animals wild vertebrates killed by roadkill, these are 466 amphibians, 393 Lepidosauria, 263 birds and 650 mammals. In the stretch of 6 km from the VNR found 400 roadkills, being 235 amphibians, 73 Lepidosauria, 35 birds and 57 mammals. The roadkill rate in the dry period RBS was 0.322 animals/km/day, while in VNR was higher, 0.536 animals/km/day. In the rainy season the roadkill rate in SBR was 1,194 animals/km/day and VNR was also higher, 2,592 animals/km/day. In the months overlay July, August and October 2014, roadkill rates in SBR were 0.280, 0.235 and 0.098 animals/km/day respectively, and VNR were higher, 2,833, 0,555 and 2,611 animals/km/day respectively. The results show that the roadkill rate in VNR is greater than SBR in all comparisons. The BR-101 cut the continuous forest in SBR, however, the maximum speed established at CU stretch is 60 km/h, with two electronic checkpoints. On the other hand, the stretch that touches the VNR maximum speed is 80 km/h without station of electronic checkpoints. Speed control in SBR stretch may be one explanation for the difference in roadkill rates. Another possible explanation for the differences in rates would be the differences in landscape features, in the vicinity of each section, in the reserves, since in the VNR the stretch cut an array of different land uses, with crops (forestry and agriculture), forest pasture and native field. We conclude that the roadkill rate is related to seasonality in rainfall, being higher in the rainy season, when the fauna is in most activities period.

Furthermore, the differences in roadkill rates between the BR-101 stretches in SBR and VNR can be for the difference in maximum speed allowed in each section, speed control and environmental characteristics surrounding the highway. We recommend that the attention to roadkill in the region is not exclusive to the impact of BR-101 at CU SBR, but also the entire 25 km stretch that intersects the forest complex, since roadkill rates are higher in the array surrounding CU than inside the CU, and this affects the fauna of the entire forest complex.

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ROAD KILLED MAMMALS FROM THE MUSEUM OF NATURAL HISTORY OF CAPÃO DA IMBUIA, CURITIBA, PARANÁ, SOUTHERN BRASIL

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Road kills represent a direct impact on wild fauna, but little is known on this matter in the Paraná state, southern Brazil. To support regional political action plans, data on animals killed in Paraná roads are being collect from distinct information sources. One of those sources is the mammal collection deposit at the Museum of Natural History of Capão da Imbuia (MNHCI), in Curitiba, Paraná. MNHCI opened in 1956, and maintains one of the most thorough zoological database from the state, honored as Paraná's Historic and Artistic Heritage. Data registered on the MNHCI's taxidermy notebook of mammals (TxNM) sums 9,854 records, and includes official records of mammals road killed from December 1988 to February 2016. Four hundred and twenty seven mammals were registered as being road killed. This corresponds to 0.43% of the mammals deposit at MNHCI. These animals belong to eight orders, 17 families and 42 species. Carnivora presented the highest number of specimens (n=232; 54.3%). Considering species level, the top three registered were the crab-eating fox *Cerdocyon thous* (n=56; 13.1%), southern oncilla *Leopardus guttulus* (n=46; 10.7%), and southern tamandua *Tamandua tetradactyla* (n=35; 8.2%). About 20% (n=86) of the species road killed are considered threatened in Paraná. Three species are critically endangered: giant anteater *Myrmecophaga tridactyla* (n=5), pampas deer *Ozotoceros bezoarticus* (n=1) and marsh deer *Blastocerus dichotomus* (n=1). And five are vulnerable: southern oncilla *Leopardus guttulus* (n=46), ocelot *Leopardus pardalis* (n=11), margay cat *Leopardus wiedii* (n=9), maned wolf *Chrysocyon brachyurus* (n=9), and cougar *Puma concolor* (n=4). Males over numbered females (n=184, 42.6% and n=143, 33.5%;

respectively); however, several specimens had no information about their sex (n=102, 23.4%). The number of road kills recorded was higher during 2008 (n=35, 8.2%), 2005 (n=33, 7.7%), and 2003 (n=30, 7.0%). Specimens from Paraná represented 86.4% (n=369), and other specimens came from states throughout Brazil: Pará (n=23, 5.4%), São Paulo (n=13, 3.0%), Santa Catarina (n=6, 1.4%), and Mato Grosso do Sul, Mato Grosso and Rio Grande do Sul (n=1, each, 0.23%). An individual from Argentina, and another from Paraguay were also recorded in the TxNM. Within Paraná, localities with the highest number of records were Foz do Iguaçu (n=30, 7.0%), São José dos Pinhais (n=23, 5.4%) and Telêmaco Borba (n=18, 4.2%). Only 5% had no locality of origin assigned. Amongst the federal roads cited, BR-277 stand out with the highest number of road kills (n=74, 17.3%), this might result from the fact this is the longest road within Paraná, with about 730 km long. It was followed by BR-116 (n=24, 5.6%) and BR-476 (n=19, 4.5%). State roads were less cited, PR-508 (also known as Alexandra-Matinhos) showed up 3.0% of the times (n=13), and has only 31 km long. PR-151 (n=10, 2.3%) and PR-090 (n=9, 2.1%) were also important. Noteworthy, the specimens deposited at the MNHCI mostly correspond to occasional findings of carcasses, rather than studies oriented for monitoring wild fauna road kills. Thus, there is a bias of detection towards medium to large sized mammals (n=402, 94.1%). The few exceptions account for some Brazilian guinea pigs *Cavia aperea* (n=21), Atlantic forest squirrels *Sciurus ingrami* (n=2), a Brazilian marmoset *Callithrix penicillata*, and a brown-eared woolly opossum *Caluromys lanatus*. The opportunistic nature of this dataset prevents statistically valid inferences on the rate of animals road killed in Paraná. Nonetheless, the 30-year records presented and described here are an extremely important testimony of the impact of roads in the local wild fauna. These records identify threatened species being continuously impacted. Among these, giant anteater and maned wolf must be highlighted, since these are species known to be road killed due to cultural beliefs and superstitions. This study also emphasizes the role of museums as holders of information. Several records were collected prior to the recent monitoring studies. This is a valuable source, opened for enquiry, that can aid research, supporting mitigation plans and regional policies.

THE OPHIDIAN ROADKILLS ON A STRETCH OF BR-040: ANALYSIS OF LOCAL ROADKILL

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The mortality on Brazilian roads are increasing due to forest fragmentation and deforestation. The frequent fragmentation of natural regions induces wildlife displacement, propitiating roadkill, affecting populations directly. The possible lack of sensitization from road users cause impacts on diverse groups, including ophidians, that many times are seen as non-charismatic character animals. The purpose of the present study is therefore to evaluate if the ophidian roadkill mortality could be intentional or not on a stretch of BR-040. The company Essati Engenharia LTDA, initiated on December of 2013, the Wildlife Roadkill Monitoring on BR-040, on the stretch of Rio de Janeiro/Juiz de Fora (360 km), under CONCER's concession, that crosses the Atlantic Forest biome. The Wildlife Roadkill Monitoring is conducted 24/day, by trained inspectors and a team of biologists and a veterinarian, 5 days a week during 8 hours a day, with a vehicle on a 40 km/h velocity. For each roadkilled specimen occurrence was registered the species (on the lightest taxonomic level possible), the date, the local and the environmental surroundings type of the road, the specimens in best conservation state were collected and housed in the Museu Nacional do Rio de Janeiro. The data analysis was conducted descriptively, comparing the roadkilled numbers on the side of the road with the roadkilled numbers on the center of the road. The obtained results are from January of 2014 to January of 2016, in this period were registered 294 individuals, distributed in 36 species and 6 families The highest number of roadkilled species were *Sibynomorphus neuwiedi* (N = 40), followed by *Crotalus durissus* (N = 37), *Oxyrhopus petolarius* (N = 20), representing 32,99% of the total, revealing abundance of the species on the study area. Of the roadkills total, 199

occurred on the side of the road (68%) and 95 occurred on the center of the road (32%) (Fig. 1). Comparatively, the percentage of mammals is 63% on the center of the road and 37% on the side of the road, therefore presenting the opposite for ophidians.

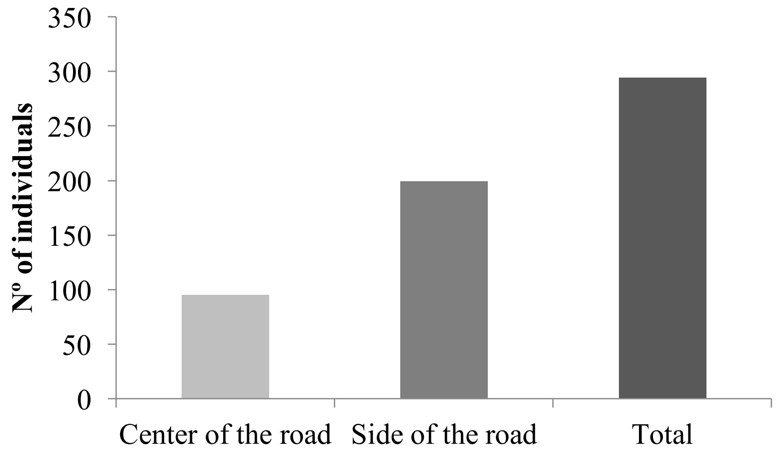

Figure 1. Roadkill ophidian distribution on study area

The high number of ophidian roadkills registered on the side of the road could be related mainly to the lack of sensitization of road user drivers, due to the possible terror ophidians cause on humans, consequence of a negative cultural heritage that remains on a large part of the population. In addition, the fact of moving slowly and even to stay put on the asphalt due to the need to regulate their body temperature, increase their exposure and vulnerability, causing higher chances of getting roadkilled. Other studies also mention the intentionality of ophidians roadkills. However, more studies like this are needed to evaluate and highlight relevant factors, so it is possible or not to consider the roadkills as intentional. It is noteworthy that such studies are of great importance, to serve as conservationist subsidy to reduce these high level of ophidian roadkills on the roadside.

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WHY DO WE REALLY NEED TO ACCOUNT FOR CARCASS REMOVAL AND DETECTION ON ROAD-KILL ESTIMATES?

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Slaughter... There is no other way to call current wildlife road-kill rates. Estimates point to 1 million dead animals per year in USA, 475 million per day on Brazilian roads. But don't go too fast, these are possibly underestimates. Animal-vehicle collision is the main direct source of terrestrial vertebrate mortality at global scale, more than poaching. Though local transport planning and mitigation initiatives do exist in some countries, the great picture is not buoying: road network and traffic are increasing worldwide, even on human low-density regions. Even low to medium traffic roads can show high road-kill rates. When low road-kill rates are found on a given road, it is much more likely that there is no more wildlife around than it is an effect of road avoidance or a good mitigation system. But before considering these hypotheses, open your eyes: you just may be not seeing the dead so well. Knowing the correct number of road-kills before and after a given time is essential to evaluate the effects of road changes (*e.g.* paving, widening, traffic increase) and effectiveness of mitigation measures (*e.g.* speed reducing, wildlife under and overpasses, fencing). It's also crucial to estimate the effect of road mortality on local populations' persistence. Giving media attention to accurate numbers of road-kills can foster society actions, such as change in drivers' behavior and increased demand for mitigation and sustainable transportation planning. So, it is highly important to properly measure road-kill rates, but how to count dead? Sampling carcasses on roads has the same two critical aspects of sampling living animal populations: spatial variation and detectability. Spatial variation in living animals or carcass abundance is important because we can rarely sample our entire area of interest. Even if you monitor all traffic lanes/shoulders along all the road stretch or network of interest, you are not sampling the entire area where a carcass from that "carcass population" can be, because some corpses (or injured animals) fall away from the road area. In England, for example, it was estimated that 24% of fox carcasses fall on 20 m road side. What about carcass detection? Detection of carcasses on roads can vary a lot, depending on method, observers' ability, road area/surface, and carcass size/color. According to our estimates, two observers in a 40 km/h vehicle can detect 85% of crab-eating fox carcasses on a two lane paved road, and just 36% for small/medium sized birds. Detection can be so low that you need other survey method: small anurans are almost impossible to be found by car, you have to sample by foot though it does not guarantee perfect detection. But counting road-kills has one more problem: dead animals on the sampled area may have a short "life time". Due mainly to scavengers and traffic, carcasses can remain on roads for less than the sampling interval, just a few hours (*e.g.* small anurans and birds) or days (*e.g.* medium mammals). How can we have a good estimate of road mortality? The proportion of carcass that fall out of the sampled area (spatial variability) is too hard to be estimated and will be a "black box" in most cases. But one possible way to measure this is by searching on the adjacencies of some randomly selected road stretches, perhaps using trained dogs, and estimating a distance decay function. We can improve detection by choosing a better method (*e.g.* on foot or low speed vehicle, more observers per area observed), but most importantly, it should be always estimated and re-estimated whenever method, team or road conditions change. The third issue, carcass removal, we can overturn by using a very short sampling interval, but this is impractical for long roads or for very short "life time" species (anuran carcasses remain less than one hour at some high traffic roads). For most monitoring programs, carcass removal is the main source of inaccurate road-kill estimations. For example, we measured that 62% of crab-eating fox carcasses were removed from road area between our monthly surveys. However, simple experiments for carcass "survival" time can deal with this issue. Analytical methods and softwares accounting for detection and carcass removal on road-kill estimates are freely available. So, how many animals really die on roads? Dunno, but we can have a better estimate.

Differences between observed and estimated (considering at least carcass removal and detection) road-kills can be huge. For example, during 12 monthly surveys on 280 km of BR-101 we found 78 crab-eating fox carcasses and estimated 647 road-kills/year. On 4 km of ERS-389, after 16 monthly surveys by foot, we found 1433 anuran carcasses, but corrected estimates point to 37680 road-kills/year! Because of the three sampling issues, to count dead on roads is a hard task, and just summing records makes underestimation a common place in road-kill assessments. Worse: you can draw false conclusions on the impact of road mortality on populations and on the effects of road change and mitigation measures on mortality. If you do not account at least for detection and carcass removal, you can sample a road for a long time, found few road-kills, and believe that nothing worthy to worry is happening there. But do not be so naïve: road-kills are a slaughter in course. One for which we no longer can be blind.

WILD BIRD AFFECTED BY ROADKILLS ON HIGHWAYS IN THE SOUTHERN OF SANTA CATARINA STATE, BRAZIL, DUE TO SEASANALITY

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Roads are manifestations of political, economic and social decisions that change the environment in different ways, such as fragmentation and habitat loss. Despite roadkill of wildlife is considered, one of the main causes of biodiversity loss, there is few data on how roadkill affects the bird community. This study aims to quantify richness and abundance of wild birds affected by roadkills on highways in the southern of Santa Catarina state, due to seasonality. The study was conducted in southern Brazil, in the state of Santa Catarina (SC), on two roads that crossing the Atlantic Forest *stricto sensu* and of Ombrophyllous Mixed Forest (49°14'52"W to 49°57'54"W, and 28°12'10" S to 28°42'07"S). The road SC 239 runs between Criciúma and Orleans municipalities and is 38 km long. The road SC 390 link Orleans and São Joaquim municipalities and is 78 km long. Both roads are paved. Biweekly samplings were performed from August 2014 to August 2015, along 116 km of highways. The surveys were conducted by car, driving at 40-50 km h^{-1}. When animal carcass was seen, we stopped the car for a closer inspection, as identification to the lowest taxonomic level possible, record of coordinates on GPS, photograph and carcass removal from the road. Carcasses in low stages of putrefaction were preserved and added to the vertebrate collections of Unidade de Zoologia Profa. Morgana Cirimbelli Gaidzinski of Universidade do Extremo Sul Catarinense. The rate of roadkill was calculated by dividing the number of individuals killed by the total of number of kilometers covered. The influence of seasonality was analyzed using circular statistics in ORIANA 4.0 software. Months were converted to angles (intervals of 30°) and the numbers of bird killed in each month were included in the analyses as the frequency of angle interval. Rayleigh Uniformity test was used to calculate the probability of the null hypothesis that the data are uniformly distributed around the

analyzed cycle by assessing the significance of the mean vector length (r). A significant result of the Rayleigh test indicates a significant mean angle, i.e. a statistically significant roadkill pattern. A total of 26 surveys of road-killed animals were conducted in 3,016 km: 2,028 on SC 239 (covering 78 km) and 988 on SC 390 (covering 38 km). In all, 274 birds of were recorded along the two roads. Thirteen specimens were identified at the level of class, 20 at the level of order and 68 at the level of species. The most commonly road-killed species were the Saffron Finch (*Sicalis flaveola*; n = 47), Burrowing Owl (*Athene cunicularia*; n = 19) and Guira Cukoo (*Guira guira*; n = 10) of total birds casualties. No species listed nationally as threatened was sampled. The overall number of road-killed birds compared to road length was 0.091 animals km^{-1}. The Rayleigh test showed a seasonal pattern of wild bird roadkills (with peaked in October - January (mid-spring to early summer) (Figure 1) statistically significant ($p < 0.001$).

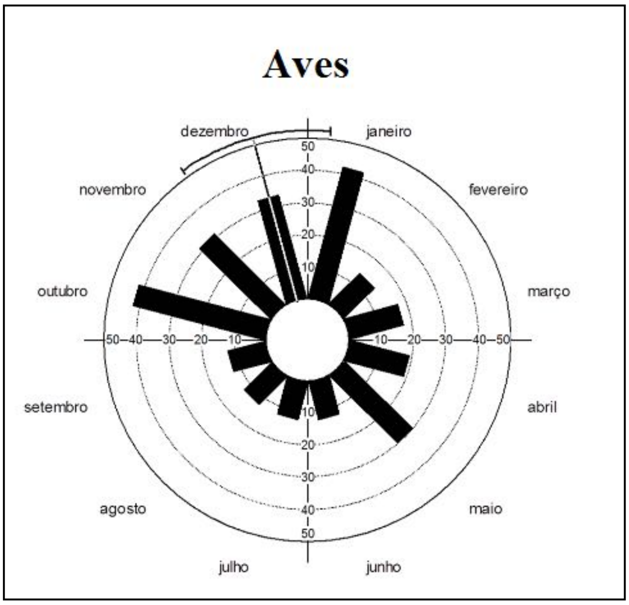

Figure 01: Rose diagrams of circular analysis of number of wild birds roadkill during the whole study.

Seasonal fluctuations are periodical and repeated on a more or less regular basis in each period, or every year. Our results showed that in an overall, warmer months (October to March) had the highest number roadkill recorded. The $p < 0.001$ indicates occurrence of seasonality in roadkills of wild birds, and $r = 0.224$ (closer to 0) indicates a more equal distribution throughout the year, even if seasonality occurs. Seasonality occurred in the Autumn months too, corroborating with others studies. Seasonality can have many influencing factors, such as migration period of some species, food searching, breeding seasons and biological cycles of the species (nest output) throughout the year.

ROAD KILLS IMPACT IN URUGUAYAN MAMMALIAN FAUNA

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In Uruguay 79 species of terrestrial mammals have been recorded, of which 30 are cataloged as a conservation priority by the National System of Protected Areas (SNAP). The roads are a threat to the survival of many species, they can cause negative impacts such as habitat fragmentation, road-kill animal, edge and barrier effect, spread of exotic species, changes in microclimates and noise pollution, among others. Is common to see many carcasses of road-killed animals in Uruguayan routes, the vast majority are medium and large mammals. However, there is almost no information on this reality, there are few studies in the subjet, the last one was carried out in 1997 by the NGO Vida Silvestre where road-kill animals on Route 9 was surveyed for one year. After which no further research was conducted until 2015, when the NGO, when the NGO ECOBIO Uruguay began working on a line of long-term research. The first project of this new line of research was funded by Rufford Small Grants and started in 2015. The objective was to start generating baseline information about the impact of roads on the populations of medium and large mammals, identify species that are most affected by the road-kill and establish a monitoring network nationwide involving different stakeholders. The study area was the eastern region of the country, covering the departments of Maldonado, Lavalleja, Canelones, Treinta y Tres, Cerro Largo and Rocha. Routes were surveyed bi-monthly n ° 1B, 7, 8, 9, 10, 15 and 26 in order to compare mortality routes of animals in high and low traffic. This region is characterized by a high diversity of ecosystems, important diversity of mammals and where most of the protected areas and wetlands that are part of the Ramsar Convention are located. The roads were traveled at a speed of between 60 and 70 km / h andthe vehicle stopped for each animal found dead. In the period between April and December a total of 1318 road-kill of vertebrates were obtained, including records received by various people who have joined the monitoring network. Of the total, 93% were mammals and most

of them belonging to medium and large mammals. Among the species recorded skunks (*Conepatus chinga*), crab eating fox (*Cerdocyon thous*) and the pampas fox (*Lycalopex gimmnocercus*) were more frequently found, exceeding 50% of the records obtained (Figure 1).

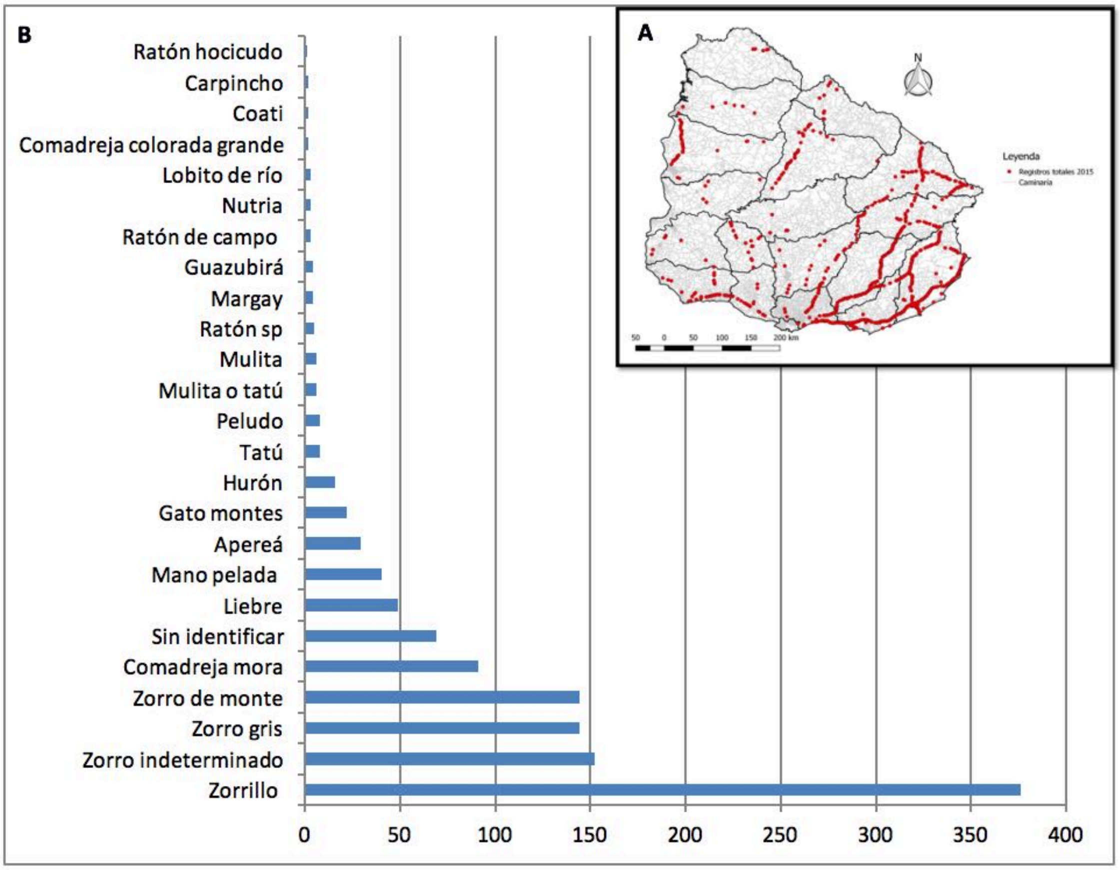

Figure 1: A- map with records collected in the period between April and December 2015. B- graph with the abundance of the species recorded in that period.

All three species have no more important conservation issues and are not considered a priority species for SNAP. However, there have been recorded other species that do have conservation problems at national and international level and are considered priority by the SNAP. Among these are the Margay (*Leopardus wiedii*) and the coati (*Nasua nasua*) as priorities for SNAP. While the Margay and Armadillo (*Dasypus hybridus*) are listed as NT (near threatened). Regarding the involvement of society to the project, to date more than 50 people have joined and provide us with information of various species road kill. It should be noted that much of that information comes from routes not covered in our surveys, this is of great importance since it sets the beginning of a future project monitoring the entire country. Currently the group is testing a Mobile application that was developed to facilitate the reporting of road-kill records by the society.

Acknowledgement: Rufford Small Grant and all the people who joined to collaborate

ROAD-KILL VERTEBRATE ALONG THE "COSTANERA SUR" ROAD, COSTA RICA

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In this study, we show a road-kill survey conducted by volunteers from Huen Tebec Biological Station, Playa Tortuga Reserve, and several staff hotels along a 42-kilometer road stretch of the Costanera Sur Road (Route 34), which runs bordering the coast in southern Costa Rica. The survey was carried out throughout the whole year 2014. The road was divided in 14 sections of 3 km each. Volunteers surveyed each section on foot registering all animals seen on the road and its surroundings. A total of 630 km were surveyed and 588 vertebrate animals were registered, with up 47 species recorded. By taxonomic groups, amphibians had the largest representation with 47% of records. Reptiles represented 24%, mammals 20% and birds just 9%. *Bufo marinus* (21) and *Agalychnis callidryas* (12) within the amphibians, and *Iguana iguana* (56) and *Boa constrictor* (10) in reptiles, were the main collided species. In mammals were *Tamandua mexicana* (12) and *Conepatus semistriatus* (12); whereas in birds *Coragyps atratus* (13) and *Ramphocelus costaricensis* (5) were the species more commonly found dead on the road during surveys. Some endangered Costa Rican species as *Alouatta palliata*, were also recorded. Some variables that contribute to explain road-kill occurrence are analyzed. Distribution of road-kill locations in relation to surrounding habitat varied among groups. Thus, amphibians are more associated to riparian areas near streams and other water- courses. Mammals are more related to forest and birds to grassland areas. Meteorological conditions were also important, and the proportion of amphibians found within the surveys was higher during cloudy days. In opposite, mammals and birds were more common during the sunny ones. In relation to road characteristics road-kills were more common on its straight sections rather than on its curves. Mitigation measures, mainly underpasses and aerial passages are recommended on the straight sections of this road in order to reduce road-kills.

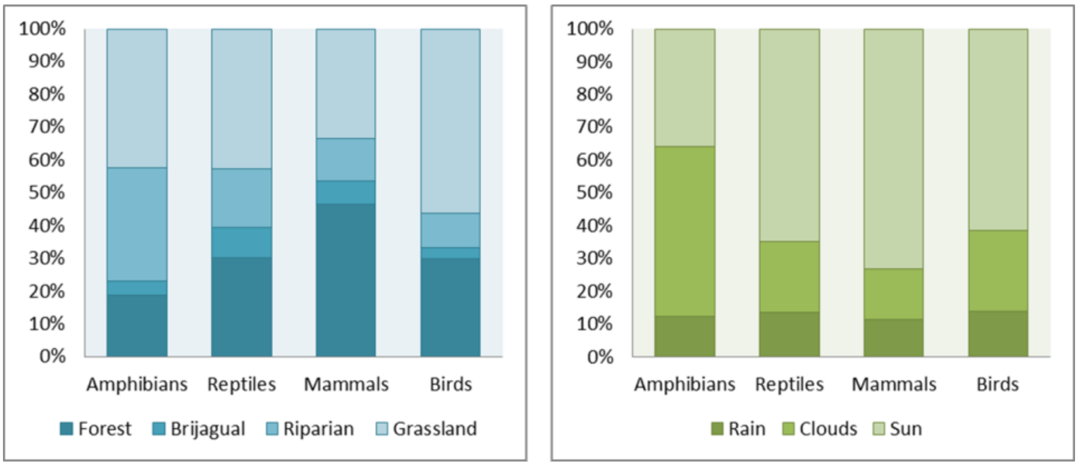

Figure 1: Distribution of road-kills by group in relation to surrounding habitats and in relation to meteorological conditions. "Brijagual" = local word for Bush-land.

ROADKILL ANIMALS IN TIJUCA NATIONAL PARK (RIO DE JANEIRO, BRAZIL): MONITORING AND EDUCATIONAL CAMPAIGNS

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The Tijuca National Park - PNT, one of the world's largest urban parks (3.960hectares), is located in the city of Rio de Janeiro, presenting features mountainous terrain with altitude ranging between 80 and 1.021m and totally covered by Atlantic forest. The TNP is divided into four subunits separated by roads and buildings: Sector A (Floresta da Tijuca), Sector B (Serra da Carioca), Sector C (Pedra Bonita/Pedra da Gávea) and Sector D (Pretos-Forros/Covanca). Each of these sectors has many attractions and also paved roads that allow the movement of vehicles. On the other hand, due to be surrounded by a large urban center, it suffers various kinds of impacts such as fires caused by balloons, anthropic pressure caused by speculation and growth of poor communities around, extraction and hunting of species of flora and fauna, introduction of exotic species, communication projects and transmission lines, religious activities and inappropriate use of water. All these conflicting activities are identified actually in the Management Plan of PNT which was published in 2006. Although the park is crossed by 42km of roads (more than 90% paved) and road-kill are recognized as one of the greatest threats to local wildlife, the use of vehicles inside and around the park was not considered as conflicting activity in its management plan. Although animal reintroduction efforts, the park has a fauna historically impoverished mainly due to deforestation and hunting. The impact of roadkill is unknown and therefore disregarded in the planning of actions for conservation of wildlife. Considering this scenario, the aim of this study was to map the roadkill into the two most visited areas of the Tijuca National Park (Sector A=30.5km and B=10.8km) and its surroundings, at the same time were conducted educational activities to mitigate this impact of road-kill. Since 2013 they are conducted weekly monitoring using cars, motorcycles, bicycles and eventually walk on foot. Although initially we want to monitor the roads from all sectors of the park because of the risks of violence we choose to search only the safest roads. The most significant feature of this road system is that much of this coincides with the urban road network of the city of Rio de Janeiro, which does not necessarily correspond to visitors of the park. A total of sixty-two individuals were found, and fifty-three were identified in genus in about three years of monitoring. Mammals were the group of roadkills animals with the largest number of individuals (n = 25) and species (n = 11). The reptiles were also well represented (n = 25 subjects) with 10 species. Birds and amphibians have two individuals and two species. The mammals most road-kill were *Didelphis aurita* (n=6), *Nasua nasua* (n=5), *Cuniculus paca* (n=4), *Coendou villosus* (n=2), *Sapajus nigritus* (n=2). The most common reptiles were two snakes *Bothrops jararaca* (n=7) and other snakes species had three individuals registered *Bothrops jararacussu*, *Chironius bicarinatus*, *Micrurus corallinus* and the lizard *Salvator merianae*. The forest sector (A) had 22 roadkill animals and the sector of the Serra da Carioca (B) had 18 roadkills in the Vista Chinesa Road. Other roads in the Sector B, as Paineiras Road and Sumaré Road had 12 roadkills. On the roads surrounding the park were identified 11 roadkill. Educational campaigns are made twice a month with the visitors and users of the PNT, addressing the problem of roadkill. Park staff and volunteers participate in actions involving direct approaches, speeches, banners and brochures, as well as paintings of animals on the ground, symbolizing the animals death. Our results show that road-kill represent negative impact to the fauna of the Tijuca National Park. Thereby, beyond educational campaigns, other actions are required to mitigate these negative impact. Additionally, they are being initiated research with camera traps in order to identify the species that occur near the roads.

Acknowledgments: All staff of the Tijuca National Park and volunteers for their support.

ROADKILL MAMMALS BEFORE AND AFTER DOUBLING THE HIGHWAY BR101-SOUTH, SOUTHERN BRAZIL

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Roadkill and the isolation of populations due to the barrier effect can be considered the main direct impacts of roads on wildlife. An important approach to effectively mitigate roadkill on highways is to locate the points where the roadkill are concentrated. Mammals by behavioral, size and charisma features are a group of vertebrates that require mitigation for mortality, since they are also among the most seriously injured on roads. The objective of this study is to evaluate the mortality of mammals of BR 101, before, during and after of doubling the stretch RS. Besides diversity data, compared the roadkill hotspots in the three periods: before (15 samples), during (11 samples) and after (19 samples) the duplication, using the Ripley's K statistics and Hotspot analysis available in Siriema v1.1 software. In these were considered only medium and large mammals due to increased detectability on the highway. The study area corresponds to 97.3 km of BR101 in southern Brazil, between the cities of Torres (29 ° 17'58.69 "S, 49 ° 46'12.28" W) to Osório (29 ° 53'37.86 "S, 50 ° 17'4.02 "W) in the state of Rio Grande do Sul (RS). Was recorded 21 mammals taxa, being the most abundant genus *Didelphis* (n = 721), followed by *Cerdocyon thous* (n = 108). The abundance decreased between before and after duplication (F=18,04 p<0,001). The correlation (r) between the hotspots of three periods was less than 0,3 indicating no overlap between the periods analyzed. This indicates that some exploratory factor has changed over the work. Possible explanations need to be explored in other studies, are likely landscape changes, increased avoidance of the duplicate route towards simple and implanted mitigation measures, such as underground passages and fauna fences. So a highway with two paviments differ from a highway with four paviments about how the mammals react in terms of movement and relationship to landscape.We recommend

other approaches that allow a greater sample size *n* roadkill at least temporally spaced sampling.

Acknowledgments: To the Foundation for Research and Innovation of the State of Santa Catarina - FAPESC for financial support and CGMAB / DNIT for the availability of data BR 101/South.

SNAKES ROADKILL ON TWO HIGHWAYS IN "TRIANGULO MINEIRO", MINAS GERAIS: AN INTENTIONAL CONDUCT?

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Although indispensable to society, roads cause great negative impacts on biodiversity, including habitat fragmentation and wildlife roadkill. Roadkill records vary according to the characteristics of each road, much of it is accidental, however some drivers reach animals intentionally, particularly animals culturally stigmatized as snakes and amphibians, causing significant losses in their populations. Thus, we aimed to evaluate whether snakes roadkill: a) occur intentionally on two highways of Triangulo Mineiro (MG); b) are intensified by the vehicles flow on each road; c) are influenced by the characteristics of the selected lanes in each section; d) are influenced by the vehicle categories used by drivers; or e) by the object of study. Therefore, there were used 15 snakes carcasses, obtained by donation of a conservationist breeding facility and 40 pre-made models one-meter long in tubular shape, made of fabric to simulate living serpents, and as control objects, transparent pet bottles partially filled with earth or sand. Specific sites from the roadside were selected, where there was enough vegetation surrounding for observers and the vehicle to be hidden during data collection. In each sample, there were placed, only on the roadsides, a model or a carcass and about twenty meters away a control object was exposed, or vice versa. At the end of the experiment, 40 snakes and 40 control objects were exposed on each road during two hours at each sampling. For each chosen sample point, the respective section of the highway was categorized into flat, downhill or uphill lane. Looking forward to recording the behavior of drivers facing the study objects, camera traps were used. Also, the observers remained in the middle of surrounding vegetation In order to

count the number of vehicles passing through there. After analyzed, the filming revealed intentional roadkill on two highways, registering 23 snakes roadkill and 12 controls roadkill on the BR-050; five snakes roadkill and five controls roadkill on the MG-223. But the number of snakes roadkill showed no difference from the one of control objects on the BR-050 (U=798.500, p=0.984) and on the MG-223 (U = 800.000, p=1000). There were no differences in the number of carcasses roadkill and models roadkill for both BR-050 (H=0.970, p=0616), and MG-223 (H=0.414, p=0.813). The total number of snakes roadkill and controls registered on the two roads, showed no difference between them (U = 879.000, p=0.307). Trucks caused more roadkill than cars in BR-050 (U=946.000, p=0.019) and MG-223 (U=940500, p=0.014). The characteristics of the selected sections on BR-050 influenced the number of roadkill, most of them occurring in uphill lanes (U=259.0, p=0.042). For the MG-223, this comparison was not possible due to the topography predominantly flat on the highway. As snakes and objects were arranged only on roadsides, all registered roadkill were classified as intentional, since the conductors should necessarily swerve their vehicles to reach the roadside in order to achieve the targets. We believe that objects arranged in other lane sites could cause an unexpected behavior from the drivers, due to the high vehicles flows on BR-050, putting the safety of its users at risk. From the record of some drivers to stop the vehicle to observe and remove of the lane both carcasses as models, we see the likelihood of the models and carcasses used. In the recorded roadkill filming we could also see drivers decreasing the acceleration and changing the vehicle position to run over, not only reptiles, but also the control objects. Also, snakes intentionally roadkill on Brazilian roads are not always associated to their visual identification on the road, because, with the need to go through long stretches for a long time, many drivers seek distractions along the way, so we believe that they run over anything as a way to distract themselves. Still, some factors such as road characteristics, vehicle travel speed and the vehicle type provide different security conditions to drivers, favoring the frequency with which it occurs intentional roadkill. On BR-050, the characteristics of the places chosen influenced the occurrence of roadkill, as it is a carriage-way highway, larger and heavier vehicles travel most of the time in the right lane, closer to the roadside explaining the fact of occurring more purposeful roadkill by trucks in uphill lanes than on downhill ones. Therefore, we conclude that drivers swerve from their route to go over both objects and snakes, being this behavior more common among truck drivers in uphill lanes.

SEASONAL DIVERSITY AND ASPECTS OF ROADKILLED CHIROPTERA ON A STRETCH OF BR-040, RIO DE JANEIRO/JUIZ DE FORA

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Although the large necessity and contribution to human development, roads cause several impacts on the world's biodiversity. Roads are fragmentation agents and exercise high pressure on wildlife causing effects such as roadkills, habitat fragmentation, among others. There are about 270 bat species present in the Atlantic Forest and 73 species are endemic to this biome. The company Essati Engenharia LTDA, started to monitor the wildlife roadkills on BR-040, on the stretch of Rio de Janeiro/Juiz de Fora (360 km) in December of 2013, under CONCER's concession, this stretch crosses the Atlantic Forest biome. This paper aims to contribute with the knowledge of the bat fauna composition of the region and evaluate the seasonal influence on roadkills, showing the most affected species generating scientific information that could help the implantation of mitigation measures, in addition to generate data corroborating with other studies analysis. The Wildlife Roadkill Monitoring is conducted 24/day, by trained inspectors and a team of biologists and a veterinarian, 5 days a week during 8 hours a day. The carcasses are collected, identified and kept in freezers. Weekly, they are directed to Universidade Veiga de Almeida where a biologist prepares, organizes, fixate and direct them to the Museu Nacional do Rio de Janeiro, where the specimens are identified and possibly housed in the museum's scientific collection deposit. The data presented are from January of 2014 to December of 2015, it was registered in this period 599 roadkilled bats, distributed in 36 species and 3 families, for the non-identified species the representative number is 180 individuals. This study evaluated each season in two years, obtaining the following results: For the summer were registered 141 individuals distributed in 23 species, among which, the most representative were:

Artibeus lituratus (n = 35); *Phyllostomus hastatus* (n = 11) e *Sturnira lilium* (n = 6). During the fall were registered 212 individuals distributed in 28 species, with more representativity for: *Artibeus lituratus* (n = 32); *Glossophaga soricina* (n = 19) e *Carollia perspicillata* (n = 20). During the winter were registered 167 individuals distributed in 17 species, specially represented by: *Artibeus lituratus* (n = 34); *Glossophaga soricina* (n = 16) e *Platyrrhinus lineatus* (n = 14) and in the spring were registered 79 individuals distributed in 14 species, with the highest abundance for: *Artibeus lituratus* (n = 18); *Phyllostomus hastatus* (n = 09) e *Artibeus fimbriatus* (n = 6) (Fig. 1).

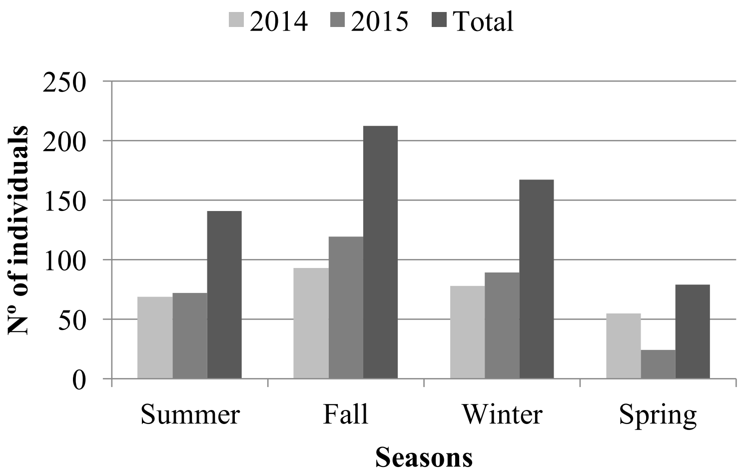

Figure 1: Individuals by season in the period of two years in a stretch of BR-040 road

In addition to the highest number of mentioned registrations, it's possible to highlight the occurrence of the species Myotis ruber (n = 1), which is stated in IUCN's Red List Category & Criteria as "Near Threatened" (NT) (2008). Also mentioning the species Platyrrhinus recifinus (n = 18) which is stated in Rio de Janeiro's State list of threatened species as "Vulnerable" (VU) (2000). Through the data obtained, it was able to notice the importance of more studies capable of evaluate the road impact on the bat fauna and its populations. The present study points that the species Artibeus lituratus was the most impacted during all the seasons, representing 20% of the total registers. Also comparing the seasons, the fall represented the highest number of registers by 35%. The possible causes raised by these results could be related to the high species distribution in Brazilian territory, occurring in all biomes, among other factors as: temperature, altitude, food resources, photoperiod that could be considered as relevant. Although there are still few studies on seasonality, analyzing the A. lituratus diet is possible to have an association between fructification timing of the most consumed fruits and the representation of results. With the data presented, it's possible to reinforce the need for more studies involving road ecology in order to minimize the impacts to wildlife.

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SPATIAL PATTERNS OF GIANT-ANTEATER (*MYRMECOPHAGA TRIDACTYLA*) PERSISTENCE: ANALYSIS WITH OBSERVED ROAD-KILL RATES AND ROAD DENSITY IN ITS DISTRIBUTION RANGE

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Roads are always associated with progress and human development but also represent an important source of mortality and habitat fragmentation that affect many animal populations. The giant-anteater *Myrmecophaga tridactyla* is considered the most threatened mammal of Central America. The southern part of South America is already critical for the giant-anteater populations which is classified as Critically Endangered in Paraná and possibly extinct in Santa Catarina, Rio Grande do Sul and Uruguay. This species has several life history traits (e.g. one brood per year, first birth at three years old and low population density) that together with high mobility capacity make them seriously vulnerable to road traffic. Population viability analysis (PVA) has become a useful tool to improve the evaluation of individual species responses to a variety of threats by estimating the persistence probability at a long term. The aim of this study is to develop a PVA for the giant-anteater based on the observed road kill rates and road density in its distribution range. We used a reaction-diffusion model proposed by Skellam to estimate the critical road density (maximum value above which population cannot persist). We developed three scenarios for different road-kill rates and population densities: I) highest road-kill rate and lowest population density, II) highest road-kill rate and highest population density and III) lowest road-kill rate and lowest population density. Road-kill rates and population density were collected from published papers. We estimated road densities for 10x10 km grid squares in the species range according to the IUCN database. The critical road density for each 10x10km square was computed for the three scenarios. We found giant-anteater road-kill rates between 0.002 and 0.19 ind./km/year and population densities varied from 0.12 to 3.03 ind./km^2 in its range. Our results show that the critical road density (expressed in km/km^2) for the first, second and third scenarios were 0.002, 0.040 and 0.159,

respectively (Figure 1). The critical road density represents 15% of the giant-anteater distribution range in the first scenario and 12% and 2% for second and third scenarios, respectively. The south and southeast Brazilian regions seems to be risk areas for the persistence of the giant-anteater populations. The critical road density in the pessimistic scenario (first scenario) correspond to 58% and 44% of the São Paulo and Paraná state, respectively.

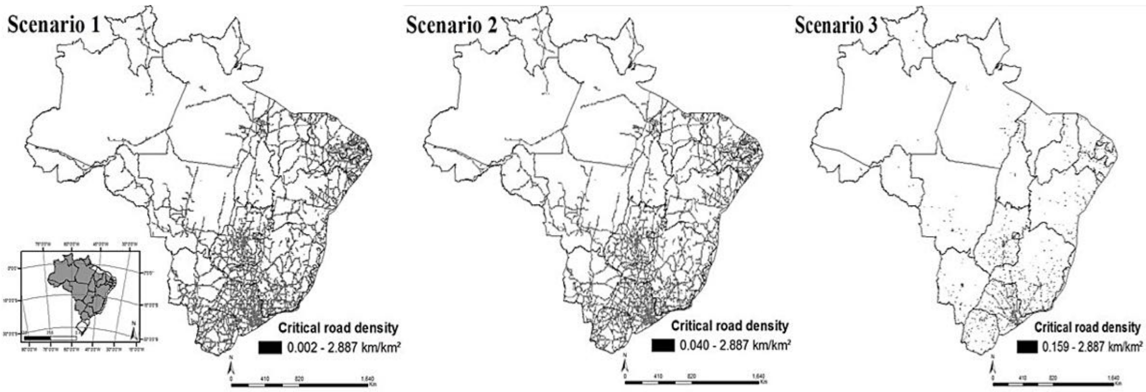

Figure 1. Scenarios with the critical road density values estimated for the giant-anteater over its range in Brazil.

Critical road density also occurs in two important protected areas in Parana state (Campos Gerais Ecological Station and Iguaçu National Park) which cover 45% and 36% of this territory. In the Midwest region (Cerrado biome), the Federal District (DF) and Goiás state 64% and 37% of the territory is above the critical road density. All federal protected areas in DF exhibited more them 70% of their regions with a road density above 0.002 km/km². In contrast, the northern region of Brazil that corresponds to the Amazon biome has large portions of continuous forest and the low road densities. The highest road densities on the northeast region are found in the east nearby the urban areas. Our findings show that a high proportion of the road network can threat the viability of this species in long-term. Further research is needed to estimate the road-kill rates and their population densities in these critical areas in order to implement measures to reduce giant-anteater-vehicle collisions.

Acknowledgments: We are grateful for the financial support provided by FAPEMIG (Process CRA–PPM-00139-14/453 and CRA–APQ-03868-10), CNPq (Process 303509/2012-0 and 401171/2014-0), Fundação Grupo Boticário Process (0945-20122),

and Tropical Forest Conservation Act – TFCA (through Fundo Brasileiro para Biodiversidade – FUNBIO.

SPECIES TRAITS EXPLAIN ROAD MORTALITY RISK FOR BIRDS AND MAMMALS IN BRAZIL

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Roads affect a wide range of species with direct mortality caused by collision with vehicles as the most conspicuous impact. However, species are not equally affected by road traffic and several studies have suggested that some species' traits (e.g. body mass, diet) are associated with increased vulnerability to roads. The main goal of this study is to explore if species' intrinsic traits explain road-kill rates of birds and mammals in Brazil. We tested three hypotheses that could explain the relationship between traits and road-kill rates (Figure 1): (1) the degree of perception of risk mainly determines vulnerability to traffic; (2) ecological specialization predicts vulnerability to traffic; and (3) both the degree of perception of risk and ecological specialization predict vulnerability. Estimates of road-kill rates for 175 bird and 75 mammal species were obtained from national/international peer-reviewed publications and grey literature considering only studies in which surveys were conducted at least once a week. We selected seven traits related to perception of risk: body mass, activity cycle (nocturnal or non-nocturnal), age at first birth (age females give birth to first litter), home range size, sociality (solitary or social), lifespan, and number of anthropogenic threaten factors (as more threatened species may be more aware of risk). We considered five traits associated to ecological specialization: diet breath (number of different diet items), trophic level (carnivore or non-carnivore), foraging substratum (volant or non-volant), land use breath (number of different land use classes) and predominant land use (preferred land use class). Trait data were obtained from: Animal Diversity Web, Annotated Checklist of Brazilian Mammals, Elton Traits, Handbook of the Birds of the

World Alive, PanTHERIA, the IUCN Red List of Threatened Species, and scientific publications on species ecology. We applied an imputation method based on random forest (missForest R package) to estimate missing data. To assess the importance of species' traits on road-kill risk we used random forest models including as additional predictors the interval between surveys and the study location to control for the detectability effect and species abundance. Variable importance was measured as the increase in mean square error (MSE) when values for a given variable are permuted.

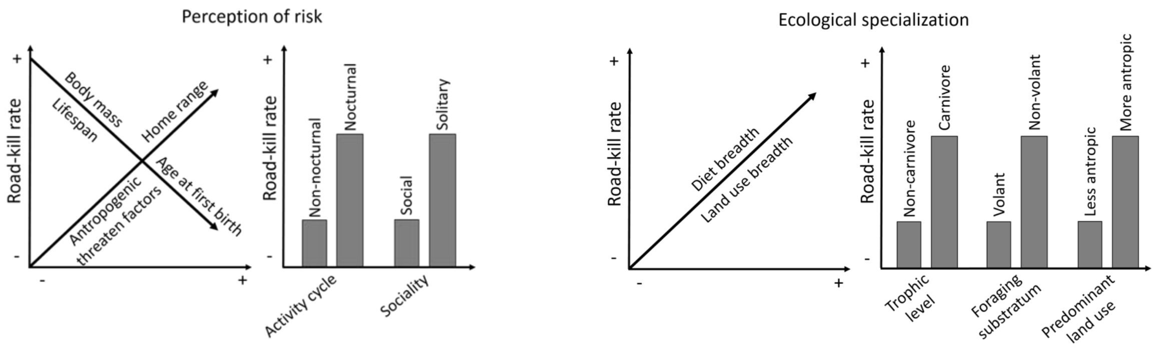

Figure 1 – Possible effects of species life-history traits on road-kill rates. Variables were grouped in two general hypotheses: perception of risk and ecological specialization.

Our results show that a combination of both perception of risk and ecological specialization seem to explain bird and mammal road-kill rates. Body mass and lifespan are the most important predictors of road-kill rates for birds (variance explained by model: 16.3%). High body mass and short lifespan are positively related with high road-kill rates. For mammals, land use breadth, home range, age at first birth, and body mass are important predictors of road-kill rates (variance explained 24.8%). Narrow land use breadth, wide home range, early age at first birth and high body mass are associated with high road-kill rates. Our findings show that several traits other than diet (as assessed in a previous study) seem to explain the mortality risk. Lifespan (for birds), home range and age at first birth (for mammals) effects on road-kill rates agree with our predictions. Contrary to our expectations, body mass and land use breadth have opposite effects. Large body mass are probably related to large home ranges which can increase the chances for an animal to cross roads while habitat specialization might be relate to their need to move more often in face of low habitat availability. Understanding how road-kill rates are associated with species traits offers an opportunity to assess the road mortality risk for species whose road-kill estimates are not available. These findings are a contribution to assure effective strategies to reduce road-kill by targeting species that are most vulnerable.

Acknowledgments: We are grateful for the financial support provided by FAPEMIG (Process CRA–PPM-00139-14/453 and CRA–APQ-03868-10), CNPq (Process 303509/2012-0 and 401171/2014-0), Fundação Grupo Boticário Process (0945-20122), and Tropical Forest Conservation Act – TFCA (through Fundo Brasileiro para Biodiversidade – FUNBIO.

SEASONALITY IN THE ROADKILL RATES ON MGC-455, UBERLÂNDIA-RIO DO PEIXE SECTION, UBERLÂNDIA-MG.

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In Brazil, with the improvements of the road network and traffic flow, the wildlife roadkill is a problem that is growing more and more. Because of the life history of each species, seasonality can influence the roadkill patterns. In the dry season, the scarcity of resources may force the animals to move over greater distances to get food, thus causing an increase in the roadkill number on highways. Reptile roadkill increases in the rainy season, because these animals are most active in this time of the year and also for presenting the behavior of warming themselves in the lane to execute thermoregulation. For other species, seasonal variations are also related with increased roadkill in breeding seasons or recruiting periods. Therefore, in order to analyze whether there are seasonal variations in roadkill, biweekly monitoring was performed, on the highway MGC-455, Uberlândia-Campo Florido section, always starting at 07: 30 a.m. and lasting the time needed to complete the trip, during the period from April 2012 to April 2015. The monitoring was carried out by two observers, by car, at an average speed of 50 km/h. Animals found victims of roadkill were photographed for later taxonomic identification using identification guides. Only animals found in the outward path were systematized, the other ones were accounted as occasional records. At the end of the data collection, the animals were removed from the road. Animals found from October to April were records of the rainy season and those found between May to September were records of the dry season. The monthly roadkill rate was calculated as follows: average monthly roadkill multiplied by 30 (days of the month) divided by the total kilometers of the highway, for each month there was a different roadkill rate. Differences in the monthly roadkill rate between the dry and rainy seasons were tested using the t test for two samples (t) when data were normal and the Mann-Whitney (U) test in the case of non-normal data. No difference was found in the monthly roadkill rate between the rainy and dry seasons for wild vertebrates mammals ($t=1.820$; $df=35$; $p=0.077$), wild mammals ($U=171.000$; $p=0.831$) and birds ($U=166.500$; $p=0.961$). However, for reptiles the roadkill rate was higher in the rainy season ($U=239.000$; $p=0.008$). Reptiles seem to be the group that suffers more influence of seasonal and climatic variables. The influence or not of these variables on the roadkill rates is possibly linked to the biology of the group, since this group has the habit of using highways, among other places, to execute thermoregulation, being more active at higher temperature periods. Because they belong to a group with great diversity, birds do not usually present a pattern of seasonal differentiation in roadkill. Mammals when pressed by lack of resources can move through even greater areas looking for food, thus increasing the need to cross the roads that pass through their home range. Amphibians often have concentrated roadkill rates on large migration events, which, similar to reptiles, occur for juveniles reproduction or dispersal. Therefore, it is extremely important to implement measures to reduce such rates, consequently reducing the impact on wildlife. Getting to know the patterns that influence wild animals roadkill, such as seasonality, allows mitigation measures to be planned according to periods or places where occur more roadkill events.

STATE OF THE ART ON WILDLIFE ROADKILL IN COLOMBIA

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This paper presents a review of the state of the art of the studies on wildlife run over in roads of Colombia; the search was conducted using the databases: Scielo, Scopus, ScienceDirect and Google Scholar. For the search we took into account the researchers who carry out these works, the corporations involved in the subject, the areas of study and the methodology implemented. Likewise, the path and length that is studied and sampled by each researcher also the hypotheses about the possible factors that are affecting the rate of road kill is included. Finally disclosed the species most affected by the tracks for each study. It is important highlight that in Colombia the amount of information on the subject is scarce and for this reason was the need to build the state of contemporary art. Within the studies that have been conducted in Colombia we can find the research by Vargas-Salinas et al in 2011, they evaluated the mortality rate in road of amphibians and reptiles in a segment of 2.4 km along the Buga-Buenaventura road that crosses the Yotoco Reserve Forest, located in the department of Valle del Cauca. The mortality rate found was a dead vertebrate every 3-4 days. Quintero-Angel et al in 2012 studied a stretch of road of 6.4Kms in the central Andes in Colombia, located between the department of Quindío and the coffee highway. The samples were taken during summer and rainy seasons, where they found a total of 117 road kill, of which 105 (89.74%) were snakes, which agrees with the results found by Vargas-Salinas et al in 2011.On the road between Sincelejo with Ovejas and Sincelejo with San Onofre, two roads bordering the *"Montes de Maria"*, De la Ossa-Nadjar and collaborators, conducted a study to determine the rate of roadkill in dry and rainy season during a period between 2011 and 2012. A total of 621 individuals were found, of which 120 were found in the rainy season and 501 during dry season; the species with the highest incidence were *Didelphis marsupials* (Common opossum), *Rhinella marina* (Common

toad), *Coragyps atratus* (Black Vulture) and *Pitangus sulphuratus* (Great Kiskadee). In another study conducted on the road from San Onofre-Sucre to Maria la baja- Bolivar, by Monroy and collaborators between 2014 and 2015, the objective was assess and compare the amount of wildlife run over in dry and rainy season. The study road length of 49Km skirts the northwest portion of Montes de María, wide area of forest dry tropical remainder of the Colombian Caribbean. By analyzing both seasons, it was concluded that there was no difference between the two rates. Also, it was found that the majority of the road kill fauna was amphibians and reptiles. On the other hand, De la Ossa et al in the period of 2010 and 2011, studied a road with a length of 27.2 km leading from the town of Toluviejo to the Caimanera`s swamp in the department of Sucre. They found a total of 431 road killed individuals, of which 121 (28.1%) were mammals, 124 (28.8%) birds, 94 (21.8%) reptiles and 92 (21.3%) amphibians. In the particular case of the department of Antioquia, there have been some studies on the Escobero route, located in the southeast part of the city of Medellin. In one of these studies conducted between the years 2000-2006, Carlos Delgado quantified the amount of road kill mammals in an area of about 11 km, with a total of 58 mammals, of which 34.6% were marsupials, 34.5% rodents and 20.6% carnivores. In the period 2008-2013, Delgado also performed a work evaluating the same route in the Escobero´s area. In this study, a total of 35 individuals were found, being the marsupials the most affected (54.3%), followed by carnivores (25.7%) and rodents (17.5%). It is important to note that the data were collected by sporadic journeys made by the author. Finally, in a study performed by Castillo et al, in the year 2012 on a stretch of 92 km of the Pan-American highway, between the city of Popayan and the municipality of Patia, 894 run over individuals were recorded; of these, 362 were mammals, 288 amphibians, 186 birds and 58 reptiles. The species with the higher incidence was *Didelphis marsupialis* with 233 cases. With the above information it can be said that in Colombia most sampled roads are paved roads, do not have appropriate signaling indicating the conservation of wildlife and have poor lighting. Climatic factors influence directly the supply of food and breeding seasons, which would have an important effect on the rate of run over, additionally ectothermic animals move to the road to regulate its temperature. For these reasons, it is necessary to keep doing this type of studies in our country, which will allow to demonstrate the magnitude of the problem and thus achieve the construction of public policies to reduce the impact of road networks on wildlife populations, modifying the design of roads, including construction of wildlife crossings, optimizing lighting levels and signaling to indicate the presence of these species.

SURVEY OF FLATTENED WILDLIFE SPECIES ON THE NORTHERN STRETCH OF HIGHWAY BR-101 IN UBATUBA CITY, SÃO PAULO, BRAZIL.

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The death of wild animals by roadkill is a common problem in many countries. Some studies indicate that wildlife roadkill could reduce the density of species and put them at risk. This problem is even more serious for endangered species or populations that typically have a few number of individuals. In recent decades, the roadkill has become more important than hunting as a direct cause of mortality of terrestrial vertebrates, tending to become a significant threat to biodiversity in countries with fast development. This problem increases with the growth of the road network and traffic flow. When the run over occurs on roads and highways that are located inside of protected areas called Conservation Units (U.C.s.) or on their surrounding areas, this is even more serious. It exists endangered species in many of these spots, as on the northern stretch of the highway BR- 101 (Governor Mário Covas) that passes thru Serra do Mar State Park – Núcleo Picinguaba region, in the city of Ubatuba, State of São Paulo, Brazil. This study analyzed the occurrence of wild animals run over during the period from January and August 2011 and January and August 2012, by monitoring the road between the kilometers 8 and 44 of the northern stretch of Highway BR- 101 in Ubatuba. The daily monitoring was performed with a Conservation Unit´s vehicle (with average speed of 50 km/hour) or even using the public transport service. In this last case, it was necessary to accommodate at the busses front seats in order to get a better vision field. After seeing a corpse, a team moved to the place to make the species identification, photographic record and biological data collection. After that, the corpses were taken off the road and dropped into the woods, thus preventing the attraction of scavengers or more collisions. The events were registered in a Microsoft Office Excel spreadsheet containing the following information: Number of Records, Date, Time, Place, Kilometer (highway stretch), Animal (popular name) and Photographic registry. At the same time, the photographs were organized in folders containing pictures of the occurrences. It was also conducted a mapping of the study area using a GPS (Global Positioning System) device "Garmin Etrex H" to draw up a reference map of the main roadkill areas. A total of 106 flattened wild animals were registered during the research period, belonging to 18 families and 24 species. The amount of records per Class was of 89 Mammals (83.96%), eight (08) Reptiles (7.54%), eight (08) Birds (7.54%) and only one (01) unidentified carcass (0.94%) which was very impaired and showing high stage of decomposition. The most victimized species was the Opossum (*Didelphis sp.*), totalizing 68 individuals and 64.15% of the total roadkill. Secondly, the most victimized species was the raccoon (*Procyon cancrivorus*) with a total of five (05) records (4.71%). The third species most affected was the capybara (*Hydrochoerus hydrochaeri*) with a total of four (04) records (3.77%). Among the considered endangered species, it was recorded one (01) (0.94%), the maned wolf (*Chrysocyon brachyurus*), currently classified as vulnerable (VU) in the Brazilian Fauna Threatened with Extinction official list and near threatened (NT) in the International Union for the Conservation of Nature – IUCN Red List of Threatened Animals. Another registered species appearing in the lists of endangered species was one (01) specimen (0.94%) of oncilla (*Leopardus tigrinus*), classified as vulnerable (VU) in the Brazilian Fauna Threatened with Extinction list and also as vulnerable (VU) in the International Union for Conservation of Nature- IUCN red list. Among the birds species, were identified the ruby-crowned tanager (*Tachyphonus coronatus*), great kiskadee (*Pitangus Sulphuratus*), brazilian tanager (*Ramphocelus bresilius*) and wook rail (A*ramides sp.*). During this survey, it was noted that little is known about the actual dimension of the impacts of roadkill on birdlife in Brazilian highways; however, this study obtained relevant data on the problem dimensions related to the avifauna on a local scale. Among the reptiles, it was mainly identified the green snake (*Chironius multiventris*), the Jararaca snake (*Bothrops jararaca*), the black snake "Muçurana" or "Limpa- campo" (*Chironius sp.*) and the Tegu lizard (*Tupinambis sp.*). Analyzing the data obtained in the research, it seems that wild animals roadkill over the study region is an issue for animal conservation. The most affected was the class Mammalia, followed by Birds and Reptillia, possibly due to the singularities and characteristics of the used method, since it was not possible to perform the Amphibian class record and neither invertebrates, especially insects. We believe that the observed numbers could be higher, since that, in cases of death, the carcasses could be taken out of the road by carnivores and scavengers and some other may even die far from the highway and so, being disregarded by this survey. Through the knowledge of affected species, it becomes clearly necessary to develop studies and propose mitigation strategies to be urgently implemented in order reduce rates of wild animals roadkill in the BR-101 routes showing higher incidence of these type of death and in the road stretches passing thru the Núcleo Picinguaba – Serra do Mar State Park area.

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SURVEY OF DEAD VERTEBRATES BY VEHICLE HIT IN BR-158, PARANÁ - BRAZIL

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Roads enable the populations' development and allow the displacement between different locations. However, they cause a series of impacts to fauna and flora, through provoking the loss of the specimens and the geographical barrier effects. In this way, tracking roadkill becomes important to evaluate the highway's negative effects, which looks for reducing the impacts on the animals' species. Thus, the present survey aims to identify the most affected animals by the highway at issue, as well as to identify the place with the biggest incident of roadkill. This research was held in a 13,0 kilometers stretch of road in BR-158 highway, between the cities of São Lourenço do Oeste – SC (Latitude: 26°20'44.77"S; Longitude: 52°50'59.31"O) and Vitorino - PR (Latitude: 26°15'30.10"S; Longitude: 52°47'14.89"O). The study section was covered with a car in average speed of 40km/h with two observers looking for carcasses of roadkill in the highway and in the roadside. There were 35 expeditions held fortnightly between March of 2015 until April of 2016. In places where there were animals, the coordinates were recorded and the specimens were photographed. If the material was in good conditions, the collection of animal was held, properly conditioned and taken to the zoology laboratory of Universidade Paranaense - UNIPAR in Francisco Beltrão. When the material was not collected, the carcasses were removed from the track to avoid being counted again. A sample of fur from the dorsal surface of animal's body belonging to the Mammalia class was collected manually. The sample of fur was stored in plastic bags with their information for subsequent analysis and identification through the fur microstructure. In this research 90 animals belonging to 22 species (Table 01) were found. The place of highest incidence was the 13th kilometer (Lat 52º15'53.2"S, Long.52º47'15.6" W) with 14 records, where the border area has dense forest, plantations and some housing. The specie with the most records was *Didelphis*

albiventris, with 11 records, followed by *Tupinambis* sp. genre, with 10 records. *Didelphis albiventris* is a solitary marsupial specie which, due to human action, are common in urban areas. On the other side, the *Tupinambis* sp. have diurnal habits and present heliothermic activity, where the asphalt acts as an attractive to the specie on hot days. There were 8 animals identified by trichology, belonging to 3 orders (Didelphimorphia, Rodentia, Felidae), organized in 3 species. The trichology consist of a technique to species identification through the fur. The fur are keratinized structures, which is an exclusive characteristic from mammalia class, divided in 3 portions, in which the outermost portion is the cuticle, the intermediary one is the cortex and the inner one is the medulla. The combination of the different standards to these portions of fur form unique standards to the species. Therefore, the trichology becomes an important study, in which many researchers have used this technique to identify species with damaged carcasses due to the impact of roadkill, aside from being an easy access and low cost technique. The influence of roads on the loss of specimens in the study section is remarkable. Among the various causes for these records, it was taken into account the fact that the roads are inserted in the natural animals habitats, human activities and the vehicles travel speed. Furthermore, there is also the constant specimens' search for food, new habitats and reproductive partners around the highway. The union of these factors makes the highway an agent of big impacts to the fauna, which should be studied for subsequent analysis and choice of the best mitigation measure, seeking out conservation of the species of our fauna.

Table 01 – Roadkill recorded in BR-158, South-west, Paraná.

Sistematic classification	N° of records	Frequency	Sistematic classification	N° of records	Frequency
Class Mammalia			**Class Aves**		
Order Carnivora			**Order Columbiformes**		
Cerdocyon thous	4	4,44%	*Zenaida auriculata*	5	5,56%
Canis lupus	6	6,67%	**Order Cuculiformes**		
Felis catus	8	8,89%	*Crotophaga ani*	1	1,11%
Order Cingulata			**Order Galliformes**		
Dasypus novemcinctus	3	3,33%	*Gallus gallus*	2	2,22%
Order Didelphimorphia			**Order Guiformes**		
Didelphis albiventris	15	16,67%	*Aramides saracura*	1	1,11%
Order Rodentia			**Order Passeriformes**		
Cavia aperea	7	7,78%	*Cyanocorax cristatellus*	1	1,11%
Myocastor coypus	1	1,11%	*Passer domesticus*	1	1,11%
			Pitangus sulphuratus	2	2,22%
Class Reptilia			*Sicalis flaveola*	3	3,33%
Order Squamata			*Turdus rufiventris*	2	2,22%
Tupinambis sp.	10	11,11%	**Order Piciiformes**		
Bothrops jararaca	1	1,11%	*Colaptes campestris*	1	1,11%
Philodryas olfersi	2	2,22%	**Order Strigiformes**		
Unidentified	5	5,56%	*Pseudoscops clamator*	1	1,11%
			Tyto furcata	1	1,11%
			Unidentified	7	7,78%
			TOTAL	90	100%

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SURVEY OF THE VERTEBRATE FAUNA ROADKILLED, DURING A YEAR, IN THE BR 304 ROAD, IN THE CAATINGA BIOME, RN.

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Roads and highways have several factors that cause negative impacts on the environment. Currently, these impacts are seen as the main threat to biodiversity conservation since, apart from the wildlife mortality caused by roadkill, it also causes habitat fragmentation and act as barriers hindering the movement of species. Road ecology studies have received increased attention by researchers in the past decade. Based on these studies, it is estimated that approximately 475 million wildlife animals are roadkilled each year, in Brazil. In addition to the impacts on wildlife, collisions also occur with domestic animals that are loose and moving in the outskirts of cities. This study aimed to survey the number of vertebrate animals, both wild and domestic, roadkilled during a year of monitoring in stretches of the BR 304 in Rio Grande do Norte, inserted in the Caatinga biome. Monitoring by vehicle occurred on a monthly basis, from April 2015 to March 2016, and was conducted at a speed of approximately 40-60 km/h. Monitored road covered 56 kilometers, ranging from Serra do Mel (5° 23′ 09.68′′ S and 37° 14′ 04.36′′ W) to Itajá (5° 37′ 49.41′′ S and 36° 51′ 48.32′′ W). The road was monitored on both sides, totaling 112 kilometers per survey. During this study, a total of 1344 km were monitored and 343 animals were found roadkilled, in a rate of 0.021 ind./km/day. Of the animals found, 288 were wild animals and 55 domestic trampling, with rates of 0.018 ind./km/day and 0.003 ind./km/day, respectively. Regarding the time of the year, 295 ind. were found in the rainy season and 48 ind. in the dry season, with mortality rates of 0.018 ind./km/day and 0.003 ind./km/day, respectively. The taxonomic groups with the highest number of roadkills recorded were the mammals (0.008 ind./km/day), the amphibians (0.006 ind./km/day) and birds (0.005 ind./km/day)

(Figure 1). From the wildlife species, those with most records were the Cururu toad (*Rhinella jimi*), the Crab-eating fox (*Cerdocyon thous*) and the black vulture (*Coragyps atratus*). Regarding he domestic animals, the species most frequently recorded were the domestic cat (*Felis silvestris catus*), the domestic dog (*Canis lupus familiaris*) and the donkey (*Equus africanus asinus*).

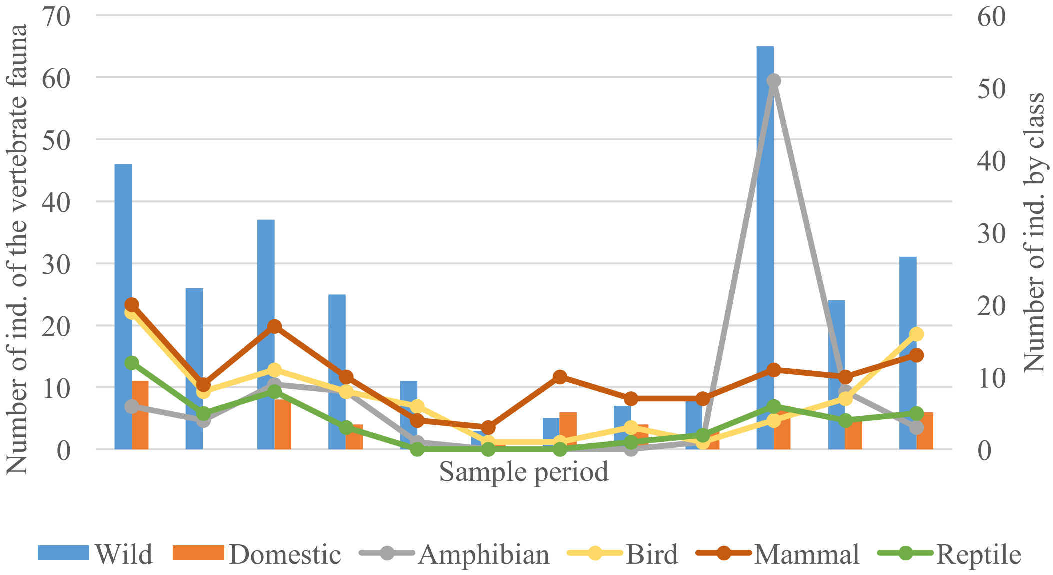

Figure 1: Roadkilled animals over the 12 months of monitoring of the BR 304. Number of roadkilled wild and domestic animals (first axis y); number of animals (individuals) per class (second axis y).

In general, the highest frequency of roadkills occurred during the rainy season. Wild fauna roadkills varied throughout the year, with its higher frequency during the rainy season (January to July), whereas in the domestic animals the roadkill frequency was constant throughout the year. This indicates that there is a greater use of the road by the wild animals in the rainy season. It may be related to a greater availability of food resources at that time and, consequently, a higher movement rate of the different animal populations. Similarly, the roadkilling of saprophages and carnivorous animals may also be related to the increased availability of resources. The presence of food on the roads, including other dead animals, can make them more attractive to these species, which promotes an increase of collisions with vehicles. In the case of the domestic animals, the BR 304 goes through several human settlements, including four villages, several farms and the municipality of Assú, which could explain the high number of roadkilled domestic animals and why the frequency of roadkills was constant throughout the year.

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ROADKILLS OF VERTEBRATES ON STATE HIGHWAY BA-120

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The road system consists in an economic and social network all around the world. This system is built over different elements of the landscape; for example: forests, mountains and rivers. Therefore, the establishment of railways and roads in the course of time has left degradation and fragmentation marks in diverse ecosystems. Undoubtedly, the main impact of roads is the roadkill, exceeding the impact of hunting on populations. We monitored a stretch of 8 kilometers from the BA-120 for 6 months, considering the roadkills and seasonal distribution. The road connects the cities of Santa Ines and Cravolândia in southwestern of Bahia. We covered 112 km between October 2015 and March 2016. The data collect started at 06:00 and were held for only walking transects, only days without precipitation. We made photographs of each roadkill and the specimens in good conditions were collected. We used the expertise of specialists and specific taxonomic keys of each class to identify the species. We have recorded a total of 249 roadkills. Of this amount, we found 220 amphibians, 23 reptiles, 4 birds and 2 mammals. The class of amphibians was the major representative, constituting 88.3% of the sample. The roadkill rate, i.e., individuals get hit by kilometer per day (ind./km/day) were: 0.140 for amphibians, reptiles to 0.014, 0.002 to 0.001 for birds and mammals. The species that were morphologically identified through traditional taxonomy are listed in Table 1. We could observe some patterns of roadkill: most roadkills in rainy periods (in its entirety, amphibians) and most roadkills in the first kilometers of the stretch (dominated by elements such as water bodies and urban areas). According to the data collected, we could see that the roadkills of animals occurred in every month of monitoring. We found more rodkills in January and February and a less in October and November. These data can be explained by regional seasonality, where the representative rainy season corroborates the months of highest record of roadkill. In view of this, the patterns found can be explained by the

dependence of water bodies by amphibians at some stage of life and even the demand for water as an important resource for other groups. Also, because some amphibians search water bodies to breed, especially in the rainy season. However, these patterns can only be confirmed with sampling effort comprising a full period of seasonality (one year) and after the completion of the statistical tests of significance.

Table 1. Scientific and common names of orders and of roadkills in the BA-120, between the cities of Santa Ines and Cravolândia-BA during October / 2015 to March / 2016 (*N/ID: no-identification).

Class/Order/*Species*	Common names	Number
Mamíferos		
Carnivora		
Lycalopex vetulus	Raposinha-do-campo	1
Chiroptera		
S/ID*	Morcego	1
Aves		
Passeriformes		
N/ID*	Passarinho	4
Anfíbios		
Anura		
Rhinella granulosa	Sapo-cururu	31
Rhinella jimi	Sapo-cururu	55
Hypsiboas crepitans	Perereca	12
Dermatonotus muelleri	Rã-manteiga	1
Leptodactylus latrans	Rã-manteiga	1
Leptodactylus troglodytes	Gia	1
Scinax x-signatus	Perereca	1
Phyllomedusa bahiana	Perereca	1
Phyllomedusa nordestina	Perereca	1
N/ID*		116
Répteis		
Squamata		
Ameivula ocellifera	Tijubina-da-Caatinga	1
Tropidurus hispidus	Lagartixa-de-muro	4
Phyllopezus pollicaris	Lagartixa	3
Amphisbaena sp.	Cobra-de-duas-cabeças	2
Micrurus sp.	Cobra coral	1
Pseudoboa nigra	Cobra preta	2
Sibynomorphus neuwied	Papa-lesma	1
Xenodon merremii	Boipeva	2
N/ID*		7

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ROADKILLS OF VERTEBRATES ON SC-290 ROAD, SOUTHERN BRAZIL

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The wildlife mortality resulting from collisions with vehicles is one of the most conspicuous impacts of roads, especially when it crosses protected areas. The knowledge about the number of roadkilled vertebrates and the spatial patterns of collisions are important for Conservation Units managers and for institutions involved in environmental impact assessment to predict adverse effects as well as to propose mitigation strategies. Therefore, we monitored the roadkills on SC-290 road in Praia Grande, Santa Catarina State, southern Brazil, which crosses two protected areas: Aparados da Serra and Serra Geral National Parks. Our aims are to increase the knowledge of roadkill in the area and give basis for mitigation plans. For that we estimated the mortality rate and we evaluated the most impacted species and the road's features which could affect the odds of collision. SC-290 road has 15.63 km of length, where we monitored roadkills between November 2014 and December 2015. We surveyed the road by car, with two observers (driver and passenger) at average speed of 30km/h. To estimate the mortality rate we needed to take into account the Searchers' efficiency or detectability (*p*) and the carcass removal by a characteristic time (*Tr*). We calculated the Searchers' efficiency by comparing the number of carcasses recorded during a driving survey to the number seen during a walking survey on the same area at the same day. The carcass removal was calculated monitoring the persistence of 75 carcasses on the road. Every vertebrate was considered: wild animals, domestic and exotics. The carcasses were identified when possible and photographed. Other information such as coordinates, pavement types, lane and geometric design of the road were also recorded. The estimations were done using the software SIRIEMA 2.0. We also calculated the frequency of occurrence (FO) for each vertebrate class in

order to evaluate the most impacted species. During this study, 162 days of survey were performed with an average interval of 3.1 ± 2.71 days. We recorded 201 carcasses: 106 amphibians, 49 reptiles, 26 birds and 20 mammals. 36 carcasses could not be identified to the species level because of their advanced stage of decomposition and compaction, among which 18 were amphibians, 9 birds, six mammals and three reptiles. In total we recorded 48 roadkilled species, of which 17 amphibians, 11 reptiles, 11 mammals and 9 birds. Within the amphibians, *Rhinella icterica* (FO=32%), *Rhinella abei* (FO=17%) and *Leptodactylus latrans* (FO=7%) were the most commonly found species. The most frequent reptiles were *Thamnodynastes* sp. (FO=18%), *Xenodon neuwiedii* (FO=18%), *Sibynomorphus neuwiedi* (FO=16%) and *Chironius* cf. *exoletus* (FO=10%). Roadkill had major impact in these amphibians and reptiles, because they are locally common and they have a low mobility, however the methodology is biased to medium-large body sized species and smaller amphibians could be even more affected. Among birds *Sicalis flaveola* (FO=19%), *Furnarius rufus*, *Gallus gallus domesticus*, *Guira guira* and *Passer domesticus* each one with FO=8% were the most frequent species. For mammals, the most impacted were *Canis familiaris*, *Didelphis albiventris* and *Oligoryzomys* cf. *nigripes* (FO=10% each). The characteristic removal time of carcasses was 2,64 days. The detectability was estimated in 0.4, which can be considered a low rate since a great part of the road is unpaved, with irregular stretches. The mortality rate was 1.371 roadkills/day or 0.088 roadkill/day/km, a low rate if it is compared to other studies. The unpaved stretches showed lower number of roadkill (N=11) than paved ones (N=190). The roadkill were influenced by geometry design of the road, since mostly of them was registered in straight stretches (N=160) and less in curves stretches (N=41). Both results can be explained by higher speeds achieved in paved and straight stretches, increasing the risk of animal collisions with vehicles. Whereas the SC-290 is a mountain pass, we hypothesized that roadkill would be greater in the left lane, since the vehicles range greater speeds downhill. However, roadkill in the left lane (N=94) was similar to roadkill in the right lane (N=91). Since SC-290 is in process of paving, which could increase the road mortality rate, a continuous evaluation of roadkill will allow the identification of mortality spatial patterns and the implementation of more efficient mitigation strategies.

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ROAD-KILLED BATS (MAMMALIA: CHIROPTERA) FROM SOORETAMA BIOLOGICAL RESERVE- ES CROSSED BY THE HIGHWAY BR-101

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The order Chiroptera is the second largest species among mammals and have the greatest diversity of eating habits, providing a great ecological importance as pollinators, seed dispersers and insect population controllers. One hundred seventy-eight bat species are recognized to occur in Brazil, in which about 117 species occur in the Altantic Forest biome. The Sooretama Biological Reserve (SBR) is currently a place in the Altantic Forest with the greatest diversity of bats, with 65 species already recorded. The SBR has about 25,000 hectares and is located in the north of the state of Espírito Santo, Brazil, cut by a stretch of 5.1 km of the BR-101 highway. The BR-101 fragmenting the landscape and causes high mortality of animals due to road kill. Bats are one of the most vertebrates affected by the road kills in the SBR. The objective of this study was to identify the bat species that were road-killed in SRB. In order to collect the road-killed animals, a technician from SBR monitored on foot every morning between 7:30 and 11:30, walking in both directions of the highway. At the time of collection, the time, the direction and kilometer were recorded, also the location where the animal was found was recorded using a GPS and the animal was photographed. The animals that were best preserved were collected and taken to the Zoology Laboratory of Agriculture Science Center at UFES and were identified and subsequently placed in formalin. Animals that were in the worst condition were removed and collected for muscle tissue sample to identify the molecular genetics. Individuals were sampled apart from the monitoring hours and the ones monitored by car were included in the species list, but were not included in the road kill rates. From August 2010 to December 2015, a period of 974 days of collection, 578 bats were registered and monitored by foot and the rate was 0.116 individual/km/day. The animals that were sampled apart from the monitoring hours or monitored by car, 27 were identified by species level. From November 2011 to December 2012, specimens were collected and photographic records were not held and the specimens were not identified. In total, 246 morphological bats and 23 molecular bats were identified by specie level. Forty-seven species of road-killed bats were identified, these represents 72% of the registered species in the SBR (65 species). Approximately 85.1% of the recorded species are insectivorous diet or supplement their diet with insects. This may occur because the insects are attracted by the open clearing the road and the light emitted by the car's headlights that passes by the highway. The family with largest number of representatives of road kill was Phyllostomidae, and it is also the family with largest number of species within the Chiropetas, with a greater diversity of eating habits. The three species with the highest number of records were *Molossus molossus* (n=70), *Carollia perspicillata* (n=15) and *Myotis nigricans* (n=14). The *Thyroptera wynnea* had eight individuals recorded in this study, this specie had its first record for the state of Espírito Santo from a road-killed specimen found in 2010, in the BR-101 highway in RBS. It was recorded a specie that is nationally endangered, *Furipterus horrens*, with three records, that is classified as Vulnerable. The high diversity of bat species affected by road kill is worrisome, especially because this occurs in a Conservation Unit that has the highest number of bat species recorded in the Atlantic Forest. Mitigation measures to avoid road kill of bat specimens are often not included in the studies of environmental impact of roads. However, in the case of SBR, mitigating of road-killed bats should be a priority action.

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LONG-TERM MONITORING OF ROAD MORTALITY IN ATLANTIC FOREST

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Wildlife-vehicle collisions are considered the main cause of anthropogenic mortality of terrestrial vertebrates. This impact negatively affects population persistence of several species, not only because of the direct loss of individuals, but also because of subpopulations fragmentation. "Rodovia do Sol" road (ES-060) connecting Vitória to Vila Velha (Espírito Santo state, Brazil), is located in the Atlantic forest, a biome that already lost 90% of its original forest cover and still has one of the highest species richness and endemism rates of the world. A long-term monitoring program entitled "É o bicho" has been conducted for 11 years by the Rodovia do Sol staff in collaboration with the OSCIP (Civil Society of Public Interest) Sinhá Laurinha (Slau). The staff surveys the 67.5 km road every 90 minutes, and all carcasses of road-killed vertebrates detected are collected for further taxonomic identification. Here, we present (1) estimates of road mortality magnitude, (2) where are the road-kill hotspots, and (3) when is mortality concentrated (monthly and daily time scales). For estimating mortality magnitude, we corrected mortality rates by accounting for detection probability (we used a detection of 0.33, estimated from another study), although we did not consider carcass removal due to lack of knowledge about removal rates between surveys carried out in short periods of time such as the one of this study (90min). We identified road-kill hotspots in different scales using Siriema V2.0 software, and we analyzed temporal road-kill concentration using Oriana V2.02 software. Mortality magnitude and the road-kill hotspots analyses carcass were separated in groups: vertebrates, amphibians, reptiles, birds, and mammals. During 11 years of monitoring 3,436 road-killed

vertebrates were observed (187 species), of those 74 were amphibians (4 species), 511 reptiles (29 species), 1,646 birds (121 species) and 1,205 mammals (33 species). The estimated mortality from 2004 to 2014 was 10,412 individuals, that is, 945 vertebrates per year. Estimated mortality of birds was the highest among all groups (453 per year), and amphibians had the lowest estimated mortality, probably the most underestimated group due to their low detection and fast carcass removal. The most road-killed species recorded were the Opossum (*Didelphis aurita*), the Burrowing Owl (*Athene cunicularia*), the Smooth-billed Ani (*Crotophaga ani*), the Red-tailed Boa (*Boa constrictor*), and the Crab-eating Fox (*Cerdocyon thous*). Three recorded species are threatened of extinction in Espírito Santo state, in Brazil and/or worldwide: the Tropical Mockingbird (*Mimus gilvus*), Bristle-spined Rat (*Chaetomys subspinosus*), and the Chestnut-bellied Seed-Finch (*Sporophila angolensis*). Hotspot analysis confirmed the presence of road-kill aggregations for all groups. Surprisingly, some vertebrate hotspots were located in zones with wildlife underpasses, and some hotspots for mammals and birds were in zones where the road cuts the Lagoa Grande Enviromental Protection Area. Analysis of road-kill temporal patterns showed that road-kills are concentrated in November, December and January, which is explained by the increase in traffic volume during summer (Pearson's r=-0.32, p=0,05). Hourly variation in road-kills was not uniform as well, showing highest mortality around 8 am, probably due to the low detection during night surveys. Our corrected estimates of mortality are likely underestimated, since we extrapolated a detection probability from a different monitoring situation (number of observers and speed), and we considered carcass removal null. The proximity of some hotspots and wildlife underpasses indicates that, although they are used by many animals, they are not as effective in reducing mortality of some species. The occurrence of hotspots in a protected area of Atlantic forest is a very serious problem that calls for mitigation planning. 80% of the remaining vegetation of Atlantic forest are spread in fragments of less than 50 ha, which means populations can be small and animals have to move between fragments. Mitigation of road mortality in this context can improve population persistence of many species in this biome. Versão em português: www.ufrgs.br/nerf/index.php/producao

INFLUENCE OF CLIMATE VARIABLES ON WILD VERTEBRATES ROADKILL IN AN AREA OF CERRADO, MINAS GERAIS, BRAZIL

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Studies about fauna roadkill have been highlighted worldwide. Only on the highways of the United States, one million of vertebrates die due to roadkill every day, a number which exceeds that of hunting as cause of direct mortality of wildlife. To implement efficient mitigation measures it is necessary to understand what influences the roadkill rates and if it suffers variation during the year. It is known that climate influences species life history, being most of them more active when the temperature is hotter. Still, when there is more rainfall, usually, there is more food available for animals. In this perspective, the present work was developed to evaluate the influence of climate variables in the roadkill of mammals, birds and reptiles (Lepidosauria), in a highway located in the domain of Cerrado biome. Our hypothesis is that only reptiles are influenced by climate variables and that there are more roadkill events when these variables are higher. We believe this because reptiles are ectotherms and they are more active in higher temperatures. The study was carried out on the section of the highway BR-050 between the cities of Uberlândia and Uberaba, MG. This section of the highway has approximately 96 km and is a dual carriageway road. The average daily volume of vehicles (VDM) along this section is 12,000 vehicles. The survey was performed between April 2012 and March 2013. This monitoring was done by car, at a speed of approximately 60 km/h, totaling 8,064 km. Two observers examined each kilometer of the road. Roadkill records were identified at the lowest possible taxonomic level. Individuals that could not be identified at a specific level, due to the advanced stage of decomposition, were classified as indeterminate and recorded for analysis only when it

could be discriminated whether or not they were wild species. The climate variables (means values of temperature, air relative humidity and total monthly precipitation) were provided from the Climatological Station of the Federal University of Uberlândia (UFU). The monthly roadkill rate was calculated as follows: average monthly roadkill multiplied by 30 (days of the month) divided by 192 (total kilometers of the highway), for each month there was a different roadkill rate. Possible relationships between climate variables (monthly mean of temperature, air relative humidity and total monthly precipitation) and the monthly roadkill rates were tested by Pearson correlation (r) or Spearman correlation (rs) tests for parametric and nonparametric data, respectively. A total of 683 vertebrates roadkill was found, including: 482 mammals (70.6%), 145 birds (21.2%) and 56 reptiles (8.2%). At species level, 57 taxa were identified, being 21 mammals, 26 birds and 10 reptiles. The monthly roadkill rate of wild vertebrates increased with the air relative humidity ($r=0.761$; $df=10$; $p=0.004$), and with the total monthly precipitation ($r=0.602$; $df=10$; $p=0.037$). For reptiles the monthly roadkill rate increased with the monthly mean of temperature ($rs=0.625$; $p<0.05$), as well as the total monthly precipitation ($r=0.589$; $df=10$; $p=0.044$). Also, a relationship was found between the air relative humidity and the total monthly precipitation ($r=0.663$; $df=10$; $p=0.019$). The other groups were not influenced by climate variables. This positive relationship between wild vertebrate roadkill and climate variables, may result from the synchronization of the flowering and fruiting of various plant species increasing the activity and movement of fauna, as suggested by other authors. As expected, reptiles are positively influenced by climate variables, due to its life history. Therefore, our results support the hypothesis that wild vertebrates roadkill rates are influenced by climatic variables, specially reptiles. So, it's necessary to understand this variation to implement effective mitigation measures and environmental planning.

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MONITORING OF WILDLIFE ROAD-KILL IN HIGHWAY RJ-149, CUNHAMBEBE STATE PARK (RIO DE JANEIRO - BRAZIL)

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Negative impacts of roads are associated with to their construction and operation, which affect the environment where are inserted. For biodiversity, mortality from road-kill is the most visible impact on wildlife and this can be a risk to a population due to the continuing loss of individuals. The issue of the road impacts is relevant in biodiversity conservation, specially in protected areas. It’s essential a diagnosis, through studies that support decision making by the environmental managers, for preservation of species and ecological processes being effective. The lack of information about how the road (RJ-149), that crosses Cunhambebe State Park (PEC), impacts on the fauna was the motivation for this study, that had as objective identifying the points of highest incidence of road-kill in RJ-149 and identify the most affected wild species. For that, a systematic monitoring was started on the road. The RJ-149 connects the municipalities of Mangaratiba and Rio Claro, across urban areas, rural and protected areas. The road has 40 km extension, of which approximately 6 km are inserted in the PEC. The monitoring was carried out throughout the full extension of the road, starting at Mangaratiba (44° 01' 32", 22° 55' 42") and ending in Rio Claro (44° 07' 44", 22° 43' 34"), in the period between May/2015 e April/2016, totalizing 53 sampling. The road was traveled for an automotive vehicle at 40 km/h limit speed, in the period of morning, at a frequency of twice a week. The monitoring team was formed by park-rangers of PEC, previously trained to make the data collect and supported by an explanatory primer previously prepared. For each individual found, photographs of road-kill, road and its surroundings at the point where the road-kill occurred were made. The following

information was recorded in a spreadsheet by the observer: km of the road where there was road-kill, geographic coordinate of the local where the animal was found, presence of scavengers in surrounding, time and date of observation. Based on the photos, the animals were identified by external features, at the most specific taxonomical level as possible. Throughout the monitoring, 46 roadkill of wild animals were registered, resulting in a monthly rate of 0,11 ind./km, distributed in four zoological Classes: Aves (37%), Mammalia (35%), Amphibia (13%) and Reptilia (13%). Only one individual can not be identified in any class, corresponding to 2% of the samples. Mostly, species that inhabit open areas or forest edges and support the human presence were recorded, indicating that the road may be acting as a barrier to animals of woods interior, impeding the flow of individuals between fragments and even leading the populations to a risk of extinction in long term. Among the recorded species, *Cerdocyon thous* (crab-eating fox) (n=5) was the species with the highest number of individuals road-kill, followed by *Coendou* sp. (porcupines) and *Eira barbara* (tayra), both with n=2. *C. thous* are generalists animals and flexible in habitat use, prioritizing edges and open areas. The passive-predator and scavengers habits associated to the need for large territory to supply their vital and reproductive needs, expose the species at risk to be road-kill, since the margins of roads are easy access to this type of food. *E. barbara* and *Coendou* sp. are mammalian scansorial habit, typically found in forested areas, however, they tolerate proximity to anthropized and degraded areas, using resources offered by these altered environments. The spatial distribution of road-kill showed highest incidence points in the kilometers 26 and 39, with n=5 each, and kilometers 25 and 27, with n=4 each. From the data obtained, it was found that the road RJ-149 impacts the wildlife of PEC through the loss of individuals by road-kill within its limits and its surroundings. It's expected this study can be used as a basis for educational campaigns and to propose mitigation measures to reduce road-kill of wildlife in the RJ 149 road.

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MAMMALIAN LOSS BY ROADKILLS IN ROADS OF THE PLAIN TABASQUEÑA

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The roads are a growing threat to the populations of wild mammals, especially in areas that had lost much of their natural coverage. They are also a barrier that limits the movement of the fauna, decreasing the accessibility of the resources and the genetic exchange. The most evident quantifiable effect is the plage of the fauna, by collisions with cars, called "roadkills". Tabasco State has lost much of its jungles, however 75% of the State are wetlands, in which still have a wide diversity of mammals. With the goal of safeguarding the welfare of the mammals of Tabasco, a study of mortality was carried out on the roads of plain Tabasqueña. Species commonly run over were identified and the spots where the bulk density of roadkills are concentrated were located on the roads (black points). 633.5 kilometers of roads were driven at an average speed of 30 Km/h from 5:00-11:00 hours, twice in dry season (February-June), and twice in rainy season (July-October). For the identification of the black points, the estimator "Densidad de Kerner" in the program ArcGis® 9.3 was used. 385 records were obtained, grouped into 11 orders, 14 families and 21 species. The biggest record was obtained during the dry season (February-June). The most run over specie are the "tlacuaches" (*Didelphis marsupialis*), the most threaten specie are the anteaters (Tamandua mexicana), followed by the tropical porcupine (Sphiggurus mexicanus). In general are medium and small mammals with mainly noctural habits. Burnings are a factor which probably makes wildlife move from their habitat incrising the risk of collisions. The study area has a lot of human settlements all along the roads, which favors the high

presence of dogs and for that reason this specie is the most run over during the dry season, as much as the Didelphidae´s family, the "tlacuaches" (*Didelphis marsupialis*) that are commonly associated to human populations that are located close to roads. The four black points that were obtained represent the high incidence of collisions. Given the condicions a relevant measure of prevention is the implementation of speeders and apropriate signaling.

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MONITORING THE ROAD KILLED FAUNA IN ROADS SC -487 AND SC- 100 IN SANTA CATARINA

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The areas occupied by roads exert pressure on wildlife by removing part of the habitat, inhibiting the dispersal and migration of species. As a result of human influence, domestic animals are also vulnerable to road kill. The present research took place at the southern end of Santa Catarina a 150 km from Florianópolis, the state's capital, at the SC-487 and SC-100 roads that although present distinguished names belong to the same highway. The 33 km sampled has a distinctly rural profile, with virtually all the land engaged with agriculture and cattle activities. This research sought evaluate the species of wild animals hit by car in State Highways SC-487 stretch of road without wildlife crossing sites and SC-100 with wildlife crossing sites, connecting Jaguaruna and Laguna downtown, Santa Catarina State. It was made: (i) perform the monitoring of wildlife road kill; (ii) identify the most frequently road kill species; and (iii) identify the *HotSpots* in the area sampled. The study conducted during the months of May 2015 to April 2016, in 12 sampling campaigns every 12 days, in a total of 28 field outputs. Was used a motor vehicle with an average speed of 40 km/h. Carcasses found had the geographic coordinate recorded, were photographed and identified at the spot whenever possible. The collected data were also available on the SISTEMA URUBU, in order to complement the respective database system. The analysis of the location of *hotspots* were carried using SIRIEMA software, *HotSpots*-linear with the parameters: 100 meters radius distance, 500 divisions and 90%. For reliability analyses of efficiency of the existing wildlife crossing sites in the stretch of the SC-100. During the monitoring, were recorded 110 individuals hit, among these, 59 mammals, 24 birds, 14 frogs, 12 reptiles and 1 arthropod. A total of 21 species were identified, of which seven were

mammals, nine birds, amphibian, three reptiles and one of arthropod. Of the 21 registered individuals were not identified as species due to the state of the carcass found. *Didelphis albiventris* was the species that presented the highest frequency (83.33%) followed by *Rhinella icterica* (75.00%) and *Felis silvestres catus* (66.67%). In total 19 hotspots were identified, of which 14 distributed in the stretch of SC-487 (Jaguaruna-SC) and five on the SC-100 (Laguna-SC) (Figure 1).

Figure 1. Representation of road kill HotSpots. Highway represented by black line and city divisions by red line.

The frequencies found are consistent with other studies already carried out in Brazil, having the *Didelphis albiventris* as species with higher frequency of mortality. Which may be especially exercised by habitat fragmentation, the pressure in the areas with high population density and adapt to changes in habitats. Moreover, it is possible to verify the presence of fragments in both sides of the road, which may influence the crossing to seek for shelter, reproduction and foraging among the fragments. Considering the existence of significant hotspots (14) in the distribution of road kill in certain stretches of the road SC-487, and the fact of absent wildlife crossing sites can suggest that this is one of the reasons for the significant number individuals and species run over at this stretch. In contrast, the SC-100 along the stretch has eight wildlife crossing sites, which probably aided in the low index of road kill.

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INFLUENCE OF SEASONALITY ON WILD VERTEBRATES ROADKILL IN AN AREA OF CERRADO, MINAS GERAIS, BRAZIL

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In Brazil, according to the latest survey carried out in the country, over 475 million of animals die per year due to accidents with vehicles. However, to implement efficient mitigation measures it is necessary to understand better the factors that influence roadkill. Several authors have reported a higher frequency of vertebrate roadkill in the dry season. These authors believe that there is an increase in roadkill accidents in the dry season due to a lack of resources, which would increase the mobility of animals and, consequently, the roadkill rates on highways. Nevertheless, other authors have found no differences in vertebrate roadkill rates between seasons. In this perspective, the present work was developed to evaluate the influence of seasonality in the roadkill of mammals, birds and reptiles (Lepidosauria), on a highway located in the domain of Cerrado biome. Our hypothesis is that only reptiles are influenced by seasonality and that there are more roadkill events in the rainy season for this group. We believe this because reptiles are ectotherms and they are more active in the rainy season. The study was carried out on the section of the highway BR-050 between the cities of Uberlândia and Uberaba, MG. This section of the highway has approximately 96 km and is a dual carriageway road. The average daily volume of vehicles (VDM) along this stretch is 12,000 vehicles. The survey was performed between April 2012 and March 2013. This monitoring was done by car, at a speed of approximately 60 km/h, totaling 8,064 km. Two observers examined each kilometer of the road. Roadkill records were identified at the lowest possible taxonomic level. Individuals that could not be identified at a specific level, due to the advanced stage of decomposition, were classified as indeterminate and recorded for analysis only when it could be discriminated whether or not they were wild species. The monthly roadkill rate was calculated as follows: average monthly roadkill multiplied by 30 (days of the month) divided by 192 (total kilometers of the highway), for each month there was a different roadkill rate. Differences in the monthly rate of roadkill between the dry and rainy seasons were tested using the t test for two samples (t) when data were normal and the Mann-Whitney (U) test in the case of non-normal data. The months from October to April were considered as the rainy season, and the months from May to September the dry season. A total of 683 vertebrates roadkill was found, including: 482 mammals (70.6%), 145 birds (21.2%) and 56 reptiles (8.2%). At species level, 57 taxa were identified, being 21 mammals, 26 birds and 10 reptiles. No difference was found in the monthly roadkill rate between the rainy and dry seasons for wild mammals (U=21.000; p=0.568) and birds (t=0.135; df=10; p=0.895). However a difference was observed in the monthly roadkill rate between the rainy and dry seasons for reptiles (t=2.691; df=10; p=0.023) and wild vertebrates (t=2.355; df=10; p=0.040), it was higher in the rainy season. Besides having not found seasonality for wild mammals and birds, when we analyzed the most abundant species, we identified a highest number of roadkill in the rainy season for *Euphractus sexcinctus* (t=2.974; df=10; p=0.014), as well as for *Boa constrictor amarali* (t=2.882; df=10; p=0.016). Perhaps, because this animals are more active in this period of the year. However, a highest number of roadkill was found for *Cariama cristata* in the dry season (U=5.500; p=0.046), maybe these animals have to move more due to the scarcity of food. There was no difference in the monthly roadkill rate between the rainy and dry seasons for *Cerdocyon thous* (t=-0.529; df=10; p=0.608), for *Procyon cancrivorus* (t=0.109; df=10; p=0.916) and for *Conepatus semistriatus* (t=-1.495; df=10; p=0.166). Then, we can notice that the period that there are more roadkill may range and that it depends on the species, so mitigation measures and environmental plaining should consider this.

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MONITORING WILDLIFE RUN OVER DURING THE IMPLANTATION AND PAVING OF BR-235, NORTH STATE OF BAHIA

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The implementation of road systems, especially road transport, is essential to the current society model, being used in almost all the national territory. However, the trampling of wild animals on roads is considered by some authors as the main anthropic factor responsible directly by mortality terrestrial vertebrates on a global scale. These impacts may result in the reduction and isolation of populations and increased risk of local extinctions of many species. This study aimed to monitor the response of the local fauna to interventions from the implementation works and paving of the BR 235, northern state of Bahia, presenting results for the monitoring of wildlife (amphibians, reptiles, birds and mammals) run over during construction specifically between the municipalities of Carira (SE/BA – 24L 0637890 8859125) and Juazeiro (BA/PE – 24L 0337550 8954778), totaling 283.3 km. Data were collected between March 2015 to April 2016, covering the whole section with frequency of three campaigns with duration three days each, totaling nine consecutive days per month, and traveled over this period approximately 1,700 km. The monitoring was performed by moving along the highway, and used a car to a standard speed of 40 km / h, with a driver responsible for driving the car and a biologist responsible for roadkill records. All occurrences were recorded in standardized specific worksheet by IBAMA, in which they were tabulated data on the species, date and place, geographical location, vegetation characteristics, track conditions, photographic record, etc. Each species was classified according to their dominance and frequency. In this method the proportion of frequency is equal to (number of samples with record of the species / total number of samples) x 100, and the proportion of dominance given by (number of individuals of the same species / total number of individuals collected in the area) x 100. The combination of frequency and

dominance proportions allow the classification of the species status: common, intermediate, rare and very rare referring to records to roadkill. For delimitation of priority areas and sections (hotspots), we divided the stretch of highway into four lots, with 10 segments each, totaling 40 sectors. Records roadkill / Km were organized increasingly, grouped into four levels of criticality (critical, semi-critical, normal and non-critical). We recorded 801 roadkill events in representatives of wildlife, being 86 amphibians (5 species), 210 reptiles (24), 420 birds (53) and 85 mammals (8). Noteworthy is the number of individuals *Rhinella jimi* (Jimi toad) and *Philodryas nattereri* (Paraguay Green Racer) run over, (with respectively 82 and 72 records), being the species with the highest number of records of all species raised. In the group of mammals, the *Cerdocyon thous* (Crab-eating fox) prevails with 69 records roadkill. In the case of birds, we highlight three species: *Tyrannus melancholicus* (Tropical Kingbird), *Mimus saturninus* (Chalk-browed Mockingbird) and *Athene cunicularia* (Burrowing Owl) with 42, 36 and 34 registers respectively (Table 1).

The paving associated with the high speed of the highway users, in periods where the supply of food and water are more abundant, resulted in a marked number of roadkill. Through the plotted data, were defined 10 segments as "critical", indicating priority sites for decision making in the implementation of feasible mitigation measures. The appointed local are environments near Caatinga areas in a good conservation state, demonstrating through records such fragments serve as a refuge for local wildlife, being indispensable the adoption of the suggested mitigation measures, in an attempt to minimize the damage for the roadkill.

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Table 1. Species with more roadkill records on the BR-235 / BA.

Class	**Species**	**Popular name**	**Nº/ Records**	**Frequency**
Amphibia	*Rhinella jimi*	Jimi toad	82	10.21%
Reptilia	*Philodryas nattereri*	Paraguay Green Racer	72	8.96%
Mammalia	*Cerdocyon thous*	Crab-eating fox	69	8.61%
Aves	*Tyrannus melancholicus*	Tropical Kingbird	42	5.23%
Aves	*Mimus saturninus*	Chalk-browed Mockingbird	36	4.48%
Aves	*Athene cunicularia*	Burrowing Owl	34	4.23%
Aves	*Paroaria dominicana*	Red-cowled Cardial	31	3.86%
Aves	*Hydropsalis torquata*	Scissor-tailed Nightjar	31	3.86%
Aves	*Nannochordeiles pusillus*	Least Nighthawk	25	3.11%
Aves	*Columbina picui*	Picui ground dove	24	2.98%
Aves	*Columbina minuta*	Plain-breasted ground-dove	24	2.98%
Aves	*Sporophila albogularis*	White-throated Seedeater	22	2.73%
Reptilia	*Bothrops erythromelas*	Caatinga lancehead	21	2.61%
Reptilia	*Oxyrhopus trigeminus*	Brazilian False Coral Snake	19	2.36%
Reptilia	*Tropidurus hispidus*	Peter's Lava Lizard	17	2.11%

MORPHOMETRY OF CRAB-EATING FOXES (*CERDOCYON THOUS*) FOUND ROADKILLED IN THE SEMIARID REAGION NORTHEASTERN BRAZIL

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Roadkilling of wild animals constitutes one of the main causes of biodiversity loss. In Brazil, it is estimated that about 15 animals are killed every second on roads and highways. Among the individuals impacted, one can mention a variety of mammals, such as the three species of foxes present in Brazil. Foxes are wild animals from the Canidae family and are widely distributed in Brazil. *Cerdocyon thous*, commonly known as the crab-eating fox, is found from Argentina to Panama and is present in virtually all Brazilian states. Although there is no information confirming the population status of this species, it is considered as stable. In southeastern Brazil, a study estimated a population density of 0.78 individuals/km^2, in an area of 8.9 km^2. This omnivorous animal has nocturnal habits and can often be seen at roadsides, moving in search of food and taking consuming other roadkilled animals. Thus, this species becomes very susceptible of itself being roadkilled. To characterize the size of foxes that are run over in roads within the Caatinga biome, recently hit animals were collected in roads, in the Seridó region of Rio Grande do Norte state, during 2014. Animals found were placed in refrigerated coolers and taken to the Laboratory Management and Wildlife Conservation at the Federal Rural University of Semi-Arid. In the laboratory, morphometric measurements of 12 individuals of *Cerdocyon thous* (eight females and four males) were taken with the help of a calliper and rulers. In total, four measurements (mean ± SD) were taken: body length (52.3 ± 2.55 cm); tail length (33.25 ± 4.0 cm); skull length (14.1 ± 0.68 cm); and chest circumference (35.52 ± 4.55 cm). All animals collected were adults and no female was pregnant. These preliminary results present differences in the morphometric measurements when comparing to previous works with this species for other regions. The collected *Cerdocyon thous* foxes presented shorter body length (52.3 cm) than what was previously found in the literature (averaging from 60 to 70 cm). Regarding tail length, averages found in the literature (less than or equal to 30 cm) are smaller than what was found in this work. These results are of great importance to characterize the population of *Cerdocyon thous* foxes impacted by roadkilling regarding their morphometry. In addition, by determining age and sex, including breeding status (in particular in females), this data allows insights on how roadkilling may be affecting the population dynamics of this species, in areas of Caatinga in the state of Rio Grande do Norte.

MORTALITY RATE OF WILD ANIMALS IN THE HIGHWAYS PR-407 AND PR-508, COAST OF PARANÁ.

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The road system is of utmost importance for the development of the country, whether social or economic, as is the main instrument for national transport and an easy and cheap way for the flow of products. These are the roads that most often make it possible to go from one place to another in a country as large as Brazil. There are many gains from its use, however, the road network is one of the main responsible for the loss of biodiversity on the planet, because of the frequency of running over of wild animals. Many of the Brazilian highways harm even more the wildlife by cut or bypass protected areas, as on the highways of the coast of Paraná, especially the highway *Engenheiro Argus Thá Heinz* (PR-407 - with 30.5 km long) and *Elisio Pereira Alves Filho* (PR-508 - with 18.8 km long), respectively located between the cities of Paranaguá/Pontal do Paraná and Paranaguá/Matinhos. In their paths, roads skirting four areas protected by conservation units: the *Floresta Estadual do Palmito* and *Estação Ecológica do Guaraguaçu*, both evaded the PR- 407, and the *Área de Proteção Ambiental de Guaratuba* and the *Parque Nacional Saint-Hilaire/Lange* circumvented by PR-508 (FIGURE 1). Although this is the region with the largest continuous area of rainforest known, few fauna trampling of survey work in the region, being the only studies in the literature dating back to 2009. Taking into account the negative aspects that the two highways have on the wildlife of these protected areas, IFPR conducts weekly monitoring of both roads to assess the mortality of vertebrates. Monitoring is conducted by a team with at least two members (driver and observer), by motor vehicle in a controlled speed of 40 km/h, always early in the morning watching the sunrise. Four types of data are collected on each output: i) environmental data (rainfall and temperature); ii) data of the average daily volume of vehicles; iii) data collection with

GPS (start time and end monitoring, traversed path, speed along the path, and registration points where roadkill were found); iv) individual data from each animal found (species identification, photography of people and landscape where it was found). In the first two months of work were performed 8 field efforts, where a total of 29 roadkill were found, 8 instances (two birds, three mammals, two reptiles and one amphibian) on PR-407 and 21 events (8 birds, 6 mammals,5 reptiles and amphibians 2) in the PR-508. To date, trampling rates found are 0.0666 animals/km/day for the PR-407 and 0.0875 animals/km/day to PR-508. While for highway PR-407 have been recorded about 5 different species belonging to 5 orders, on PR-508 were identified 12 different species of 9 orders. Even though these are partial results, the ecological importance of the region and trampling rates already show the great importance of studies of the impact of wildlife running over to the Paraná coastal region, especially as regards the lack of previous studies for the area.

FIGURE 1 - Highway PR-407 and PR-508, the main access to beaches in the state, and its relationship to protected areas. Source: Google maps.

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INFORMATION AS THE KEY TO REDUCE ROADKILLS

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The roads are built in order to facilitate communication and to transport resources between cities, as a socioeconomic improvement of the country. Given its purpose, this kind of infrastructure has become the principal mean of transportation, created jobs and contributed positively to the economy. But the roads also end up causing a number of environmental impacts, both in their construction, maintenance, traffic flow and the location where they were installed, and also the impact generated by the collision between motor vehicles with non-human animals. The Road Ecology is the branch of Ecology that studies interactions between these roads and the ecosystem around it, aiming to find mitigation measures to help reduce the impacts that they may cause. One of the main impacts are the roadkills, which can affect all species living near the roads that need to cross them or are attracted to them. Wildlife crossings, fencing, signalization, electronic radar and speed bumps are some measures that can help reduce the number of roadkills. However, these are actions that can be more effective if linked to the awareness of drivers since these are the subjects directly linked to accidents. A questionnaire was applied to 53 students of the Youth and Adult Education program in Joseph Oscar D 'Plácido e Silva school, located in Curitiba, Paraná, Brazil, in order to analyze the perception of the subject. The questionnaire had 10 questions relating the actions taken in situations involving animals on the roads, opinions and personal views on the subject. It is important to highlight that the same questionnaire was applied before and after a 50-minute presentation containing information on the subject. Such dynamics aimed to inform and educate participants. The post lecture questionnaire was used to observe if the perception of respondents changed after contact with the information. As a result of the activity, was perceived a new awareness on the problem for 60% of the participants on the issue, as shown in Figure 1, about what they believe to be the main cause of roadkills.

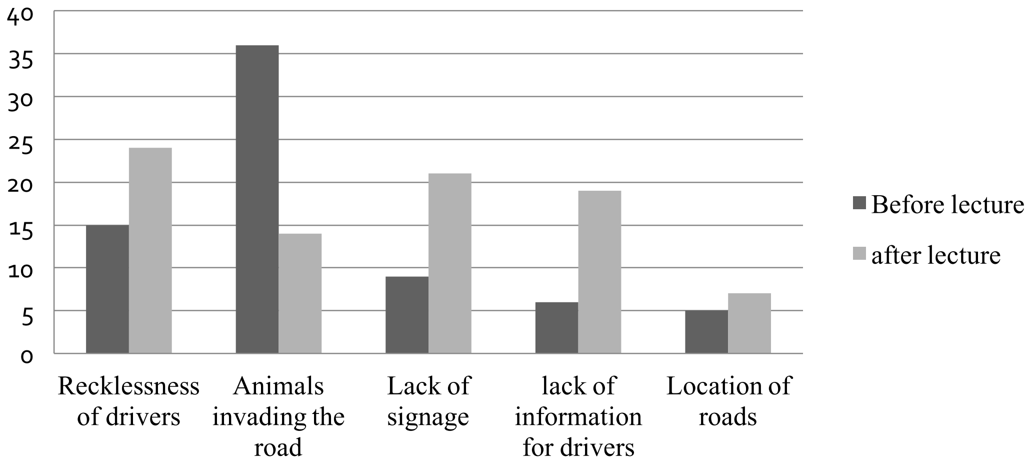

Figure 1. Frequency of responses of students in Oscar Joseph D ' Plácido e Silva school in pre questionnaires and after the lecture, as the question "In your opinion , what is the main cause of roadkills?"

During the lecture the students learned about the impacts of roads, being able to recognize the fauna as one of the main victims of the construction of these infrastructures. It was identified that before the lecture the participants thought that invasion of animals in the tracks was the main cause of pedestrian accidents, however, afterwards they realized that the lack of information or recklessness of drivers were also important causes in this equation. In the question "In your opinion, what is the best measure to be adopted to reduce the number of roadkill?" Before the lecture, three participants judged that the creation of safe crossings for animals was one of the best measures to be adopted, and over 70% of respondents pointed the construction of barriers preventing the animals from invading the track was the best measure. After the lecture the result of the response was the opposite, with 70% of participants indicating thatwild crossings is indeed a better measure. In the same question, the alternatives "Increasing the number of signs" and "raise awareness among drivers about the issue" were voted respectively for 19 and 21 participants, and before the lecture only 9 and 15 of the 53 participants. This change made after the contact of information, demonstrates the importance of including this issue in driver training course or in the last year of high school classes, i.e. future drivers. Environmental Education programs are ways to show drivers and future drivers that they have a role of great responsibility on the roads, helping to reduce the number of collisions and animal'sdeaths on highways. To ensure data consistency , the activity will still be applied in 3 more school to high school.

EXPANSION OF ROAD NETWORK AND BIODIVERSITY: A CASE STUDY ABOUT WILDLIFE ROADKILL ON THE BA-099 HIGHWAY, NORTH COAST OF BAHIA

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In Brazil are built around 1.7 million kilometers of roads, of which 12.9% are paved, 11.2% are single and 0.6% are duplicated. Roads implantation affects the structure of ecosystems, the dynamics of ecosystem functioning, and has direct effects on ecosystem components, including their species composition. One of the main negative impacts is roadkill, which affects the most varied species inhabiting the vicinity of a road. In this sense, several actions have been studied in order to mitigate this impact, such as speed controllers, wildlife crossings, intensification of signs, among others. In this scenario, the present study aims to diagnose the current state of wildlife roadkill on the BA-099 highway, in order to propose mitigation measures of this impact and wildlife protection. The BA-099 is located on the north coast of Bahia, with a length of 191 km and has been recently duplicated a new stretch. The region is part of the sedimentary plain, with the presence of dunes, lake / humid environments, rain forest, restinga, and anthropized areas. The study is carried out in the second and last third of the highway to the north, totaling 141.6 km of paved road. The first five kilometers of the monitored stretch are duplicated, with two traffic lanes in each direction, in which there are wildlife crossings (overpasses and underpasses). Data collection began in March 2016, is performed weekly, totaling 10 samples over three months. The samplings occurred both on weekdays as weekends / holidays, starting in the morning shift and realized with a car at an average speed of 45 km / h. A biologist has been responsible for registering the roadkill, primarily on the right side of the sampling direction. When observed, the specimen was previously identified, photographed, georeferenced and removed from the highway. The photographs of roadkill were evaluated a posteriori again in order to confirm the taxonomic order, seeking to achieve

the specific level when possible. Initial results in 10 sampling visits allowed the registration of 261 roadkill, distributed in 40 species, reaching a rate of roadkill of 0.178 ind / km. The specimens belong to four classes of terrestrial vertebrates, 8 taxa of amphibians, 12 reptiles, 14 birds and 6 mammals. Regarding the abundance, the amphibians represented an absolute dominance with 188 individuals get hit, followed of birds with 28, reptiles with 24 and mammals with 21. The first stretch (5 km), with duplicate traffic lanes and wildlife crossings, presented a hit-rate of 0.150 ind / km, while the longest stretch had a rate of 0.180 ind / km. When excluding amphibians, which represent more than 70% of the records, the rates become in the first stretch 0.030 ind / km and 0.051 ind / km in the second. The most frequent taxa among run over ones were the amphibians *Rhinella* sp. (N = 150), *Leptodactylus* sp. (N = 24), *Dermatonotus muelleri* (N = 4) and the mammal *Callithrix jacchus* (N = 4). A single endangered species, the rodent *Chaetomys subspinosus*, was recorded in the first stretch. The diversity index of the highway was 1.886 (Shannon-Winner Index), while the first stretch obtained value of 0.988 and the second of 1.759. The evenness index was 0.515 (Pielou Index), 0.713 for the first stretch and 0.487 for the second. This initial results not yet allow an observation in the standard range of roadkill or periods when they are more expressive. However, comparing the roadkill rates for stretches, which ranged from 0.030 to 0.051 ind / km, they are significantly smaller than the reported in a study developed on the BR-392, in a similar environment, in southern Brazil, where rates were recorded of 0.065 to 5.2 ind / km in the different stretches. The large number of amphibians hit by vehicles is possibly influenced by the overall structure of the landscape, with the remarkable presence of rivers, lakes and wetlands typical of coastal plain. The first stretch, even duplicated, with more intense traffic and surrounding by rain forest presented lower rate of roadkill, even when amphibians are removed from the analysis. An initial hypothesis is the presence of the wildlife crossings, which may have been used. However, only in this sretch was observed to occurrence *C. subspinosus* hit, even with the existence of passages. Therefore, the inclusion of data regarding the effectiveness of fauna passages, through a specific monitoring, is essential to elucidate the effects of this factor on the roadkill. The highest diversity in the second stretch was certainly influenced by the total number of species, since it is a bigger stretch, but there is also very high dominance of *Rhinella* sp., reducing the evenness among roadkill, which was more uniform in the first stretch. The partial data point to a low roadkill rate on BA-099, even when compared to other highways in similar environments. Nevertheless, the inclusion of analysis about factors associated to records, such as the structure of the landscape surrounding the highway, traffic intensity in the traffic lanes, presence of equipment for mitigation are fundamental to better elucidate its causes, as there is a variety of contexts that can exert effect on this impact, which will be the targets of future results.

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GEOGRAPHICAL DISTRIBUTION OF MAMMAL ROAD-KILL IN BRAZIL

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Road-kill records could be a useful data source to biogeographical and ecological studies. Some cryptic species that do not avoid roads could be killed and generate new records to improve knowledge about its distribution in local and biogeographical scales. In Brazil, road-kill monitoring usually has local range focusing in one road for a limited period of time. However, a systematic review of published articles, reports and online news could be used to build a database of species records. This study aims to evaluate the geographical distribution of road-kill records of mammals in Brazil. We have searched published articles, during nine months - October 2015 to May 2016 - reports and online news available from January 2004 to December 2015. We have not succeeded in downloading road-kill events in the CBEE's BAFS, thus we could not use them. We found 2,509 road-kill records of mammals in Brazil . The ten more frequent species corresponded to 2,106 (83.9% of total) and were: *Didelphis sp.* (opossum, 667), *Cerdocyon thous* (crab-eating-fox, 584), *Euphractus sexcinctus* (six-banded armadillo, 202), *Tamandua tetradactyla* (southern tamandua, 170), *Myrmecophaga tridactyla* (giant anteater, 165), *Procyon cancrivorus* (crab-eating raccoon, 104), *Dasypus novemcinctus* (nine-banded armadillo, 97), *Nasua nasua* (ring-tailed coati, 42), *Hydrochoerus hydrochaeris* (capybara, 38), *Conepatus chinga* (Andes skunk, 37; Table 1). The biomes with more road-kill records were Atlantic Forest (915, 43.4%), the transition between Brazilian Savanna and Pantanal (464, 22%) and Brazilian Savanna (411, 19.5%, Table 1). Pampas and Amazon showed less road-kill events, respectively, 27 (1%) and 84 (4%, Table 1), and Caatinga did not show any records of road-kill, probably these biomes need more studies on their roads. Based on road-kill records, we can say that *Cerdocyon thous* is in all biomes, but more in Atlantic Forest (204, 34.9%), the transition between Brazilian Savanna and Pantanal (171, 29.3%) and Brazilian Savanna (128, 21.9%). The map of distribution of *Cerdocyon thous* done by IUCN does not show some

sites of our road-kill records. We need investigate more about geographical distribution and new records of *C. thous* in Brazil, but that is an example how road-kill records could update biogeographical knowledge on this species.

Table 1 - The ten more frequent mammal species found in road-kill monitoring distributed by Brazilian biomes.

Ordem and *Species*	Amazon	Pantanal	Cerrado	Atlantic Forest	Pampa	Cerrado/ Pantanal	Cerrado/ Atlantic Forest	TOTAL	
Carnivora								**N**	**(%)**
Cerdocyon thous	18	43	128	204	5	171	15	**584**	27.7
Procyon cancrivorus		12	10	63	1	15	3	**104**	4.94
Nasua nasua	8	9	14	6		5		**42**	1.99
Conepadus chinga				20	17			**37**	1.76
Pilosa									
Tamandua tetradactyla	5	27	76	24		38		**170**	8.07
Myrmecophaga tridactyla		8	97	2		57	1	**165**	7.83
Cingulata									
Euphractus sexcinctus	25	10	41	9		117		**202**	9.59
Dasypus novemcinctus	8	5	16	35		33		**97**	4.61
Rodentia									
Hydrochoerus hydrochaeris		17	3	4		12	2	**38**	1.8
Didelphimorfia									
Didelphis sp.	20		26	548	4	16	53	**667**	31.7
TOTAL (by biome)	**84**	**131**	**411**	**915**	**27**	**464**	**74**	<u>2106</u>	100

Other nine most road killed species did not occur in all biomes. *Procyon cancrivorus* and *Didelphis* sp. were not present in only one biome, respectively, Amazon and Pantanal. *Didelphis* sp. was more frequent in Atlantic Forest (548, 82.2%) as *Procyon cancrivorus* (63, 60.6%). *Tamandua tetradactyla*, *Myrmecophaga tridactyla* and *Euphractus sexcinctus* occurred more in Brazilian Savanna (respectively 44.7%, 58.8% and 20.3%) and the transition between Brazilian Savanna and Pantanal (respectively 22.4%, 34.5% and 57.9%). *Dasypus novemcinctus* occurred more in Atlantic Forest (35, 36.1%) and in the transition between Brazilian Savanna and Pantanal (33, 34%). *Nasua nasua* occurred more in Brazilian Savanna (14, 33.3%); *Hydrochoerus hydrochaeris* in Pantanal (17, 44.7%) and the transition between Brazilian Savanna and Pantanal (12, 31.6%); and *Conepatus chinga* only in Atlantic Forest (20, 54.1%) and Pampa (17, 45.9%). Some published articles present some descriptions on landscape and site around the road-kill event that could help to understand more on ecological aspects of this species, in addition to biogeographical distribution of them.

INCORPORATING THE RESULTS OF WILDLIFE MONITORING ON ROADS IN RECOMMENDING MEASURES FOR REDUCING THE IMPACT OF ROAD DEVELOPMENT: ROUTE 32, LIMON, COSTA RICA

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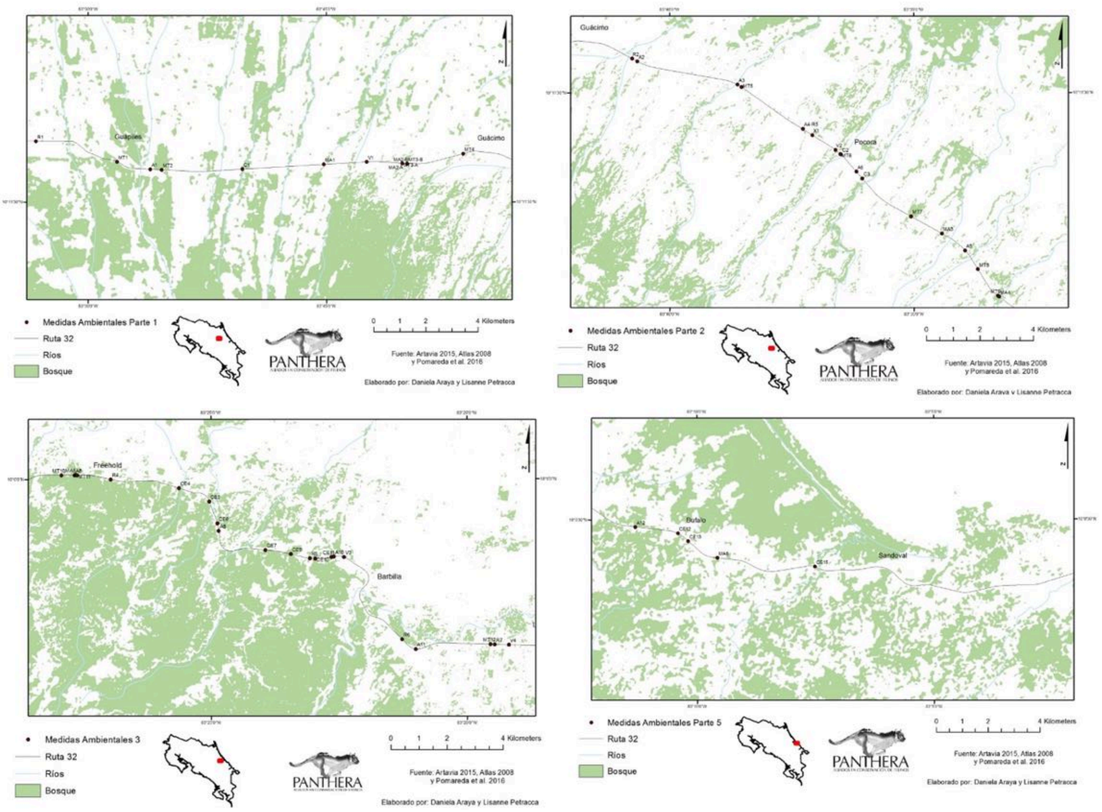
The increasing road development in Central America for the efficient transport of goods must be implemented harmoniously with the conservation of the rich biodiversity characteristic of this region. Roads not only impact local communities and water resources also impact ecosystems. Through monitoring of wildlife on roads we have learned its main impacts: forest reduction, isolation and displacement of populations, fragmentation, transformation, reduction and habitat degradation. Recently Costa Rica introduce a tool to reduce traffic impact of a more comprehensive manner incorporating topics such as legislation, methodology for monitoring and recommendations on specific measures The Environmental Guide: "Wildlife Friendly Roads" The objective of this research is the application of this Guide in an expansion project of a highway, Route 32, in the Atlantic Zone of Costa Rica. The section of this road has a length of 100 km and with this expansion is to improve the transport of goods to and from the port in this coastal area. As part of the research methodology environmentally fragile areas and wildlife vulnerable to road impact were identified. One of the main actions was the biological monitoring of the route for 8 months, consultation with local communities, identifying the cross points of animals and recommending measures to reduce the potential impact of the project on wildlife-based monitoring results. biological corridors, state and private in the margins of the road protected areas were identified. Among the main results was recorded during the monitoring period a total of 1071 roadkill individuals (amphibians, reptiles, birds and mammals) before the enlargement of the route. The measures recommended are air steps, underpasses (round and square culverts), signaling and speeders at points identified as wildlife crossings and designed to the specifications required by the species identified for monitoring. The road development is important to achieve compliance on issues of efficient freight for our country, but to fulfill this objective

cannot compromise our biodiversity, since a road growth without measures to reduce its impact on wildlife, commits our biological wealth. Our protected areas have suffered many impacts (e.g. Hunting, illegal logging, illegal mining, effects of climate change) coupled with this, in recent decades has identified another great impact, known as the silent giant conservation ecology: the roads.

Wildlife crossings points potential and identified on Route 32 through monitoring, independent reports, prioritization of species, historical records and structural connectivity, Limon. Costa Rica. 2016

Taxonomic Group	Wildlife crossings points
Amphibians	12
Reptiles	8
Flying species	7
Arboreal Mammals	6
Terrestrial Mammals	12
Forest connectivity**	15
TOTAL	**60**



Wildlife crossing points and its mitigation measure at the National Route 32, Limon. Costa Rica. 2016

FELIDS AND ROADS INTERACTION IN BRAZIL: TEMPORAL AND SPATIAL PATTERNS OF ROAD-KILLS

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Felids are particularly vulnerable to road mortality because of their large home ranges, high mobility and low population density and reproductive rates. In Brazil, mortality rates are around 78 ind./100km/year for Geoffroy's cat *Leopardus geoffroyi*, 58 for northern tiger cat *Leopardus tigrinus*, 46 for ocelot *Leopardus pardalis*, 23 for jaguarundi *Puma yagouaroundi*, pampas cat *Leopardus colocolo* and puma *Puma concolor* and 10 for margay *Leopardus wiedii*. Although there are several studies on felids road mortality, there is still lack of knowledge on the temporal and spatial factors that explain mortality risk. The main goal of this study is to assess the temporal and spatial patterns of road-kills along the distribution area of eight species of felids in Brazil: jaguarundi, puma, margay, ocelot, pampas cat, northern tiger cat, Geoffroy's cat and southern tiger cat *L. guttulus*. More specifically, we aimed to: (a) detect the periods of high incidence of road-kill occurrence and assess their relationship with their life cycle, (b) assess the role of spatial factors on the road-kill likelihood and (c) identify road segments with high risk of road mortality. We compiled georreferenced road-kill occurrence data from Sistema Urubu database, published and unpublished data. To characterize temporal patterns in road-kill events we described the proportion of road-kill occurrences over each season. We used the Maximum Entropy Modelling algorithm to evaluate the role of landscape (elevation, land cover, streams and protected areas) and human-pressure variables (anthropic areas, human population density and roads) on the mortality risk. We run the models over a Brazilian road network raster (4/6-lane highways, 2-lane paved roads and unpaved roads) with 1km resolution. For each model, 70% of the data were used for training and 30% for testing. The likelihood of road-kill for each species was

obtained by a logistic output format in continuous maps with grid cell values ranging from 0 (no probability of road-kill events) to 1 (maximum probability of road-kill occurrence). Models were evaluated through the area under receiver-operating characteristic curve (AUC). Models showing AUC values greater than 0.7 are potentially useful to predict road-kill occurrence. We compiled a total of 459 road-kill records: 118 records for jaguarundi, 37 for puma, 12 for margay, 62 for ocelot, 15 for pampas cat, 129 for tiger cats (northern and southern tiger cats were analysed together) and 86 for Geoffroy's cat. The incidence of road-kills over the year varied among species. Jaguarundi´s road-kill records were dispersed over the year with higher incidences in early spring (16%). Around 38% and 33% of pampas cat and puma´s road-kills were recorded in late fall and 40% and 18% of margay and ocelot´s records occurred in the early winter, respectively. In mid and late fall there were more casualties of tiger cats (26%) and 18% of Geoffroy´s cats´ road-kills occurred in late winter. Although there is little information on phenological patterns of felids in Brazil, the highest incidence of records of pumas and Geoffroy´s cats were related to the dispersal period and for pampas cats to the breeding season, both periods correspond to a period of high mobility to find new territories or to find mates. Models for all species showed AUC values above 0.9. The variables that most explained the road-kills occurrence were: 4/6-lane highways for jaguarundi, puma, ocelot and tiger cats; 2-lane paved roads for Geoffroy´s cat; low areas of cropland for margay and low elevation for pampas cat. Forest also explains jaguarundi and margay mortality likelihood whereas low and high elevation were related to Geoffroy´s and tiger cats´ road-kills, respectively. Low proportion of wood, cropland/vegetation mosaic and low human population density were related to puma, pampas cat and ocelot road-kills, respectively. A total of 3843km have high probability of road-kills (75-100%) for jaguarundi, 1700km for puma, 10km for margay, 1044km for ocelot, 99km for pampas cat, 1718km for tiger cats and 37km for Geoffroy´s cat. The road segments with high risk of mortality represent between 0.003 and 1% of the road network in each species distribution. Our findings show that road mortality risk can be a threat for some jaguarundi, puma, tiger cats and Geoffroy´s cat populations. We recommend further research (population viability analysis taking into account the road segments with high risk of mortality) to understand the impact of roads on the persistence of these populations at long-term.

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ASSESSING THE ROADKILL IMPACT ON BATS (MAMMALIA, CHIROPTERA): A CASE STUDY FROM SOUTHEASTERN BRAZIL

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The roadkill of bats has been neglected in most road ecology studies. However, research held in Europe and North America has indicated that, contrary to what was expected, bats are among the faunal groups most affected by roads. In order to test the vulnerability of bats to the impacts caused by roads, we have compiled the roadkill data recorded in BR-040 highway, within the stretch Rio de Janeiro/Juiz de Fora, deposited in the mammal collection of Museu Nacional do Rio de Janeiro. The daily monitoring ocurred between April 2006 and February 2016, accomplished from a vehicle at 40-60 km/h. This highway runs along the Atlantic Forest remnants, agricultural fields, and urban areas. We have recorded 804 roadkills of mammals, being 298 in Chiroptera, and 506 in other mammals (157 Carnivora, 99 Rodentia, 90 Primates, 69 Didelphimorphia, 44 Pilosa, 27 Lagomorpha, 19 Cingulata, 1 Cetartiodactyla; Figure 1A). Forty seven bat species have been identified, with Chiroptera holding the highest number of species and roadkills, accounting for 37% of all mammalian records. The high number of bat roadkills could be explained from its outstanding abundance and species richness. Chiroptera is the second richest order in species among mammals, presenting a high population density, which constitute more than half of the mammal community (both in number of species and individuals) in the region. The hypothesis of correlation between vulnerability to roadkills and body mass was rejected by linear regression test (R^2 = 0.228, p = 1.657), indicating that the size of the species does not influence the susceptibility to roadkills. There was a statistically significant difference in the roadkills

number between trophic guilds ($t = 2.594$, $p = 0.031$), being the frugivorous species most susceptible to roadkills, representing 64% of the records (Figure 1B).

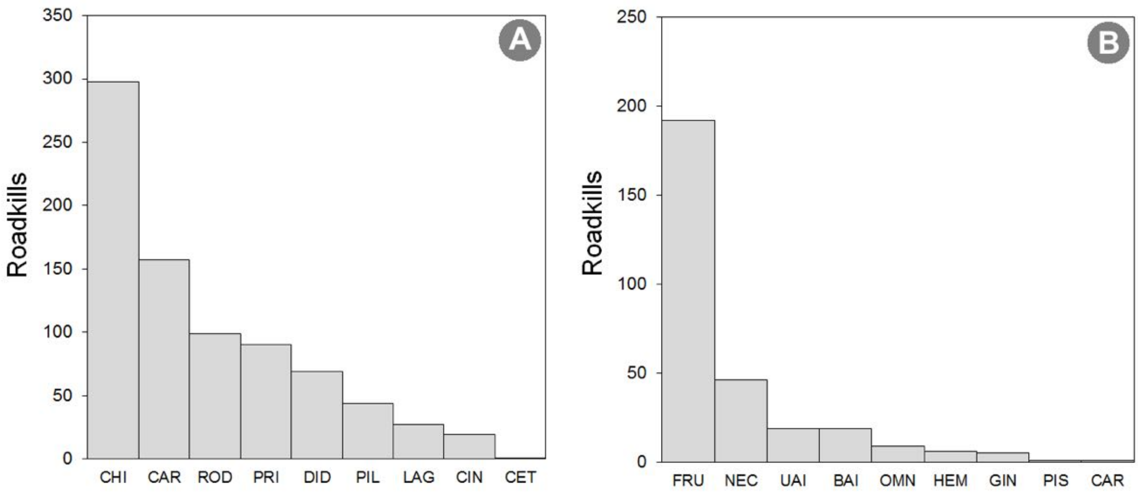

Figure 1. Number of roadkills during the monitoring of highway BR-040, trecho entre Rio de Janeiro/Juiz de fora, being: (A) Roadkills records of Chiroptera (CHI) compared to others mammalian orders (CAR = Carnivora, ROD = Rodentia, DID = Didelphimorphia, PIL = Pilosa, LAG = Lagomorpha, CIN = Cingulata, CET = Cetartiodactyla); (B) Roadkills records of different chiropteran's trophic guilds (FRU = Frugivore, NEC = Nectarivore, UAI = Uncluttered aerial insectivore of open areas, BAI = Background aerial insectivore of forests, OMN = Omnivore, GIN = Gleaning insectivore, PIS = piscivore, CAR = Carnivore).

Our hypothesis suggests that the greater vulnerability of fruit bats may be related to two factors not mutually exclusive: (1) greater abundance of individuals of this guild, since more than 80% of individuals in neotropical forest communities can be frugivorous species; (2) use of lower strata of the landscape, with foraging and movements being carried out at low heights, making it more susceptible to collisions with vehicles. Unlike in all the wildlife road kill studies conducted in the Neotropics, in our study the bats were the most abundant group in roadkill records. This is mainly due to the realized monitoring method, done at low speed. This study is the first to indicate the high vulnerability of bats to roadkilling in the Neotropics, which can be an important negative impact on the populations of this group rarely considered in road ecology studies.

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INVISIBLE DEATH IN OUR DAILY LIVES

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When we think about wildlife road-kills, we associate them with large roads in rural environments, forests and grasslands far away from big cities. However, this kind of wildlife mortality may also happen in urban areas, even if it is invisible for many people. In a city, driver's attention to wildlife is reduced or absent, specially in cities where few areas of native vegetation and fauna are left. In Porto Alegre, there are only 24% of remaining native vegetation, from which 12.2% are in Santana hill (1459 ha), where campus of Federal University of Rio Grande do Sul is located (Campus do Vale - UFRGS). The aim of this study is to present the results of road-kill monitoring in Campus do Vale road network. This monitoring was demanded by the University's Superintendence of Infrastructure (SUINFRA) for the Ecology Center of Roads and Railways (NERF), and it is part of environmental regularization of Campus do Vale. We identified road-kill species, estimated the magnitude of mortality and determined the locations and periods of higher road-kill aggregations. Between November 2013 and April 2016, we monitored the paved streets at Campus do Vale (5.6 km) twice a week with two observers by car at 30 km/h. To estimate the magnitude of roadkills, we used SiriemaV2.0 software, considering the detection capacity as 0.34 for small carcasses (< 20 cm) and 0.49 for large carcasses (> 20 cm). For the removal characteristic time (time when approximately 63.33% of carcasses were removed), we considered 1.7 days for small carcasses and 2.7 days for large ones. These estimates correspond to the mean detection and removal obtained from experiments performed in other roads. We

identified spatial road-kill aggregations in the road network of Campus do Vale through kernel density analysis in SANET software. After 29 survey months, we recorded 153 vertebrates, summing 13 amphibians, 63 reptiles, 56 birds, 20 mammals and one without identification. Correcting by detection and removal time, we estimated 321 road-kills per year. The higher observed road-kill temporal aggregation was between November and December. We identified two locations of spatial road-kill aggregations: one located in a descent where vehicles are often observed above the speed limit, and the other adjacent to a wetland. These results showed that it is necessary attention for the wildlife that still occurs in urban areas of Porto Alegre city. Proposals for urban expansion are still a threat in this area, like a project of extension of an avenue close to campus, that would fragment a part of Santana hill and expand the road network within campus, increasing the chances of wildlife road-kills. Mitigation measures to decrease road-kills can be implemented by the university, such as speed reducers (40 km/h), wildlife passages and barriers for reptiles which are the most recorded animals. Investments in awareness of drivers to show the value of this wildlife, invisible on their daily lives, should also be done. Installing educative signs, publishing this issue in the university media, and drawing road-kill symbol on asphalt at mortality locations are some ways we intend to put in practice to draw attention to and start to change this invisible reality. Versão em português: www.ufrgs.br/nerf/index.php/producao

ANALYSIS OF SPATIOTEMPORAL FACTORS RELATED TO WILD ANIMALS ROADKILL IN THE NORTHERN STRETCH OF HIGHWAY BR-101, UBATUBA, SP, BRAZIL.

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The Atlantic Forest is one of the most threatened biomes due to the accelerated and disordered urban settlement on the forest outskirts, as well as the high expansion of economic development in coastal regions. This problem increases concomitantly with the growth of the road network and traffic flow. The construction and expansion of roads causes significant social, economic and environmental changes over time. The main effects on biodiversity are habitat fragmentation, hydrological changes, noise pollution, introduction of exotic species and the wildlife roadkill. The highway BR 101 (Governor Mário Covas) is one of the main highways in the state of São Paulo fulfilling an important role in coastal tourism development on the north coast of the state. Although the highway deployment brings great social and economic development for the Ubatuba region, it also brought major environmental impacts, especially the high levels of wildlife roadkill. Thus, the understanding of the geological, climatic and environmental factors become an important step for the development of mitigation measures for impacts of roads on wildlife. Given the importance of environmental factors that could be related to wildlife run over and the lack of studies of this nature in the region, the aim of this research was to identify the critical routes (Km) with higher incidence of roadkill and examine whether there is a relation between accidents and climatological and environmental factors. The wild fauna roadkill was monitored during a period of 16 months divided into two cycles, from January to August 2011, and from January to August 2012, in the interval between kilometers 08 and 44 of the highway,

totaling 37 km. A highway mapping using GPS (Global Positioning System) device "Garmin Etrex H" was conducted in order to build maps for identification of critical points, i.e. the highway stretches with the highest rates of roadkill. Concurrently, a rapid assessment protocol was applied for vegetation characterization on the right and left bank of the highway. Environmental aspects considered was: presence of waterways, urban, forest, salt marsh, mangrove, wetland, slope, slope or plane, and these parameters were evaluated over a length of approximately 50 meters to each side of the highway. Anthropogenic features were added to the evaluation, such as: presence of houses, roads, dumps, sentry-boxes and pipes for rainwater. For further verification and validation of the results obtained during the rapid assessment of vegetation, the Google Street View tool made possible to review every kilometer analyzed. Spatiotemporal variations were assessed from the number of records in order to detect run over occurrence patterns of fauna occurring in the region. Pluviosity was also used for setting two stations: dry and wet, in order to correlate the number of occurrence within each station. The pattern of environmental variables (vegetation of the highway margins) was described by principal component analysis (PCA) per kilometer observed. The principal components analysis described the patterns of environmental variables selected by ordering the kilometers sampled. The profile of the vegetation, extract and density were taken by the following environmental variables: low, medium or high density and vegetative characteristics as herbaceous, shrubs and trees. It was found that 40, 6% of the total variation showed a positive association for arboreal vegetation type and negative association with herbaceous vegetation type and low density, and 22.4% of the variation showed a positive association for shrubby vegetation type and high density, and negative association for medium density. In the 16 months of data collection, we analyzed the period in which there were the greatest rainfalls based on the National System for Environmental Data, in order to relate accidents occurred during the same period. The passages that showed a higher number of roadkill were in between Km 8 to 11, with 32 occurrences, followed by stretches between kilometers 18 to 22, with 18 occurrences. The lower occurrence was in the kilometer 40 to 44, with 6 run over specimens. In other tracks, occurrences were low, ranging 01-04 in the frequency of road kill, which can have various causes. One hypothesis is that the type of the landscape (fruit trees, seed and most pristine stretches of forest, water resources), could attract animals that go out in search of food. The distribution of roadkill along the sampled sites showed significant differences. The main points were the regions with better environmental quality, where is also noted that the relief in most of these sections shows slopes, where vehicles travel at high speed. Seasonality showed differences in roadkill because there were more accidents during the rainy season (January, February, March and April) with a total of 65 records (61.3%), and 45 records (42.4%) in the dry season (May, June, July and August). This fact demonstrates the need to implement actions to mitigate the impact on wildlife on these road points. From the knowledge of the affected species, it becomes necessary to develop studies, propose and implement mitigation measures such as appropriate signage, aerial corridors, tunnels, fences, floodlights, sounders, electronic cameras as other structures suggested by experts. This should be done concomitantly with a wildlife monitoring program in the region, in order to minimize the impact of presence of BR-101 highway in local wildlife, especially in the confrontational stretch with the Serra do Mar State Park - Picinguaba, seeking the conservation of local and regional wildlife.

Acknowledgments: We thank those who have collaborated to data collection; the Fauna News website and the Serra do Mar State Park, Picinguaba.

ASSESSING THE ROLE OF ENVIRONMENTAL VARIABLES TO EXPLAIN ROAD-KILL LIKELIHOOD ACROSS MULTIPLE SCALES

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Several studies document that species perceives or responds to its environment at different spatial scales. Knowledge on which spatial scale should be used to assess the importance of environmental variables to explain road mortality risk is still scarce. Roads cause a particular impact on large carnivores, since they usually have large home ranges and low reproduction rates. However, few studies explore the use of different spatial units on modeling and the influence of one scale may cause on the results. The maned wolf (*Chrysocyon brachyurus)* is a generalist carnivore, classified as Vulnerable by the ICMBio and as Near Threatened by the IUCN Red List. Collisions with vehicles are one of the main threats suffered by the species. The aim of this research is to evaluate role of environmental variables to explain maned wolf road-kill likelihood across multiple scales and therefore the implications on spatial patterns of road mortality risk. We used two spatial extents (species distribution and only the road network within the species distribution) and two spatial unit sizes (species home-range size (64km^2) and the standard size for road-kill modeling (1km length) – 1km^2) to model the maned wolf road-kill likelihood. More specifically, we performed three models: 1) species distribution area with the home range size as the spatial unit, 2) species distribution area with 1km^2 resolution, and 3) road network with 1km^2 resolution. For the data collection, road-kill georeferenced data were obtained from Urubu System database and from published papers. Variables used to predict species mortality risk included bioclimatic (maximum temperature of the warmest month), landscape (river density, area of mosaic croplands/open vegetation, forest, mosaic forest/open vegetation and open vegetation), landscape metrics (Simpson's index) and human pressure (human population density, Euclidean distance to protected areas and type of

road where the road-kill occurred). Variables were obtained from the open databases, WorldClim, European Space Agency, Open Street Maps, Ministry of the Environment, National Agency of Waters and Brazilian Institute of Geography and Statistics. We used MaxEnt software to run the road-kill models with 30% of the sample used as random test and with 10 replicates per model, using bootstrap as replicate run type. All models obtained high AUC values: the species distribution area with the spatial unit of $1km^2$ had the best result (AUC=0.989±0.001), followed by the species distribution area with the spatial unit of $64km^2$ (AUC=0.959±0.007) and the road network with the spatial unit of $1km^2$ (AUC=0.902±0.012). The type of road where the road-kill occurred, distance to protected areas and temperature showed the highest explanatory power for all models. Road-kills were more likely to occur in 4/6-lane highways whereas distance to protected areas show a negative correlation with the probability of road-kills occurrence. Maximum temperature at 28°C of the warmest month seem to be highly related to road-kill likelihood. Even though all models presented high AUC values, we found differences regarding the proportion and location of areas with high road kill risk (>75% of road-kill likelihood) (Figure 1). The proportion of high road kill risk was 0.7% for the road network at spatial unit of $1km^2$, followed by 0.5% of the species range at $64km^2$ resolution and 0.1% of the species range at $1km^2$ resolution. We also found differences in the location: the high road-kill risk areas of road network $1km^2$ model match 78% of the high risk areas estimated by the species distribution model at $1km^2$ whereas the high road-kill risk areas of road network $1km^2$ model match only 5% of the risk areas obtained from species distribution at $64km^2$. The three models did not show any differences concerning the quality of models, which may be explained mainly by two reasons: 1) the species is habitat generalist, which becomes harder to find patterns of mortality risk in any spatial scale and 2) the large resolution used (the smallest one was $1km^2$). Although the central and southeast part of Brazil show high road-kill risk for all three models, we found significant differences in the location of those areas. Thus, the use of small spatial units may make more effective the performance of mitigation measures to reduce the road-kill rates.

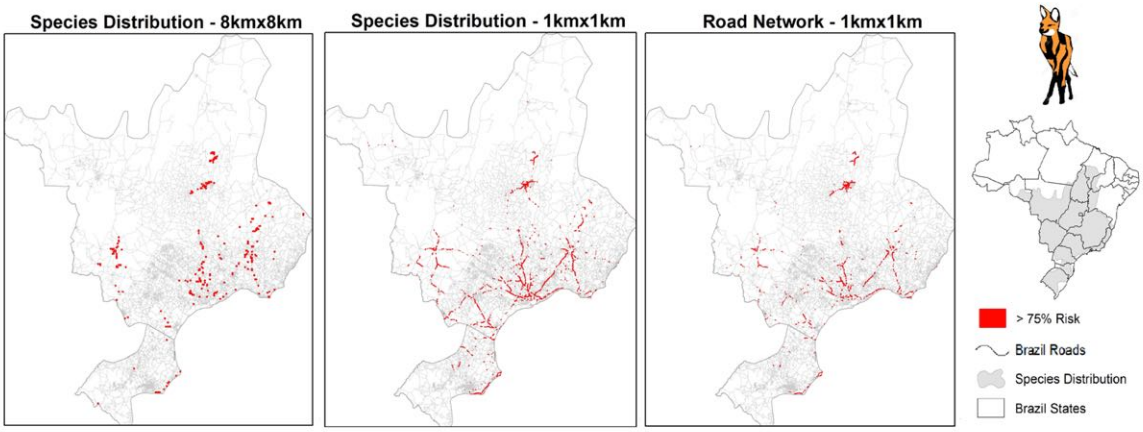

Figure 1. High road-kill risk (>75% of road-kill likelihood) showed by the three models for the maned wolf.

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ASSESSING VEHICLE TRAFFIC VOLUME EFFECTS ON MAMMALIAN PERSISTENCE: A THEORETICAL APPROACH

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Roads are recognized as one of the main drivers of biodiversity loss, altering the landscape and directly affecting wildlife population persistence. Wildlife road mortality, due to vehicle collisions, has substantial effects on population density, and the evidence suggests that it can have greater consequences to population persistence than isolation by road avoidance behavior or any other barrier effect. The identification of causal factors of road mortality and the necessary actions to reduce it play an important role in biodiversity conservation context. Although the effects of roads and traffic volume on animal population persistence have already been extensively documented in the literature, understanding how they affect populations and their magnitude are still unappreciated. Moreover, there is an urgent call to turn ecology and conservation biology, disciplines that have been traditionally focussing on describing patterns, into more predictive sciences, if we want to reduce the loss of biodiversity. Thus, creating mechanistic models capable of describing and predicting the effects of roads on wildlife is an urgent task. Individual based models are a class of mechanistic computational models that allows the explicit inclusion of individual variation and the direct mechanistic interpretation of any complex system. Therefore, our aim here was to evaluate how traffic volume affects mammalian population persistence, using theoretical models based on data from 11 mammalian species, divided in three groups based on their body size. We developed an individual based model, simulating initial small populations (N_0=100), characterized by specific birth rates (b=0.5, at each time step), carrying capacity (2 x N_0) and mortality rates, which are determined based on the probability that an individual will be killed while crossing a road. This collision

probability considers: 1) the traffic volume; 2) a kill zone that takes into account the animal body length and the average width of vehicles (here we multiplied this value by 2 to represent a two-lane road); and 3) the animal speed while crossing a road. As it is difficult to estimate the speed of each animal species in real scenarios, we considered the median between zero (an animal immobile on the road) and the fastest speed recorded in the literature for each species. At each time step, each individual had a 0.5 probability of crossing the road. We varied traffic volume from 1 to 35 vehicles per minute and run the model for 500 time steps for each traffic value. We selected mammalian species that have their speed available in the literature and divided them in three groups, considering their body length. Large mammals: *Odocoileus virginianus* (body length = 1.51 m and speed = 1066 m/min), *Panthera pardus* (1.37 m and 999 m/min), and *Canis lupus* (1.05 m and 1066 m/min). Medium mammals: *Procyon lotor* (0.48 m and 1.44 m/min), *Nasua narica* (0.54 m and 1.62 m/min), *Didelphis marsupialis* (0.42 m and 0.44 m/min), and *Bradypus tridactylus* (0.54 m and 0.09 m/min). Small mammals: *Sciurus vulgaris* (0.21 m and 1.20 m/min), *Dipodomys microps* (0.11 m and 1.26 m/min), *Microtus pennsylvanicus* (0.11 m and 0.66 m/min), and *Notomys cervinus* (0.10 m and 0.84 m/min). After modelling the response for each species, we estimated the minimum traffic volume needed to cause populations to decline in each group (large, medium and small species) using a Bayesian modeling approach. We used non-informative priors for all parameters. The posterior distribution was obtained based on Monte Carlo Markov Chains, using Gibbs sampling. All analyses were conducted in the R programming environment. The median traffic volume to cause decline in small mammal populations was 22.97 vehicles/min (95%CrI: $16.45 \leq \bar{y} \leq 29.52$). For medium mammals the median was 17.03 vehicles/min (95%CrI: $-4.02 \leq \bar{y} \leq 37.41$ - Fig.1). Large mammal populations did not decline. Our results are preliminary, and at this stage of model development, we adopted homogenous values for a number of parameter to keep the model simple, although we know they vary among species. Here, we illustrate how individual based models can be used, for example, to map and select priority road stretches for mortality mitigation of target species or groups based on traffic volume, an information easily obtained and an important determinant of wildlife-vehicle collisions. (Versão em português em: http://www.ufrgs.br/nerf/index.php/producao)

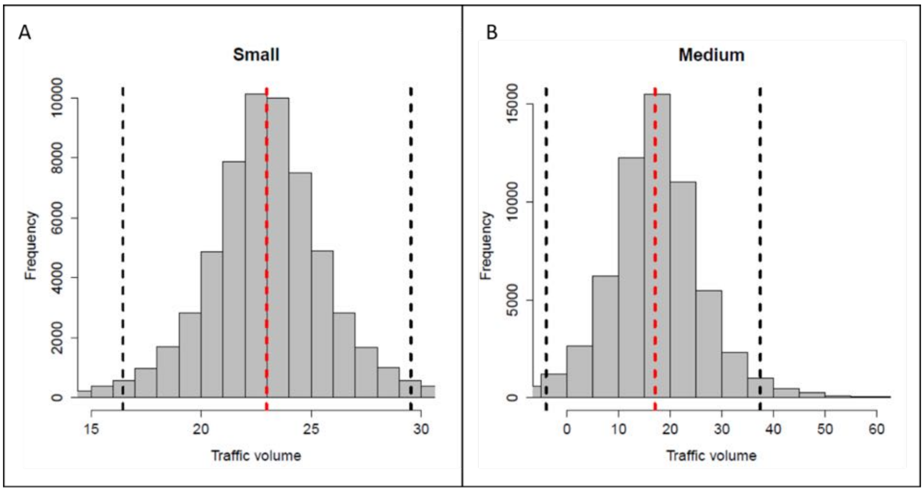

Figure 1. The median traffic volume to cause mammalian population decline (red line) and 95% Credible Interval (black lines) for small (A) and medium (B) mammals.

ASSESSMENT OF THE IMPACTS BY ROAD INFRASTRUCTURE OVER THE MORTALITY OF VERTEBRATES IN THE CENTRAL ANDES OF ANTIOQUIA, COLOMBIA

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Highways projects are a critical element for development, but the expansion of these infrastructures, as well as other major human transformation, might have negative effects on the environment. Over the last decades, highway projects along the country have affected a number of environments and processes, destroying resources like soil, fauna, flora, cultural and community goods. Roads are a new threat to biodiversity because of their critical ecological effects, such as fragmentation and destruction of natural habitats, loss of landscape connectivity, reduction of native populations and their distribution ranges, and dispersal of exotic species. Mortality from traffic is a major problem at global scale, signifying the loss of a large number of individuals from natural populations, thus becoming a main issue for biological conservation. This effect is so big that since the 80's, death by road traffic has overcome hunting as the main cause of mortality for vertebrates. In Colombia, despite several awareness campaigns from environmental NGO's, there is an information deficit in regard to the impacts of highways on the mortality of vertebrates, and few academic publications provide detailed information on the variables associated to the increase of this conflict. Therefore, it is essential to advance research surveys to understand the real impact of highways over the fauna of the country, to generate mitigation activities to improve the preservation of our biodiversity. This project aims to establish a standardized methodology to estimate the impact of highways over the mortality of vertebrates, to identify variables that can predict these effects over similar areas, and to propose mitigation actions for those impacts, thus generating key information for infrastructure

planning in Antioquia, and the development of public policies for land use and sustainability. By using cartographic information from IGAC, the Secretary of Public Works of Antioquia, and the Ministry of Transportation, the study area was established along 158 km of highways, including national (first order), departmental (second order) and municipality (third order) roads, over 7 municipalities of Antioquia. For complex geoprocessing tasks, a LANDSAT image taken on January 27th, 2016 (USGS), handled on QGIS with the Semi-Automatic Classification complement was used. Each month, four surveys along these roads were completed on a vehicle moving at 30 km/h, and including 4 observers. At each event of road-killing, several data were gathered: total distance, geographic coordinates, elevation, forest cover along the road, wetlands, weather conditions, road width, number of lines, presence of a mid-separator, speed signs, curves and slope of the segment, degree of urbanization, and use of the road. Each individual was digitally recorded before taking it out of the road, and whenever possible its gender, age, overall size, condition (fresh, recent, dry), and taxonomic identification (to species, or the lowest possible category) was taken. In a few cases, a tissue sample was taken for future use (ID barcoding) in an associated project of our group. The data on road-killed animals are taxonomically grouped by Class and Genus, to estimate abundance and density by groups or size (mass). To analyze impact of accidents along specific road sections, the diversity index of Mergalef will be calculated for seasons (dry or rainy) and months. Abundance, density and diversity estimates will be compared through ANOVA and MANOVA tests, among seasons, years, and type of roads; these same tests will be applied to compare environmental, anthropogenic and structural variables of roads. Finally, relative richness will be calculated for each road section through the year, using the kilometric index of abundance (KIA) for road-kills by kilometer and by day. Preliminary results from the first eight months (35 surveys) show clear trends on several points, which allow to present some basic analyses for the understanding of this issue in Antioquia. The largest proportion of road-kills involved mammals (47%), followed by birds (31%), amphibians (13%), and reptiles (9%); these results depart from similar studies on the country, where amphibians and birds are the dominant groups. In regard to traffic condition, second order roads accumulated 53% of accidents, followed by first order roads (33%). Some technical conditions were more related to road-kills, like proximity to closed (48%) and open (27%) curves; width between 4 to 8 m (78%); legal speed of 60 km/h (42%) and 30 km/h (33%). The dominant landscape nearby these points included cultivars, gardens, houses or tree nurseries (51%), but well-preserved forests accounted for only 7%. The incidence of road-kills is almost evenly distributed throughout the study area, with greater values nearby highly transformed habitats, which concentrate most of the 'hotspots' for accidents involving all vertebrate groups. Mammal's incidents occurred all over the study area, with highest densities nearby large gardens, tree-nurseries, and around barns or storehouses. However, reptiles, amphibians and birds show distinctive habitat associations for each. These results reinforce the need to continue with these standardized surveys and analyses, to recognize the real scale and complexity of road-killings in Antioquia, looking for an integrative understanding that might provide useful management and mitigation alternatives.

CAN DIET AND HABITAT USE INFLUENCE BIRDS ROADKILL?

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Roadkills of wild animals is among the leading causes of mortality of vertebrates by direct influence of human activities. The factors that determine roadkills may vary according to the various taxonomic groups and are related to the biology and ecology of the affected species. The difference in the number of roadkills between species can be influenced by characteristics such as diet, habitat use, mobility, population density and activity schedule. To understand the mechanisms that lead some species to be more or less likely than others to be roadkilled in a region, it is necessary to consider the levels of organization. These functional divisions, involving the biological and ecological characteristics of the species, may show which characteristics influence the roadkills in general or within the different taxonomic groups. Thus, the aim of this study was to identify the ecological characteristics of species of birds that most influence the roadkill frequency in a subtropical forest region in southern Brazil. The study was conducted on highways RS-331 and RS-420 in the northern region of the state of Rio Grande do Sul, southern Brazil. The region is in the morphoclimatic area of the Atlantic Forest biome and integrates the area of the Atlantic Forest Biosphere Reserve. Data on roadkills were obtained from two 12 km sections on the RS-331 highway and RS-420. Driving surveys were conducted by two observers. Two surveys were carried out per month, lasting five days each, totaling 10 days per month. Sampling lasted six months, from September 2014 to February 2015. The diversity of roadkilled species found was compared with the diversity of species recorded for the study area. The species of birds were categorized according to their feeding habits and habitat use. The proportion of species in each category was compared between the roadkills and the total number of species in the region. To evaluate the influence of ecological characteristics, a principal component analysis was carried out considering a matrix with the ecological

characteristics and the total number of roadkill individuals. A total of 120 roadkill individuals of birds were found. Thirty species of birds were identified. The number of roadkill species represents over 18.1% of the species of birds in the region (n = 165). Feeding habits and habitat use of the roadkill species of birds and the total species of the region show different proportions. The granivorous and omnivorous feeding habits were most common in the roadkill species. However, although omnivorous species are common, granivorous species are less represented in the region. Insectivorous species are common in the environment, but few were represented in the roadkills. Bird species that use anthropic areas and forest edges were more common in roadkills. Species occupying anthropic areas were frequent among the roadkills, but proportionally less represented in the region. Species that prefer forests are common in the region but underrepresented among the roadkills. In the principal component analysis (PCA), the first component is related to three ecological characteristics: granivorous (0.64), anthropic area (0.76) and diurnal activity (0.79) and inversely related to forest (-0.71), nocturnal activity (-0.70) and carnivorous feeding habits (-0.57). When comparing the number of roadkill species to the number of species estimated for the region, the idea that roadkills affect the species that do not avoid the highways is reinforced. Most of the species of birds found in the study area are apparently not subject to roadkills, or occur at very low frequencies in roadkill data. The use of anthropic areas and granivorous feeding habits seem to be, among the analyzed characteristics, those that increase the likelihood of roadkills. Species with the ability to use anthropic areas are more subject to roadkills because, apparently, the highway is not an effective barrier for their displacement. This condition can be applied also to species that use forest edges, since they have the ability to occupy transition areas. Granivorous species can be favored by the increase in edge area generated by the highways, since habitats with high light incidence contribute to the proliferation of grain producing plants. In addition, the loss of grains by trucks during the harvesting season may attract granivorous species to the highways. For these, the highway can function as an ecological trap, attracting individuals to the highway and increasing their chances of being run over. On one hand a few ecological characteristics seem to increase the likelihood of bird roadkills but, on the other hand, others seem to reduce this probability. Essentially, forest dwelling birds are common in the region, but little represented amongst the roadkills. These species may show an avoidance effect, common in animal groups that are dependent on the forest interior. For these species, the highway can be an effective barrier to prevent displacement and reduce roadkill. Similarly, most of the birds in the area are insectivorous and birds with this diet may move between forest fragments, possibly resulting in roadkills in fragments bordered by highways. It is possible that, in this case, the factor determining the roadkills is not the diet, but the use of the disturbed environments. Apparently, the use of anthropic areas associated with the search for prey on highways, are the characteristics that influence bird roadkills in the study area.

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CAN WILDLIFE-VEHICLE-COLLISIONS BE USED AS AN INDICATOR OF POPULATION HEALTH?

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Is wildlife-vehicle collision a chance event for the animal? Could illness prevent the animal from avoiding collision? These are frequent questions in the routine of pathology institutions receiving animals with history of vehicle collision. Over 15 animals per second die in Brazilian highways. However, many of these animals are not referred to diagnostic laboratories or veterinary institutions, for various reasons, including: degree of autolysis, distance to populated areas, and environmental conditions. Thus, the animals killed along the highways add to the long list of events classified as "motorway impact on biodiversity conservation". There is evidence of a link between infectious diseases outbreaks in wild populations and an increased number of wildlife-vehicle collisions. In an attempt to answer these questions, selected cases of wild mammals with history of vehicle collision received by our laboratory, were selected for a retrospective study. We analyzed general epidemiological information (sex, age, species, body condition, collision year, season, municipality), gross findings (integumentary, respiratory, cardiovascular, gastrointestinal-hepatic, pancreatic, urogenital, endocrine, hematopoietic and nervous) and histopathological findings. All the epidemiological information and gross findings were obtained based on necropsy reports. For the histopathological evaluation, tissues of representative organs and systems were collected and fixed in 10% neutral buffered formalin, processed following routine protocols, embedded in paraffin, sectioned at 5µm, and stained with Hematoxylin and Eosin (H&E). Microsoft Excel was used for data collection and

statistical analysis was performed based on descriptive statistics. A total of 40 wild mammals with vehicle collision reports were analyzed, distributed according with the species' taxonomic order: Artiodactyla 52.5% (21/40), Rodentia 17.5% (7/40), Carnivora 15% (6/40), Didelphimorphia 5% (2/40), Primates 2%(2/40), Cingulata 2.5% (1/40) and Pilosa 2.5% (1/40). Epidemiological parameters were also evaluated: sex- male (21/40), female (17/40); age- adult (27/40), juvenile (6/40), infant (4/40); body condition- good (29/40), regular (7/40), bad (2/40); season- autumn (6/40), spring (9/40), summer (5/40), winter (19/40). Major gross findings included: skeletal fractures (27/40), ectoparasites (21/40), skin lacerations (16/40), soft tissue hematomas (13/40), pulmonary edema (13/40), TGI-liver rupture (11/40), liver congestion (8/40), hemoperitoneum (8/40), pulmonary congestion (8/40), nephritis (8/40), liver degeneration (7/40) and pulmonary hemorrhage (7/40). Major histopathological findings included: pneumonia (13/22), hepatic vacuolar degeneration (12/22), pulmonary edema (11/22), white pulp splenic depletion (11/22), pulmonary congestion (8/22), renal congestion (8/22), hepatitis (7/22), liver congestion (6/22), and renal tubular degeneration (6/22). The frequency of skeletal fractures was as follows: ribs (7/27), femur (6/27), pubic bones (4/27) and temporal bone (4/27). As expected, main gross findings were trauma-related (skeletal fractures, skin lacerations, soft tissue hematomas, pulmonary edema and TGI-liver rupture), and only a small number were disease-related: nephritis (8/40), liver degeneration (7/40), and pneumonia (4/40). Nevertheless, histopathological evaluation showed findings compatible with disease: pneumonia (13/22), hepatic vacuolar degeneration (13/22), lymphoid depletion (11/22), and hepatitis (7/22). Only 22/40 cases were evaluated by histopathology, due to autolysis or absence of gross findings. This study shows that the majority of the evaluated animals were adults with good body condition, which could be interpreted as a loss of reproductively viable and apparently healthy individuals - a great populational impact in terms of birth rate. Further investigations are needed to evaluate more species and obtain more representative data. Animals killed by vehicle-collision could be used as useful indicators of circulating infectious and noninfectious conditions affecting wild populations. Because of the high casuistic of wildlife-vehicle collisions in Brazil, these samples are valuable tools to define the main pathological processes affecting Brazilian wildlife populations.

Medidas de Mitigação

ARE PARKWAYS REALLY GOOD FOR WILDLIFE? THE FIRST CASE STUDY OF THE RIO DE JANEIRO STATE

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Itatiaia National Park and Pedra Selada State Park protects one of the most important remnants of Atlantic Forest in Mantiqueira mountains, located in the southern of the Rio de Janeiro State. In this region, considered as world biodiversity hotspot, have been identified many endemic and threatened large terrestrial mammals species, like the giant anteater *Myrmecophaga tridactyla* (Myrmecophagidae), maned wolf *Chrysocyon brachyurus* (Canidae), jaguar *Panthera onca*, puma *Puma concolor*, oncilla *Leopardus guttulus*, eyra cat *Puma yagouaroundi* (Felidae), White-Lipped Peccary *Tayassu* pecari, Collared Peccary *Pecari tajacu* (Tayassuidae) and also primates like northern muriqui or wooly spider monkey *Brachyteles hypoxanthus* (Atelidae). Large mammals typically move long distances every day to maintain their often large territories, increasing their probability of encountering roads and be roadkilled. The roads are recognized as one of the greatest threats to biodiversity conservation, because promote among other things, habitat loss, fragmentation of natural landscape, alter the hydrology, microclimate, interrupt dynamics of wildlife populations causing isolation by barrier effect or reduction of populations due to animal vehicle collision. The loss of individual caused by roadkill can be especially impactful on low densities species. In this context, due to lack of information on the impact of roads on wildlife in the surroundings of Protected Areas in southern Rio de Janeiro State, we studied the impact of the Parkway RJ-163 (28km) and BR-354 (27km), from August 2013 to July 2015, in the vicinity of the Protected Areas above cited on wild mammals to: (1) recording roadkill mammals; (2) identifying the factors that influence the accidents; (3) analyze it´s seasonal variation;

(4) identifying their spatial distribution; (5) suggest the implementation of mitigation measures and wildlife protection. The roads were monitored twice a day, three days per month, during twenty four consecutive months. The species identification, date, and GPS location was recorded for each accident recorded. After two consecutive years and 192 hours sampling effort, equally divided between the BR-354 and RJ-163, were recorded 87 roadkill mammals, from 26 different species belonging to 15 families. Each road had accidents with 18 different species. The Parkway RJ-163 was responsible for 74% of the accidents registered. Most of the identified mammal species were medium-sized (n=12), then large-sized (n=10) and, at last, small-sized (n=5). Only five species were responsible for 60% of records: Big-eared opossum *Didelphis aurita* (35,63%), Brazilian porcupine *Coendou spinosus* (8,05%), Domestic dog *Canis lupus familiaris* (5,75%), Four-eyed Opossum *Philander frenatus* (5,75%) and Capybara *Hydrochoerus hydrochaeris* (4,60%). Four species, that are nationally listed as "Vulnerable" to extinction (MMA 2014), were found: eyra cat, maned wolf, giant anteater and oncilla. These last two animals are also internationally listed as "Vulnerable" (IUCN Red List of Threatened Species). The Maned wolf and Black-horned Capuchin *Sapajus nigritus* (Cebidae) are internationally listed as "near threatened". Most of the mammal species (65%) are considered to be of "least concern" (BioBrasil 2012, IUCN 2016). The species richness estimator (the first-order Jackknife) produced estimates (30,11 species) greater than the actual recorded species richness. Thus, only 86,66% of the road kill diversity was recorded by the estimator. The rarefaction curve of species accumulation did not achieve stability during the months of sampling. An average of 2,36 species were added each month, with a maximum of five species additions between July and August. The mortality rate was 1,4 mammal km^{-1} (BR-354) and 1,8 (RJ-163). The average of roadkill during the two years of monitoring was 4,35 mammals km^{-1}. The mortality was significantly higher during the wet season (69,5% of total). Analyzing a 1km buffer around the roads, it was identified that the most adjacent landscape of RJ-163 is composed by livestock and crop fields, dominated by pasture and grasslands (61,6%), followed by forest cover (36,1%) and urban areas (2,4%). On the other hand, in the BR-354, most adjacent landscape in BR-354 is composed by forest cover (56,3%), livestock fields (40,3%) and urban areas (3,3%). After analyzing the number of times that great rivers cross the roads, we have identified that RJ-163 has more than twice the

number of crosses (n=7) than BR-354 (n=3). Regarding logistic regression models, livestock and crop fields vegetation cover, both matrix effect models, were associated to the small mammals. In turn, the elevation was negatively correlated with the number of roadkills and positively with increase travelled distance. About 68% of roadkill records were made in the first half (1-15km) of both roads, where the maximum altitude was 644m in RJ-163 and 745m on the BR-354, with altitudinal variation respectively 156m and 468m. In these first 15km of the road, the predominant vegetation was grassland (> 80%, IR-163 and> 60%, BR-354). In the other half of roads (15-28km) there is a significantly increase altitude (RJ-163 = 650m; BR-354 = 745m) and also increasing dominance of forest cover in the vicinity of the road (> 80%, RJ-163 and > 90%, BR-354). In these second half of the roads, the number of roadkill were much smaller than in the first half, although more species were found in this sector, where the roads are closer to the protected areas. Although the roads are similar in many aspects such as length and the type of vegetation around, we would expect that the Parkway RJ-163 had the lowest number of roadkill, because it has mitigation structures installed, including wildlife crossings, in combination with fences. According to our results, these mitigating measures are not effective in reducing the number of roadkill when compared to a road that does not have these. Critical points were identified and require the installation of physical speed bumps or automatic radars with wildlife signs that indicate wildlife crossings. In addition, the continued monitoring of roadkill and the addition of monitoring of wildlife crossings and surrounding these with the use of camera traps are needed to improve the understanding of this case. The implementation of Parkways and the installation of mitigation measures to reduce wildlife roadkill should be made more cautiously and with accompanying environmental agencies in order to avoid incomplete and ineffective measures. For example, until now the wildlife crossings over the road are incomplete and are considered a joke by the local residents.

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FISH PASSAGE AT THE NORTE-SUL RAILROAD, BOIS RIVER- CASE STUDY

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The EF-151 Norte-Sul Railroad is the largest railroad in Brazil. It starts at Maranhão State and ends at São Paulo State, totalizing 1976 km of extension. The construction of a railroad is more impactful to the near environment than a construction of a highway because the restricted limits of inclination does not allow flexible changes in its tracing; therefore, it influences many natural areas. These natural areas include some wetlands where occur different species of fish and others species that depends on seasonal water variation. The conflict between these areas and the linear constructions (railroads, highways,...) happens because in that zones the technique of construction is very aggressive in environmental terms. In order to keep the road in the right place the soil under embankment cannot sag. To ensure this, engineers uses a classical methodology, which consist in removing a big amount of soil under embankment and substituting it by rocks. This technique provides required stability to construction and allows the water flows between both sides, solving the hydraulic problem. At a certain point, the Norte-Sul Railroad crosses a river called "Bois" where the river has a large curve. During the rainy season, when the river level ascends, the water extrapolates the bank and floods throughout the region creating a parallel canal to the riverbed. When the river level lowers occur a water accumulation in the inner curve region, keeping waterlogged throughout the dry season and the following year, reconnecting to the original river. After attest to the great presence of fish populations in the region during the dry season, it was found that the site is a nursery for fish. The blockage caused by classical railroad construction would put at risk the entire life cycle of the local fish fauna. Seeking for solution to the problem, it was installed a double circular culvert of 1.20m diameter to function as a fish passage (Fig. 1). Technically, the culvert function as an orifice, once the water level reaches its height, it works at full capacity. Field observations show that fish populations makes use of the passage stating the feasibility

of its use. After the detection and resolution of this problem the same technique was implemented in others two points of the Norte-Sul Railroad, where we also have attested their use by aquatic populations. Unfortunately we had no time between the detection of the problem and culvert installation to do a better accurate predictor of local fish populations to be sure which species and to what degree there was the positive impact the installation of the passage, but even so we are sure that the adopted solution was helpful. We understand that the problem detected at this point of the railroad occur in all linear constructions and compromises the aquatic local life requiring greater attention during the licensing process. The technique adopted is very simple and must be made in order to improve the applied technique.

Figure 1: Fish passage at Norte-Sul Railroad, dry season. Source: ATERPA/EBATE

LONG-TERM MONITORING OF WILDLIFE CROSSINGS STRUCTURES IN THE ATLANTIC FOREST, ARGENTINA

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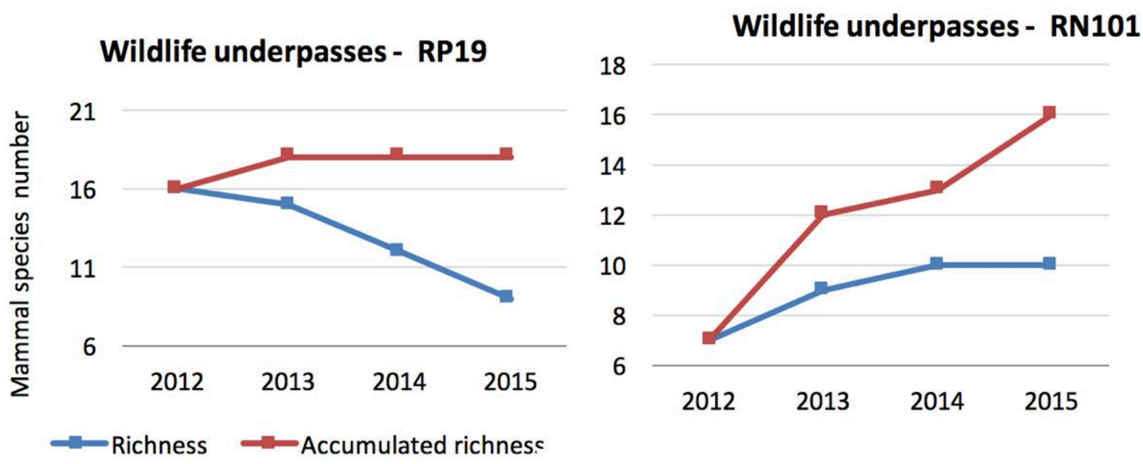
The current increase of transport infrastructure in Latin America represents a serious threat to habitats and species in biodiversity hotspots. Nowadays, new roads break through protected areas and biological corridors, and old dirt roads are being paved, thus decreasing ecological connectivity and increasing wildlife road-kills. The subtropical forests of north-eastern Argentina (Misiones Province) are considered one of the major and best connected remnants of the whole Atlantic Forest eco-region, sustaining healthy populations of large mammals. However, increasing of paved roads in Misiones is affecting threatened species as jaguars and tapirs. Wildlife crossing structures are uncommon in Latin America and there are only few known cases of mitigation measures designed to minimize the impact of roads on Neotropical wildlife. During the last years, the Road Administration of the Misiones Province showed an increasing commitment about wildlife issues undertaking the construction of the first wildlife passages (underpasses) of Argentina and the first wildlife overpass (ecoduct) of Latin America. The aim of this study was to evaluate long-term performance of seven wildlife passages located on two roads (RP-19 and RN-101) within and around Urugua-í Provincial Park (84,000 ha). The RP-19 cross through the park and have four small underpasses without streams (three 2m wide x 2m height, and one 4m w x 2m h) built 22 years ago, whereas RN-101 border the park and have two medium-sized underpasses (4m w x 3.5 h, 5.5m w x 3.5 h) and one wildlife overpass (40 m width) built in 2008. Wildlife passages were monitored by camera traps (Reconyx RC60OH) to record large- and medium-sized mammals use. All cameras operated 24h per day. The overpass was monitored for five years (2011-2015) and underpasses for four years (2012-2015). Total sampling effort was 4,740 camera-days. To ensure independence, consecutive photographs of the same species within one hour were excluded. Wildlife

Crossing Use Index (WCUI) was defined as the ratio between independent crossing events and sampling effort (camera-days). Till now, 28 species of large- and medium-sized mammals were recorded in the seven wildlife crossings. This represents about 80% of all species potentially present in the region. Tapir, Brazilian Dwarf Brocket, Red Brocket, Collared Peccary, Paca, Puma, Ocelot, and Oncilla were recorded, among others species. The WCUI in the oldest underpasses of RP-19 were more than tenfold greater that in RN-101 underpasses. However, only the wildlife crossings of RN-101 (over- and under-passes) showed an increase in WCUI and in the number of species recorded across years (Fig. 1), revealing a process of progressive species adaptation to the structures after its construction. In last years, some underpasses of RP-19 showed a decrease in WCUI possibly due to management problems, such as excessive water accumulation or anthropogenic disturbances (road maintenance works). The flooding of passages affects medium-sized mammals, mainly carnivores. Twenty-five of the 28 mammal species registered to date utilized the RN101's group of 3 passages (ecoduct and underpasses). Instead, only 19 species used the group of 4 underpasses in the RP19. However, these ones were used at higher rates by 4 ungulate species, including tapirs. These results indicate that wildlife crossings provide safe passage for Neotropical mammals on roads of Misiones. Nonetheless, species like jaguars and white-lipped peccaries were not recorded using wildlife crossings yet. Long-term monitoring will allow a better understanding of species adaptation to these structures and will lead to better planning of mitigation measures for Latin American roads.



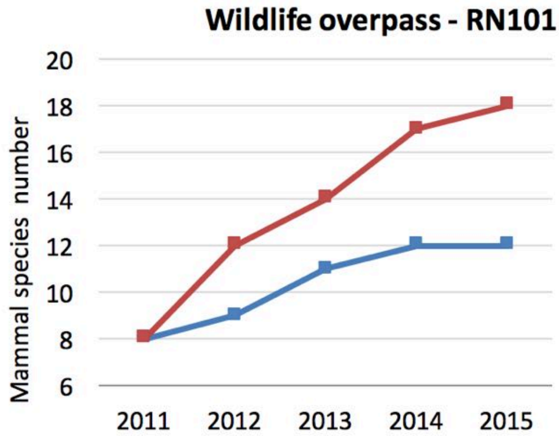


Figure 1. Annual changes in species richness recorded in wildlife passages of RN101 and RP19, Misiones Province, Argentina.

Acknowledgments: Dirección Provincial de Vialidad (DPV), Gobierno de la Provincia de Misiones.

THE USE OF FAUNA UNDERPASSAGES ALONG THE RAILWAY BETWEEN APARECIDA DO TABOADO/MS AND RONDONÓPOLIS/MT

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Designed to connect habitats, fauna passages make possible the transposition of roads and railways by the surrounding fauna, besides allowing the reestablishment and maintenance of populations and metapopulations. Underpassages are the kind of passages most used along Brazil roadways, and the ones studied on the present work. There are many interpretations about fauna passages functionality, and that is why the monitoring post construction is essential. Structures monitoring may assist the identification of possible improvements and a database consolidation that support future decisions. Based on this information, we monitored the effective use of 67 underpassages installed under railway ground along its 752 km connection between Aparecida do Taboado-MS and Rondonópolis-MT, also checked the efficiency of the methods used to collect data. Each structure were monitored for 10 consecutive days with two trap cameras, one at each passage end, a total of 134 traps. Four different types of structure were monitored; fauna passages (PF), cattle passage/fauna passage (PG/PF), bridges (PT) and ecological galleries (GE). As a complement to the monitoring, three track plots at each exit of the structures were installed (402 plots). We reviewed these plots every three days for 10 days, in order to identify the animals that moved around the passages but not necessarily crossed through the structures. We registered 1,387 specimens during three monitoring campaigns, belonging to 29 species from Mammalia Class. Those specimens are distributed among eight Orders: Artiodactyla (N=6), Carnivora (N=9), Cingulata (N=5), Lagomorpha (N=1), Perissodactyla (N=1), Pilosa (N=2), Primates (N=1), Didelphimorphia (N=1) and Rodentia (N=4). About the methods: the trap cameras registered 670 animals, the track plots 370 animals, direct

visualizations at the passages surrounding areas registered 347 animals. The species that most used the passages were *Tapirus terrestris* with 182 registers, *Cerdocyon thous* with 103 registers, and *Hydrochoerus hydrochaeris* with 47 registers. Analyzing diversity in each passage, most diverse structures were PG/PF16 with H'=2.44 nats/ind., PTE14 with H'=2.30 nats/ind., and PTE02 with H'=2.29 nats/ind. We noticed a variation on groups, by the similarity comparison among the different underpassages type, in which most groups presented similarity under 0.8 (cut point of 80% similarity). Only one group pointed out with 85% similarity, formed by structures PG/PF01 and PG/PF17. This group presented high similarity mostly by presence of species like *Cerdocyon thous*, *Chrysocyon brachyurus*, *Euphractus sexcinctus*, *Mazama gouazoubira* and *Tapirus terrestris*, with *Dasypus novemcinctus* registered only at PG/PF17 (Fig. 1).

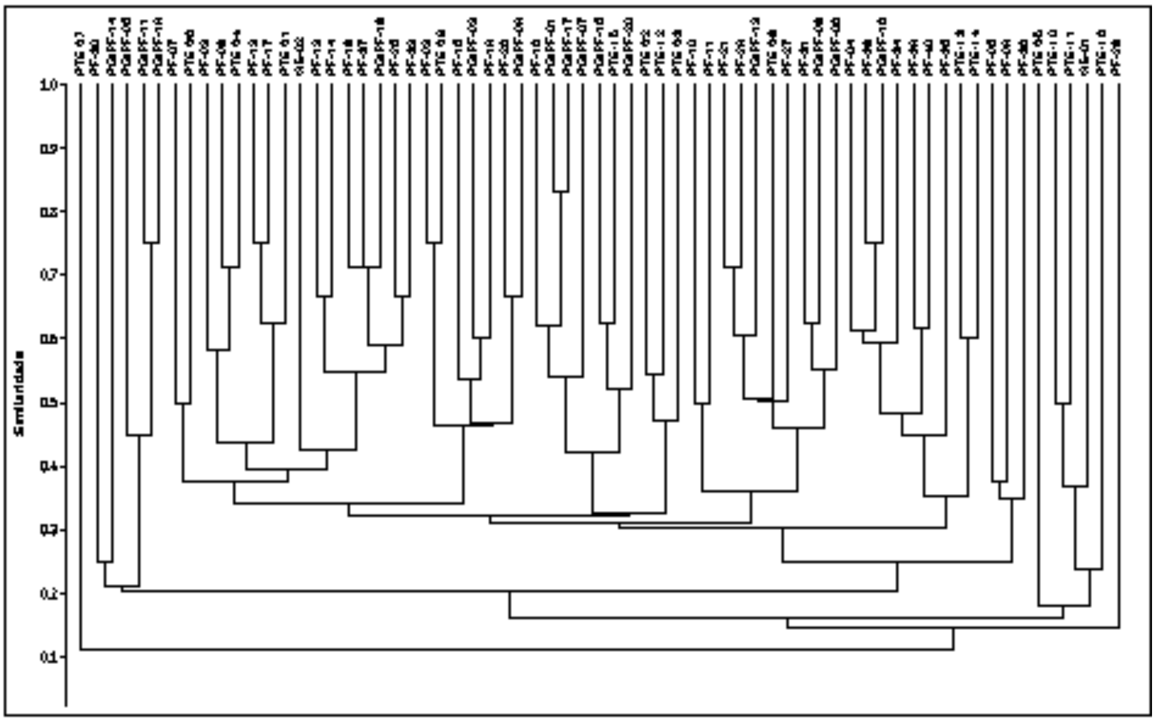

Figure 1 – Similarity dendrogram between structures studied during the campaigns.

Underpassages registered as most diverse and more similar are structures installed as to attend both wild fauna and domestic fauna, and structures that are by their original design already wider. Therefore, we noticed that underpassages are very important means for fauna movements and that they apparently use more embracing passages.

Acknowledgements: We thanks RUMO ALL Logistic for the support and all the contributors involved in field data collection and work analyses.

MAINTENANCE AND EFFECTIVINESS OF MITIGATION MEASURES CONCERNING ROADKILLS: THE CASE OF SP 322

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Highways are the main modal in Brazilian transportation system and from its implementation and duplication arise numerous environmental impacts. Some of these impacts have negative effects on biodiversity, such as the reduction of vegetation cover with consequent habitat loss and increase events of wildlife collisions. Road environmental licensing statewide is done by São Paulo State Environmental Agency (CETESB) and includes, amongst others, the implementation of mitigation measures concerning wildlife roadkills. The study case comprises the section between km 343+500 and 391+032 of highway Armando Salles de Oliveira (SP 322), located at the northwest of São Paulo State about 360 km from the capital, passing from Sertãozinho to Bebedouro municipalities and currently operated by Vianorte concessionaire. This highway section was duplicated between the years of 2001 and 2007, and due to environmental licensing requirements five wildlife crossing structures were established near remnants of native vegetation fragments – two of them built as underpasses combined with culverts for watercourse crossing (km 348+500 and 355+300) and three as dry underpasses (km 372+000, 382+600 and 387+900) –, as well as fencing and warning signs. This study investigated the adequacy of those implemented measures, both in relation to its effectiveness as to its proper location. Wildlife roadkill records registered by Vianorte technicians and presented in Annual Operation Reports submitted by the concessionaire to CETESB from October 2009 to October 2015 were analyzed, providing information about the date, location and popular name of the animals involved in roadkills. Based on those data, collision hotspots were identified in the highway section analyzed, and a technical inspection was carried out in April 2016 in order to identify general conditions of the existing mitigation measures, including wildlife underpasses. Between 2009 and 2015, 502 wild animals roadkills were recorded

at this duplicated section of SP 322, belonging to at least 39 different species, some of them endangered species in Brazil, like the giant anteater (*Myrmecophaga tridactyla*), lesser anteater (*Tamandua tetradactyla*), maned wolf (*Chrysocyon brachyurus*) and puma (*Puma concolor*). Amongst the roadkill records, capybaras (*Hydrochoerus hydrochaeris*) accounted for 45% of total occurrences (N=224), armadillos (*Dasypus novemcinctus*) for 11% (N=56) and tapitis (*Sylvilagus brasiliensis*) for 9% (N=45). We identified the main hotspot between km 359 and 361, responsible for about 22% (N=109) of total roadkill records on the highway section. It is also worth mentioning other hotspots between km 346 and 348 (10%, N=49), at km 355 (5%; N=25), 372 (6%; N=30), 378 (3%, N=14) and 390 (2%; N=11). The main roadkill hotspot corresponded to Mogi Guaçu river crossing and its adjacent fluvial vegetation. At this spot, the highway crosses the river over a bridge that does not have any fencing around it, allowing easy animal access into the road. This free and constant movement resulted in massive capybaras (an animal typically associated with water environments) roadkill during the period analyzed, with 32% (N=72) of the species records in the whole road section. Three of the other identified roadkill hotspots curiously coincide with the location of the wildlife underpasses (kms 348+500, 355+300 and 372+000). The technical inspection attested that those underpasses were design for the crossing of a wide range of animal sizes, and were all clean and clear at the day of the visit. However, although there were wire fences of about 500 meters length along the roadside, they were not appropriate in height (approximately 1.5 meters) and were not buried into the ground, allowing the passage of burrowing animals such as armadillos, and jumpers such as capybaras. At several points the fence was damaged, indicating previous access by humans and a consequent facilitation to fauna escape into the road. Also, in the wet underpasses that coincide with roadkill hotspots (km 348+500 and 355+300) it was noticed that fences were broken in the immediate surroundings and there were no dry steps inside the culverts, making it impossible for access of animals without any water contact. The underpass in km 372 is also used sporadically by the borderer property as a motor vehicle passage, even bearing height limit sign inside it. As a result, among the mitigation measures adopted and analyzed, fencing presented major problems in its implementation and maintenance, allowing the wild animals to access the highway and often causing roadkills. The location of the underpasses proposed during the environmental licensing process was adequate, verified by the coincidence of underpasses and roadkills hotspots, but the maintenance of other measures, such as fencing, was proved to be also an essential factor to its effectiveness. Furthermore, given the possibility of identifying new critical points during highway operation, mitigation measures should be implemented in those places, emphasizing the need for constant maintenance and checking its sufficiency through roadkill data records.

Acknowledgements: We thank concessionaire Arteris/Vianorte and its environmental team for cooperation and monitoring in the field.

ENVIRONMENTAL GUIDE: WILDLIFE FRIENDLY ROADS

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For developing countries in Latinamerica is essential to harmonize the relationship between infrastructure development and biodiversity conservation. Roads are used as an indicator for development growth, so it is expected an accelerated increase on road construction projects in the region. The impacts of roads on wildlife have been extensively studied in North America and Europe. Significantly, in the central region of America research on this topic and measures to reduce traffic impact on wild life are scarce. In Costa Rica, Road Ecology research started in 1996. Since then, valuable data was collected and the evidence of roads impact on the biodiversity of Protected Areas. Even with this amount of information generated, few measures have been implemented in road development projects. It is therefore important to find a tool to decrease the impacts on environmental vulnerable areas by the growing road development. To address this need an Environmental Guide "Wildlife Friendly Roads" was elaborated. Previous initiatives of research and mitigation actions were valuable but disperse and isolated. With this tool it is intended that the identification of the impact and measures to decrease it, would be a requisite for roads projects to obtain their Environmental Viability. We provide this tools to government agencies and other entities involved, to improved the roads planning, construction and operation in behalf of wildlife respect, protection and conservation .This toolbox through adjustments to the characterization of each Central American country, can become the basis for each them, to build their path to the decrease of roads impact on this biodiverse region. This guide was developed based on the review of Road Ecology literature at national and international levels, experts' consultation and the study of the Costa Rican environmental legal system. As validation process a workshop was developed with representatives of government agencies and other sectors involved and the document was reviewed by 23 national and international (Spain, USA and México) professionals

(road ecology-road construction, planning and financing-wildlife management-biology- government agencies-legal). Technical Guidelines are the core of this toolbox. The first guideline is the identification of Environmentally Fragile Areas and Wildlife Vulnerable to Road Impact, as a basis to determine if the road project requires continuing fulfilling the guidelines. If it is the case, the next step is the identification of Wildlife Crossing sites in the project area as a basis for the implementation of specific Environmental Measures to reduce the local impact of road development. We have identified that the planning phase of a road project is the most important. It is where scientific information from Wildlife crossing sites in the project and suggested mitigation actions should be referred and included in the design of the road project and the costs of the measures included in the budget. The Guide was made official by the National Council of Conservation Areas of the Ministry of Environment and Energy of Costa Rica and currently is used as a reference by other institutions as the Ministry of Transportation to hire profesional for the scientific study on the impact of diverse projects the will be developt in the next five years, an example of them is expansion of Route 32 in the Caribbean side by a Chinese company.

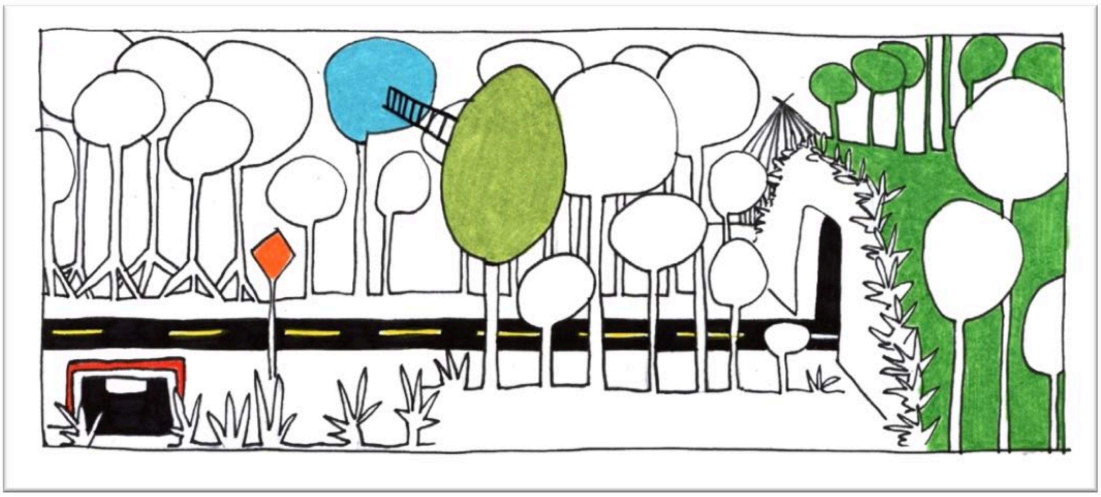

Figure 1. Environmental Measures on Wildlife Friendly Roads

Métodos e Diagnósticos

A MODEL TO DETERMINE FAUNA PASSAGES ON THE ROAD CROSSING THE CONSERVATION AREA GUANACASTE, COSTA RICA

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Like biological corridors, crossings wildlife (wildlife crossings) can reduce roadkill and increase the movement and dispersal between populations and that can meet vital requirements in response to changes and anthropogenic disturbances, also maintains metapopulation long term and ecosystem processes. There are many models to design crossings wildlife, one uses circuit theory, which identifies areas where movement is restricted and quantify the extent of the landscape that contributes to connectivity, this allows decisions and establishing mitigation measures to reduce mortality on the road and increase functional connectivity. According to the above, we developed a model connectivity to identify potential wildlife crossings in the Pan American North highway crossing the Conversation Area Guanacaste (ACG). In the ACG, there are 15 culverts under the highway and are used as fauna passages for many wildlife species. Among the species most frequently crossing through these culverts are the ocelot (*Leopardus* p*ardalis*), which was used to develop a model of functional connectivity over the area surrounding the road. The model consider ocelot mobility through road using conductance values (resistance) of this species, the different land uses that exists around this road. A buffer area of a rectangular shape of 14 x 13.5 km was delimited, trying to include the area where culverts are located 15 delimited. This area buffer (Shape) and parallel to the road, focal patches or sources dry forest forests_they were identified, where there has been the presence of ocelots was identified. The model was constructed according to the theory of circuits using Circuitscape 3.4.5, developed to determine the most likely sites where ocelots cross the road. This model of functional connectivity for ocelot (Figure 1) indicates the areas in which the movement is likely to occur (intense red), except for the site to the north, where there are culverts. The location of culverts coincided with the areas of greatest connectivity for ocelot, three of the areas of road with good connections do not have culverts or fauna passages (black arrows), according to the model. In the southern part of the road, where connectivity is more marked and continuous culverts have an appropriate location, because all four culverts are located in seasonal streams, which maintain riparian forest edges and in the dry season are possibly used as roads mainly cats. The model showed three areas of high mobility with no culverts, and which must be made mitigation measures to maintain the connectivity. Were also identified culverts at sites with high connectivity but were not used by ocelots, which was attributed to restrictions on the size, shape and material of the culverts. The species that are more mobile, as the ocelot, would be better able to adapt to the loss of habitat by roads, as shown on the map. The connectivity model shown in this paper presents a simple and quick way to get an idea of the state of connectivity between forest patches on both sides of the road, but must be tested in more detail in future studies and the same way for other mammals with similar characteristics and requirements of mobility

Acknowledgments: JS and LT were supported by the project: *Impacto de las carreteras que cruzan Áreas Protegidas de Costa Rica* and financially supported by National Geographic, ICOMVIS-UNA.

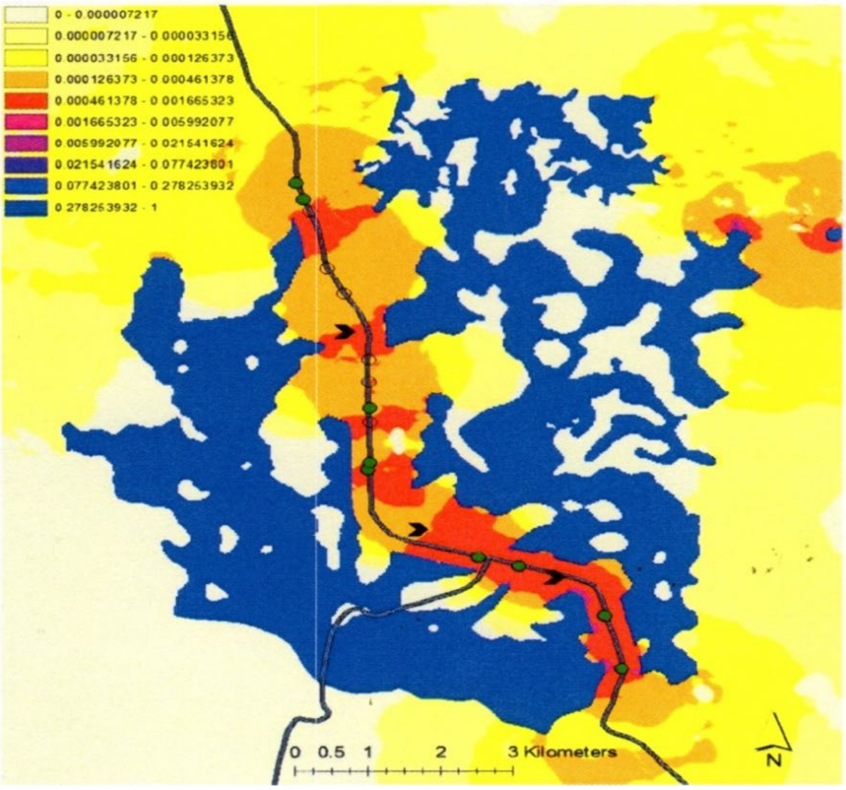

Figura 1. El color rojo intenso muestra alta movilidad (cruce de carretera). Las fechas negras señalan sitios de alta conectividad sin alcantarillas según el modelo. Functional map conductivity (mobility) for ocelot on the road that crosses the Guanacaste Conservation Area, Costa Rica. Circles are areas with culverts. Intense red color shows areas of high mobility (road crossing). The black arrows indicate high connectivity without culverts sites, according to the model.

HOW TO DECIDE THE SAMPLING EFFORT: A CASE FROM SC-290 ROAD, SANTA CATARINA, BRAZIL

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The construction of roads was one of the main human disturbances with great impacts on the landscape in the 20th-century and roadkill became, since then, a major threat to wildlife populations. In Brazil, it is estimated that more than 475 million native vertebrates are killed each year. Nevertheless, the knowledge about the topic is precarious in Brazil, with little and unreliable information due to small sampling effort used in some technical reports. In 2013, through the Normative Instruction IBAMA 13, a standard methodology was created for environmental impact assessment, which had set a minimum survey period of once a month over one year. Therefore the aim of this study is to compare the mortality rates estimated from different sampling designs to the estimation from a larger effort in order to determine their reliability. To do so, we used a roadkill survey dataset from the mountain pass SC-209 in Praia Grande, Santa Catarina State, which is 15.63Km long. The roadkill survey was conducted from November 2014 to December 2015, following the IBAMA's Normative Instruction nº13/2013. We did daily surveys, except weekends, holidays and days with some other impossibilities, totaling 162 days and 201 vertebrate carcasses found (from amphibians to mammals considering also native, domestic and exotic animals). To estimate the mortality rate we took into account the detection probability (*D=0.4*) and the removal rate (*Tr= 2.64*). We calculated *D* as the ratio of detected carcasses by car surveys to the detection by foot. The *Tr* was estimated based in the monitoring of 75 carcasses using the Software SIRIEMA 2.0. From our dataset we selected 20 different subsets with four different sampling efforts (five replicates each, randomly selected): one single day, fortnightly (24 surveys); one single day, monthly (12 surveys); two consecutive days, bimestrial (six surveys); three consecutive days, quarterly (four surveys); and the total dataset. For each subset we estimated the mortality rate using the software SIRIEMA 2.0, and for the analysis we calculated the interval as the mean number of days between surveys. Then we compared the average mortality rate of each sampling design with the mortality rate of the total dataset, which we considered the closest to the real. The mortality rate estimated with the total dataset was 1.37 killed animals per day, which means around 550 animals killed during the 398 days of survey period. For the other sampling designs we estimated an average of 1.18 ± SD 0.1978 for fortnightly surveys; 1.12± 0.430 for monthly surveys; 1.12± 0.522 for bimestrial surveys; and 1.14± 0.217 for quarterly surveys (Fig. 1).

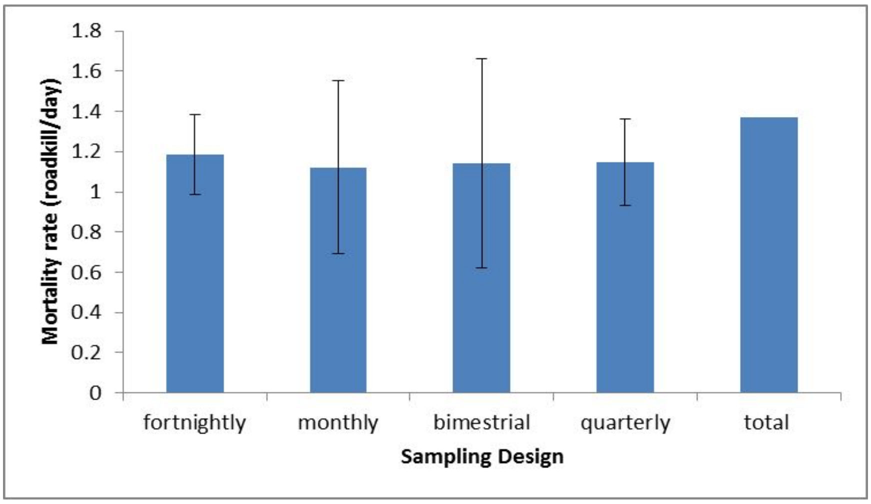

Figure 1. Average estimated mortality rate and standard deviation for five replicates of four different sample designs obtained from the total dataset of the Roadkill Survey on the SC-209 highway (16km) in Praia Grande, SC, Southern Brazil.

All sampling designs took into account the variation in mortality rates over time and space since it can be a wide source of variation. Thus, the mortality rates were very similar to each other and close to the estimation of the total dataset. However the standard deviation had a wide variation within monthly and bimestrial surveys, showing that in a particular Roadkill survey this issue's magnitude could be under or overestimated, misleading following action. Despite of the IBAMA's suggestion of monthly surveys, a bigger sampling effort fortnightly or with several consecutive days quarterly seems to be more representative and reliable. However more studies should be done to ensure the choice of the most reliable sampling design, in order to develop better action plans to mitigate or remediate the roadkill issue.

Acknowledgments: This project had logistic support from PROSUL Projetos Supervisão e Planejamento LTDA and it was financially supported by DEINFRA – Departamento Estadual de Infraestrutura. We are very grateful to the NERF - Núcleo de Ecologia de Rodovias e Ferrovias from UFRGS for their suggestions on this study and Sara Hutton for the English revision.

MOLECULAR DETECTION OF SPECIES AND GENDER IN ROAD KILLED FOXES IN URUGUAY

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Road mortality was documented as one of the main causes of vertebrate species loss. In mammals, the species vulnerability to road kills depends on body size, reproductive rate, dispersal capabilities and diet. In Uruguay foxes are one of the most road killed mammals documented, but the specie and gender recognition in road killed foxes it has not been well reported. The taxonomic identification of road killed animal's remains of great importance to analyze local biodiversity and abundance of species. Furthermore because males are in most cases the dispersing sex in mammals and maintains gene flow, gender determination is required in road killed foxes in order to analyze the impact of the roads in population's connectivity. In this study we developed a fast and reliable molecular tool for fox species and gender recognition. In Uruguay there are two wild canid species widely spread, the crab eating fox (*Cerdocyon thous*) and pampas fox (*Lycalopex gymnocercus*). We collected samples from Uruguayan roads (mostly southern roads) and stored them in 95° ethanol under 4°C until DNA extraction. To avoid contamination, tissue samples were obtained using gloves, sterile scissors and tweezers. For species recognition we designed a TaqMan™ probe Real Time PCR assay, which consisted in the amplification of a 154bp fragment of the mitochondrial DNA cytochrome oxidase II region. The hydrolysis probe that binds to the crab eating fox samples is detected through yellow channel; meanwhile the one binding to pampas fox samples is detected in the green one. The sex was determined by High Resolution Melting analysis (HRMA) of 195bp amplicons of the ZFX and ZFY genes, obtained by Real Time PCR reaction. Both Real Time PCR amplifications were conducted in the Rotor Gene 6000 (Corbett Research) equipment. We firstly tested this technique in 65 samples and we detected 56 crab eating foxes and 9 pampas foxes. The HRMA showed

a pattern of two melting curves in males and a single curve in females (Fig. 1). In our preliminary results from sex determination, we detected four males and six females for crab eating fox. On the other hand, we recognized one male and three females in pampas fox. We need to continue sexing the road killed foxes that were previously recognized as pampas or crab eating fox. The molecular tools described here proved to be powerful enough to distinguish species and gender in crab eating and pampas foxes road killed samples. To take conclusions about abundance and gene flow we need to conduct more DNA experiments from road killed foxes. In this regard we started a scientific collaboration with the ONG ECOBIO, through the project "Fauna road impacts in Uruguay" (Responsible: Hugo Coitiño).

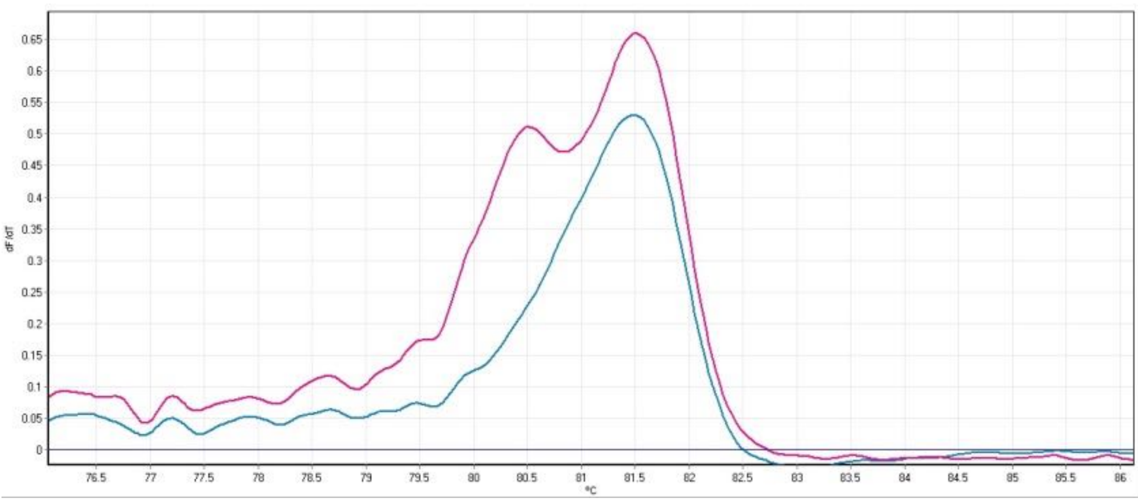

Figure 1: High resolution melting curves for females (one single peak corresponding to ZFX gene copies) and males (two peaks corresponding to ZFX and ZFY gene copies).

Acknowledgements: We thank PEDECIBA for financial support and Carolina Beloso for technical assistance in TaqMan probe design.

ROAD ECOLOGY IN THE VISION OF ENVIRONMENTAL BIOETHICS

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The benefits that roads provide are indisputable, as in transportation of people or cargo. However, the expansion of the roads directly contributes to the loss of biodiversity. Their impacts are related to fragmentation and habitat loss, roadkills, changes in migration patterns, soil erosion and edge effects. Those are likely to change distribution, behavior and survival of flora and fauna species. This study aimed to evaluate the ethical issue of road ecology under the bioethical standpoint. For this, it is essential to the identify the moral agents and patients and the values used to set the choices that generate vulnerabilities. Initially, in order to systematize the content posted in popular sources, a survey we conducted through Google browser using this terms (in Portuguese and English): "road ecology" and "roadkill". The data was transcribed into spreadsheets considering: the source (type, authors, address, origin), information (type), public participation (comments, sharing and likes). In this study, we categorized 299 pages, with 282 sites and 17 blogs, composed by 66% of private addresses, 16% public and 11% coming from the Academy. Within the problems related to the subject, 56% were related to the impacts on fauna due to linear developments, followed by its impact on flora (13%) and impact on small\medium\large domesticated animals (11%). As for the responsibility of these impacts, there was 40% for linear developments followed by drivers (19%), it was also pointed out the animals and public bodies, both with 1%. In 39% of the sites did not mentioned any responsible. Several mitigation measures and suggestions were pointed out, such as the wildlife crossings (13%), data collection for research\studies\applications (9%), driving grids\fences and awareness\population participation\environmental education\signaling\traffic signs (6%). However, measures such as not littering on the highway, carcass report to locate hotspots and also charge drivers who run over animals (1%), were not significantly indicated as means to reduce the impact of roadkills. The results of this study make

possible to start the reflection on the reach and effectiveness of the theme. This research also permits the generation of discussion about the factors cited by different sources to identify flaws in communication and seek effective solutions to the identified problems. It was noticed that despite the broad approach of the subject on websites and blogs, there is little disclosure on the issue by government sites, which corroborates with the present deficient laws aimed to mitigate the impacts of roads on natural ecosystems. In addition, it was found that the responsibility of the impacts of roadkills is attributed mainly to linear developments and drivers. Which reinforces the distance of public agencies about their manager's role in relation to this issue. Regarding the proposition of wildlife crossings and the encouragement of research on the subject, it suggests that the population thinks about the issue of roadkills, seeking to inform the main alternatives currently disclosed. Although they continue delegating the responsibility, rather than seeking ways to become actors in solving the problem. This fact it is proved by the low representation of websites and blogs that mentioned simple steps and what could the people adopt. Some examples are not litter the roads, avoiding the attraction of animals for food, respect the signs, speed limits and download applications such as "Sistema Urubu", which helps to increase the database on species impacted by roads. Therefore, the results show that the road ecology is an issue that can and should be embraced by environmental bioethics, which aims to settle dialogues between the actors involved in a complex, plural and global issue, whose only with moral and legal parameters could not be solved. Even though each day increases the management of roads by public or private enterprises, positive and negative impacts of the roads are in the interest of the entire population. This fact demands a critical role to the citizens, in order to make important decisions guided by multidisciplinary visions, especially the sectors that delegate in favor of the vulnerable.

CARCASS PERSISTENCE TIME ON THE ROADS: MORE THAN MEETS THE EYE

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Biased counts of carcasses during roadkill surveys may lead to wrong estimates of road mortality rates. Ultimately, this may lead to failure of road mitigation programs, for example by prioritizing roads according to their mortality in an incorrect way. A main source of such biases stem from the different persistence time of carcasses, which varies with the traffic volume/road type, position on the road, the carcass body size, and scavenging activity. Here we tested for differences in persistence time according to the position of the carcass on the road and the road type (related to traffic volume), while controlling for the effect of body size and scavenger presence/abundance. The study was conducted in Brasília, within the Federal District, Brazil and took place in nine roads (total 114 km), including four-lane (BR-020 and DF-001, 16 km), two-lane (DF-001, DF-345 and DF-128, 74 km), and dirt roads (DF-205 and DF-001, 24 km). We displaced two types of dead mice (fresh carcasses) along the roads: small mice (ca. 30 g), both on shoulders and lanes, every 1000 m (N = 225 carcasses); and large mice (ca. 400 g), only on road shoulders, every 2000 m (N = 169). In all cases, carcasses were placed at the earliest hours of morning. The multivariate Cox proportional hazard mixed model was used to assess differences in persistence times. Overall, the median persistence time was very low, being 2 days for the 4-lane and 1 day for the 2-lane and dirt roads. The 4-lane roads exhibited the highest persistence probabilities, reaching 0.56 (0.42-0.73, Confidence Interval) after one day and 0.05 (0.08-0.33) after four days.

The probability of a carcass being detected after being on the 2-lane road for one day was 0.19 (0.14-0.26), decreasing to 0.04 (0.02-0.09) at the fourth day. Dirt roads showed similar carcass persistence time when compared to the 2-lane roads, with a probability of persistence of 0.23 (0.14-0.38) after one day and 0.01 (0.002-0.12) after four days. We found significant differences between the four-lane and two-lane. Moreover, the persistence was lower for carcasses located on lanes relatively to shoulders. As expected, the persistence time was lower for carcasses of small body size and in sections with a higher probability of scavenger's presence nearby. The higher persistence time in 4-lane roads is probably related to the heavy traffic therein, which is likely to prevent the access of scavengers to carcasses. On the other hand, the dirt roads here studied have a significantly lower traffic volume and are embedded in areas with higher likelihood of scavenger occurrence. These results suggest that the impact of dirt roads on wildlife may have been greatly underestimated. Despite the low probability of roadkill in dirt roads (given their low traffic volumes), carcasses are rapidly removed by scavengers, leading to extremely low counts in roadkill surveys. This study highlights the importance of estimating carcass persistence rates according to road type and position and may be used for a more accurate estimate of real mortality rates.

ENVIRONMENTAL PRESSURE BY ROADS ON STREAMS OF SOUTHERN BRAZIL

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Roads can affect stream integrity and biodiversity in several ways. Engineering structures in road-stream crossings (culverts) are increasingly common and can profoundly affect aquatic ecosystems and diversity patterns. Additionally, road networks can affect the dynamics of water flow and sediment delivery into streams at the watershed and riparian scale, and by input of substances from vehicles into the streams. Effects may be local or regional, occur both upstream and downstream. Roads can be either the primary or complementary factor affecting aquatic biodiversity, interacting with other factors, such as instream habitat degradation caused by watershed landuse, habitat loss, fishing and pollution. Therefore, conservation planning and prioritization of management actions may benefit from regional assessments of the potential pressure of roads on streams. In this study, we present preliminary results from a regional assessment of the potential environmental pressure by roads on stream ecosystems of southern Brazil. We used GIS analysis and data from a 1:50.000 spatial database to assess road density, road density at riparian zones and road crossings across a 281,189 km^2 area (the State of Rio Grande do Sul). The study area was divided into 5624 hexagons with 50 km^2 and data for three road pressure indicators were obtained for each hexagon. In this study, the road pressure indicators are used as surrogates for potential road effects on streams. The first indicator, road density, was measured as the total road length in each hexagon divided by hexagon area; the second indicator is the road-crossing index, i.e., the density of intersections between roads and streams, which was calculated as the number of road crossings divided by the total stream length in each hexagon; the third indicator is road density in the riparian zone, measured as the total length of roads in the riparian zone divided

by the riparian area in each hexagon. Riparian zone was defined as a 100 m buffer at both sides of stream segments. We used reference values from the literature to determine potential thresholds for effective effects of total road density at the hexagon on stream ecosystems. We defined five road density pressure classes: none (0 km/km²), low (above 0 to 0.5 km/km²), intermediary (over 0.5 to 2 km/km²), high (up from 2 to 4 km/km²) and very high (over 4 km/km²). We found no similar information for defining thresholds for effects of road density at riparian zone and road crossing index, therefore we assumed they have a positive linear relation with environmental pressure. We assessed road pressure on streams for two biomes (Pampa and Mata Atlântica) and four aquatic ecoregions (Lower Uruguay, Upper Uruguay, Laguna dos Patos and Tramandaí-Mampituba). Here we present results only for total road-density at 50-km² hexagons. Regarding road-density, from a total of 5,624 hexagons, only 4.7% had no road pressure, 11.5% had low pressure, 80.7% had intermediary pressure and 3.2% had high or very pressure (hexagons with high urban cover). The most pressed hexagons (intermediary to very high pressure), represent 83% of the total study area; 58% belong to the Pampa biome and 42% to the Atlantic Forest biome. The Upper Uruguay is the most pressed aquatic ecorregion (96% of hexagons from intermediary to highly pressed), followed by Laguna dos Patos (89%). Nearly 80% of the study area is least under intermediary pressure caused by road density, according to threshold values taken from the literature, which suggest that a road density greater than 0.5 km/km² produces effects on the stream environment. When we compare biomes, the Mata Atlântica shows a road density pressure much greater than the Pampa, and jointly analyzing biome and ecoregion regional units, the Mata Atlântica/Upper Uruguay region is the most pressed, suggesting that conservation, mitigation and restoration actions would be needed in these locations, as well as research on effective instream effects of roads. We intend to assess the cumulative pressure of the three road pressure factors (total road density, road crossing density and road density at the riparian zone). Also, we will check whether there is a spatial coincidence between road pressured areas and the spatial distribution of threatened fish species.

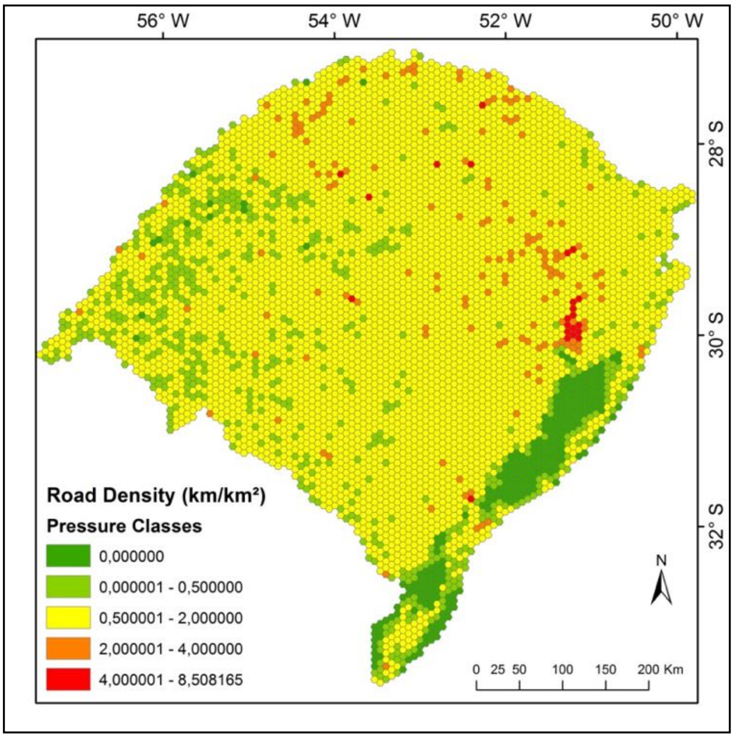

Figure 1: Study area representing road density (km/km²) in hexagons with50km².

Efeitos Marginais

EVALUATING MAMMAL OCCURRENCE AND VEHICLE TRAFFIC EFFECT IN ROADSIDE PATCHES IN SOUTHEASTERN, BRAZIL

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Linear infrastructure such as roads and railways play a very important role in socioeconomic development. However, their effects on the local and regional biodiversity can be negative, resulting in direct and indirect impacts. Despite the growing number of studies in road ecology framework, there is still few studies dedicated to investigate the responses of species activity and occurrence in relation to roads. In this study, we aimed: i) To evaluate the detection number of medium and large mammals species in patches near and far from roads; ii) to verify the influence of vehicle traffic in the detection number of species according to their period of activity. We sampled 12 patches (six near and six farm from roads), among March 2013 to May 2014 in South of Minas Gerais state, Brazil. The patches were located in three roads: BR-265 and MG-335 (near Lavras municipality) and MG-354 split in two stretches (between Lavras and Luminárias municipalities) (Fig. 1). We recorded individuals and species using camera traps. The number of traps installed were proportionally and based on patch size (ranging from two to eight cameras per patch). Vehicle traffic was monitored by using cameras (model Plotwatcher Pro Time Lapse HD Video Cam). With a sampling effort of 5.472 hours, we recorded 276 photos of 16 species of medium and large mammals. Mean weekly traffic volume was 3325 ± 247 vehicles in BR-265, 786 ± 145 in MG-335, 443 ± 59 in MG-354 (S1) and 653 ± 26 in MG-354 (S2). Traffic volume was also analyzed separately during periods from 00:00 h to 5:59 h a.m., 06:00 h to 5:59 h p.m. and 06:00 h to 11:59 h p.m. For statistical analysis, we selected only species with 20 or more detections. These species are Spotted Paca (*Cuniculus paca)*, Nine-banded Armadillo (*Dasypus novemcinctus*), White-eared Opossum (*Didelphis albiventris*), Brazilian Common Opossum (*Didelphis aurita*), Ocelot (*Leopardus pardalis*) and South American Coati (*Nasua nasua*). In order to test if species detection number was similar

in patches near and far from roads, we used Paired T-tests. To test the vehicle traffic influence on species (diurnal and nocturnal) detection number in patches near roads, we fitted Generalized Linear Mixed Models (GLMM) using package "nlme" in Software R. Of the species analyzed only Brazilian Common Opossum had higher detection number in patches near than far from roads (t = -3.9, $P < 0.001$). This difference could be related to its opportunistic behavior and the road could be acting positively in this species. Vehicle traffic volume had no influence on species detection number in patches near roads, neither in diurnal nor for nocturnal species (ΔAIC > 2). We believe that as traffic volume in these roads are low, even during the day, it is unlikely to cause negative effects on medium and large mammal species. Understanding how these species react to disorders associated to roads becomes important, since the effects of roads can change the abundance, distribution, behavior of species and in the community level change species richness and composition.

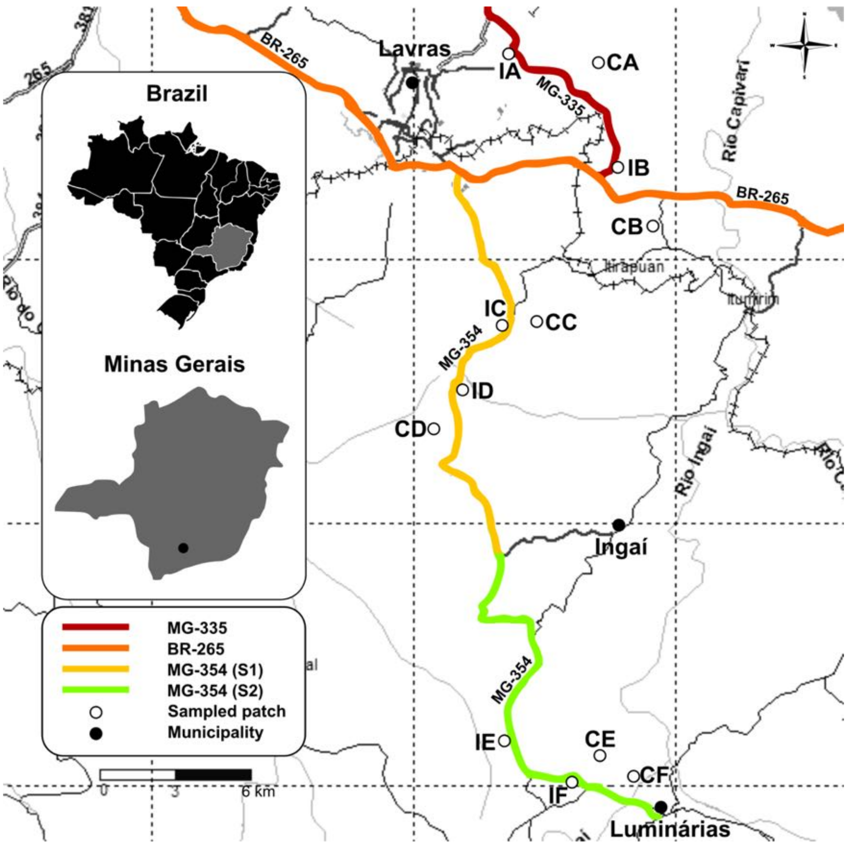

Figure 1. Sampled areas near BR-265 and MG-335 (Lavras), MG-354 (S1) (Ingaí) and MG-354 (S2) (Luminárias) in Southern Minas Gerais, Brazil.

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TROPICAL FOREST FRAGMENTATION IN ROADED LANDSCAPES: EFFECTS ON THE OCCURRENCE OF BLACK-TUFTED-EAR MARMOSET *CALLITHRIX PENICILLATA*

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Forests can be divided into smaller fragments by road construction, which can affect the availability of refuge and food resources for many species and limit their daily and dispersal movements. Although there are several primate species with high risk of extinction in small forest fragments disturbed by anthropogenic activities, some species exhibit high ecological plasticity to persist in human-modified landscapes. The main goal of this study is to assess the relative role of roads on the spatial behaviour of black-tufted-ear marmosets within the forest fragments located in the southern region of Minas Gerais, Brazil. We examine the influence of the habitat quality (mean distance between trees and mean canopy cover), disturbance (distance to the road, distance to the edge and edge type), and spatial configuration variables (spatial autocorrelation index, position within the fragment and fragment type) on the occurrence of black-tufted-ear marmoset in fragments distributed along a transition biome area between Atlantic Forest and Cerrado. We monitored black-tufted-ear marmoset groups inhabiting forest fragments away from the roads (three control fragments) and fragments close to road segments (three impacted fragments). Impacted fragments were located in an urban area at least 1 km from each other, and with an average distance of 8 m from the nearest road. All control fragments were located in a rural area at least 4 km from each other, and with an average distance of 426 m from the nearest road. We defined 0.4-ha quadrats (64 m x 64 m) as survey units within the fragments, according to the minimum size of home-range area recorded for black-tufted-ear marmosets. Six surveys were conducted between October 2012 and August 2013, totalling 432 h of observation effort (72 h per fragment). For each fragment, we conduct

a survey that comprised two periods of 6 hours of observation (from 0600 h to 1200 h and from 1200 h to 1800 h). When one individual was detected in a quadrat, the observer recorded geographical position using a GPS system. We used generalized linear mixed models (GLMM) to evaluate the variables that could explain the occurrence of black-tufted-ear marmosets in quadrats within fragments. The response variable was the number of records of species presence in each quadrat on all surveys (Poisson distribution). The Akaike information criterion (AIC) was used to rank the candidate models. We estimated 147 presence records in impacted fragments (103 edge/44 interior), and 31 in control fragments (19 edge/12 interior). Three models had best inference capacity in explaining the occurrence of black-tufted-ear marmosets within the fragments (ΔAIC<2). Model accuracy was examined to assess how well the most parsimonious model fits the data using quantile-quantile plots. The averaged model shows a significant positive association of edge quadrats in impacted fragments (impact/edge) and Zscore on the occurrence of the black-tufted-ear marmoset (Table 1). This result confirm the spatial autocorrelation between quadrats, which means that exist preferential zones.

Table 1. Parameters of the variables included in the averaged model explaining the black-tufted-ear marmosets occurrence in quadrats of the impacted and control fragments: β = regression coefficient; SE = standard error, Z-value = Z test, p-value = significance in the Z test. Road_dis = distance to the road; Canopy = mean canopy cover; Zscore = spatial autocorrelation index; Control/Edge, Impact/Edge, Impact/Forest = fragment type and position within the fragment.

Variable	*β*	SE	Z-value	*p-value*
Intercept	-2.080	0.676	-2.936	<0.01
Road_dis	-0.001	0.001	0.455	>0.1
Canopy	0.016	0.009	1.763	<0.1
Zscore	0.068	0.016	3.851	<0.01
Control/Edge	-0.030	0.372	-0.073	>0.1
Impact/Edge	0.811	0.319	2.349	<0.05
Impact/Forest	0.531	0.324	1.516	<0.1

In severe conditions of geographic isolation, the black-tufted-ear marmosets can develop adaptive behaviour on foraging and movements. In this sense, the trunks of several trees near the edge of fragments showed bite marks, which indicates that black-tufted-ear marmosets use gum exudates in their diet as observed in several studies. The need to cross to other forest fragments or to reach individual trees that produce fruit at distinct periods of the year may also explain the occurrence of black-tufted-ear marmosets at the edges of impacted fragments. We argue that black-tufted-ear marmosets is an example of "winner" species by adapting to habitat modifications imposed by human activities such as deforestation and urbanization, increasing their distribution range. The high incidence of black-tufted-ear marmosets in ecological edges represented by edge habitats in forest fragments in contact with roads is an indication of cross-habitat spillover - species tend to disperse from natural areas to human-modified areas. Besides the apparent positive impact of roads on marmosets, identifying the traffic volume and road width thresholds affecting this species is crucial to understand the mechanisms underlying the species response to roads.

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RELATIONSHIP BETWEEN ROAD DENSITY AND RICHNESS OF BIRD SPECIES IN SÃO PAULO STATE

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In Brazil, there are about 1800 species of birds, which is about 19% of birds of the world. The greatest treats to birds are habitat loss, mainly caused by land cover and land usage changes, such as expansion of agriculture, roads and urbanization. Road density is a good indicator of road expansion, and agriculture and urbanization depend of roads to expand. Thus, we analyzed the relation between road density and richness of bird species in order to evaluate the influence of roads to birds' community, in São Paulo state. Besides the total richness (number of bird species), we considered different functional groups of birds to calculate their richness: habitat type, foraging layer, endemism, extinction risk (IUCN). We used maps of roads (IBGE/DNIT) and bird species presence (Biota-FAPESP), which were divided in hexagons 1.000 km² by GIS tools. Each hexagon had its road density and bird richness (total and functional groups) calculated. For considering sample effort, bird richness was divided by the number of collection sites in the hexagon, generating the relative richness. We've done a Pearson correlation between road density and relative bird richness (total and functional groups). Correlation found between bird richness and road density was significantly positive to birds of pasture areas, birds of aerial foraging and birds of open areas; and significantly negative to birds in red list (IUCN) and endemic birds of Atlantic Forest (Table 1). In other study, Lupinetti (in preparation) evaluated the relationship between bird richness and landscape and climate parameters, showing that forest, urban areas, climate and sampling effort are relevant factors to explain bird richness in São Paulo state. To improve the results discussion, we included the results for each functional group, obtained by Lupinetti (in preparation), in Table 1. Bird groups with positive significant correlation to road density, in Lupinetti (in preparation), showed higher richness in hexagons with more urban area. Birds of pasture areas, birds of aerial foraging and birds of open areas prefer open vegetation areas where there are higher road density and

urban areas nearby, particularly in the "interior" of São Paulo state. On the other side, birds with negative significant correlation to road density, in Lupinetti (in preparation), showed higher richness in hexagons with more tree cover or more isothermality variation. Richness of birds in the red list (IUCN) was better explained by more tree cover (more forests, where habitat loss is the greatest treat). Richness of endemic birds of Atlantic Forest was better explained by more variation of isothermality. Isothermality (%) quantifies how the day-to-night temperatures (mean) oscillate in comparison to the summer-to-winter (annual) oscillations. An isothermal value of 100 indicates that the diurnal temperature range is equivalent to the annual temperature range, while anything less than 100 indicates a smaller level of temperature variability within an average month relative to the year. Species distribution may be influenced by this kind of temperature fluctuation and this predictor is useful for ascertaining such information. It seems that more species of endemic birds of Atlantic Forest is found in places with more variation of isothermality, which represents more temperature conditions and more habitats, such as *campos rupestres* montane savanna or mangroves. In conclusion, road density has a weak but significant correlation to the richness of some functional groups of birds, which could be best interpreted with support of other landscape or climate characteristics. It is also important to remember that while the road density does not show a strong correlation with the bird richness itself, it shows a strong correlation (higher than 0.5) with the density of urban areas (positive) and tree cover (negative), the best models selected by Lupinetti (in preparation).

RELATIONSHIP BETWEEN ROAD DISTANCE AND FIRE EVENTS IN ATLANTIC FOREST

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Roads expansion is one of the proximate causes of deforestation in tropics, because increases accessibility to wood extraction or agricultural expansion. In addition, fires are more frequent near roads, which degrades the forest, increasing edge effect. In Brazilian Amazonia, about 95% of all deforestation and fires occur within 50 km of roads. Roads also can create artificial firebreaks, leading to a proliferation of mesic vegetation at the expense of fire-adapted species. Atlantic Forest is also a tropical forest, but the higher topographic variation may cause a different relationship between fires and road distance than found in the Amazonia. Here we evaluate the relationship between fire events and road distance in Atlantic Forest biome. We used maps of fire events produced by *Instituto Nacional de Pesquisas Espaciais* (INPE), available at *BD Queimadas*. The fire events maps were produces using of NOAA, MODIS and GOES satellite images to detect high temperature (~427ºC) spots. An additional image processing is done to eliminate wrong fire detections during daylight caused by solar reflexion in hot surfaces. We downloaded and used month fire events maps, from January 2001 to December 2006 (6 years), of Atlantic Forest. We also used a road map (IBGE/DNIT) to create buffers of 1, 10, 25 and 50 km from roads at QGIS software. In the same software, we intersect each month fire events to road buffers, and, after, month fire events was counted for each distance zone from roads: 0-1 km, 1-10 km, 10-25 km e 25-50 km. For each month/year, only one fire event at a given location was considered in order to avoid the detection of the same fire event by different satellites or a fire event during many days. Taking this decision, we may underestimate fire events but we prefer a more conservative estimation. During 6 years, we found 244,497 fire events in Atlantic Forest. Most of them, 97%, were up to 10 km roads: 25.54% up to 1 km, 71.70% from 1 km to 10 km, 2.75% from 10 km to 25 km, and 0.02% from 25 km to 50 km (Figure

1). Most fire events, 61%, occurred in August (16.44%), in September (22.58%) and October (21.93%, Figure 1). The year with more fire events was 2003 (69,328, 28.36%) and 2001 had lesser fire events (12,175, 4.98%). In comparison to Amazonia, fire occurred nearer to roads in Atlantic Forest, most up to 10 km. It is necessary investigate what factors are more relevant to start and propagate fires in Atlantic Forest to know why fire spread less than in Amazonia. Besides roads, we expect that declivity, drought and land use may play an important role. Dry season months and some years had more fire events. Climate and land use changes could affect incidence of fire and cause this temporal variation. In conclusion, the higher frequency of fire events up to 10 km of roads points out a road impact that should not be neglected because creates more deforested areas and degraded forest in a highly threatened biome.

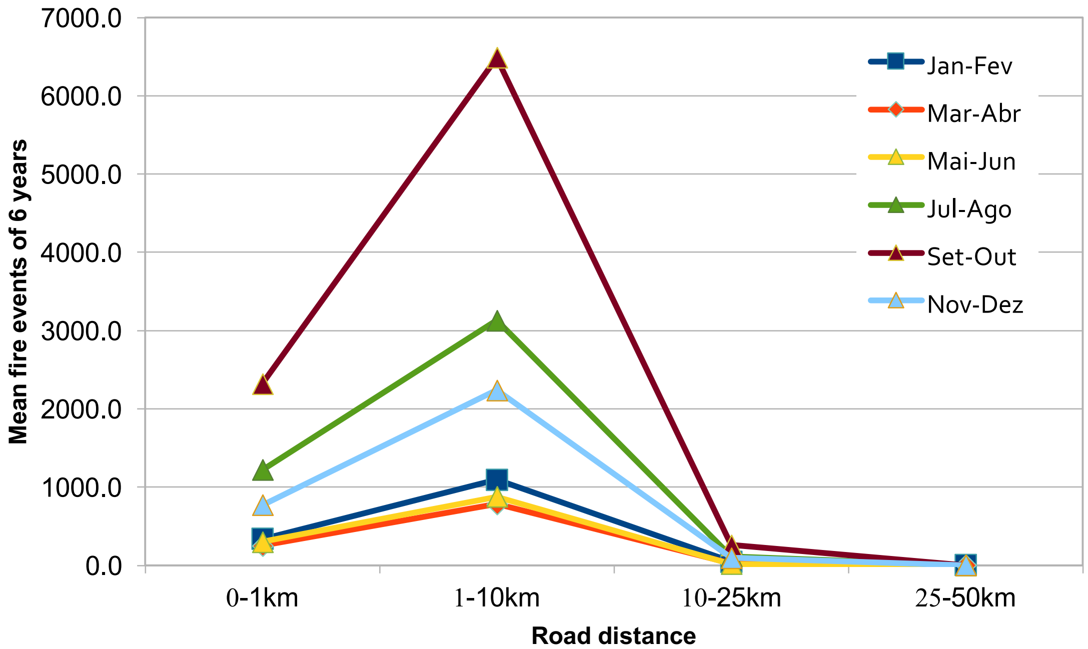

Figure 1. Relationship between road distance and mean fire events of 6 years, by each two months.

Table 1. Correlation between bird richness and road density, and best model selected by AIC in other study (Lupinetti, in preparation). * p ≤ 0.05, ** p ≤ 0.01

Bird groups	R	p	Best model selected by AIC (Lupinetti, in preparation)
Total richness	0.018	0.82	+ variation of tree cover
Birds of pasture areas (rural areas)	0.198	0.01**	+ proportion of urban area
Birds in red list (IUCN)	-0.187	0.01**	+ variation of tree cover
Endemic birds of Atlantic Forest	-0.163	0.03*	+ variation of isothermality
Birds of aerial foraging	0.161	0.04*	+ proportion of urban area
Birds of open areas	0.156	0.04*	+ proportion of urban area
Birds of terrestrial foraging	0.122	0.11	+ density of collection sites
Aquatic birds	0.113	0.14	+ density of collection sites
Birds of aquatic foraging	0.105	0.17	+ density of collection sites
Birds of midstory foraging	-0.095	0.22	+ variation of tree cover
Birds of canopy foraging	0.050	0.52	+ density of collection sites
Forest birds	-0.031	0.68	- monthly mean of daily temperature variation
Birds of understory foraging	0.001	0.99	+ variation of tree cover

EVALUATION OF THE RABIES VIRUS IN *CERDOCYON THOUS* (LINNAEUS, 1766) FROM THE FOREST THE ATLANTIC IN ESPÍRITO SANTO

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Compared to habitat loss, hunting and pollution, disease occurrence is camouflaged due to not being a visible problem when regarding the conservation of wild animal species. The occurrence of pathogens such as rabies, a zoonotic disease belonging to the *Lyssavirus* genre and *Rhabdoviridae* family, of high mortality, is reported as a major threat to the conservation of free-life wild animals, public health, and animal health. Transmitted by the saliva of terrestrial mammals and infected chiropterans during biting episodes, rabies causes an acute viral encephalomyelitis frame of a progressive character, affecting the central nervous system of all mammalian species including humans. Rabies is distributed worldwide, in Latin America countries are working to decrease the incidence of rabies in humans by controlling the disease in dogs. However, chances are that sylvatic rabies, maintained in a variety of mammalian hosts, will emerge as a new problem for public health. In addition to urbanization, population advance and, therefore, changes in the ecosystem, this leads to a decrease in food supply for several species, eating habits, and a greater contact possibility with humans, increasing the risk of disease transmission between species. In Brazil, as in other Latin American countries, studies observed a decrease in the existence of the urban cycle and an increase in the aerial, rural, and sylvatic cycles, but there are still recent cases of deaths in years when disease outbreaks are recorded. In the Northeast region, rabies transmission occurred among wild canids and humans, as well as among domestic animals, being the crab-eating fox considered the main reservoir of rabies among the wild species of the region. Brazil is a country with a complex mammalian fauna; the main animals of interest for the sylvatic rabies cycle may vary in specific and regional character. A study performed in Vitória/ES, addressing the rabies epidemiological profile in the state, suggests that the number of samples analyzed from terrestrial wild animals, in twenty years, has a small quantitative when compared to other animal species, with a total of 136 samples. This small sample may not be sufficient to demonstrate the viral circulation in wildlife species. The present study evaluated *Cerdocyon thous* individuals who were collected dead due to collision with motor vehicles, on the state highway ES-060 and were later sent to the University Vila Velha. This state highway connects the municipalities of Vila Velha and Guarapari, going through two areas of environmental protection, the State Park Paulo Cézar Vinha (1.500 ha) and the Municipal Park of Jacarenema (307 ha). Regularly, the concessionary that manages the highway monitors 67 km of the track, every hour and a half, 24 hours a day to verify the occurrence of incidents, accidents and fauna roadkill. The animals found alive and/or dead are readily collected, registered as for the location found and time of occurrence. In this study, a total of 16 crab-eating foxes (*Cerdocyon thous*, Linnaeus, 1766), were subjected to analysis aiming to investigate the occurrence or non-occurrence of the rabies virus. For this, necropsy exams were performed and subsequently encephalic material was collected after opening of the skull, performed with the aid of a dental diamond coupled to a micro-grinder. Biological samples were identified and frozen and were subsequently forwarded to the Rabies Diagnostic Laboratory - Agricultural and Forestry Protection Institute of Espírito Santo – IDAF for performance of the tests using the direct immunofluorescence technique and biological test through intracerebral inoculation in Swiss mice, as recommended by WHO (World Health Organization). All 16 samples tested negative for rabies. This confirms the state's epidemiological study between the years 1994 and 2013, which concluded that rabies in wild animals had a percentage below one in the total number of cases. This is the first rabies virus investigation in *Cerdocyon thous* from a region comprising two reserves with an area superior to 300 hectares in southeastern Brazil. Therefore, it is suggested that the cause of the accidents were not due to neurological disorders resulting from infection by the rabies virus. It is emphasized that, the results of this research demonstrate the epidemiological situation in the species involved in one part of the metropolitan region of one of the capitals of Brazil's Southeast region. Confirming the low rabies incidence in wild animals in the state of Espírito Santo, disagreeing with observations made in other Brazilian states, especially those located in the Northeast. Despite the absence of cases in the analyzed animal samples, the need for improvements in campaigns for rabies control and surveillance in wild animals can be pointed out, due to the increase in the number of specimens for laboratory diagnosis of rabies. And the use of dead animals on highway margins, besides facilitating the researchers' access to the material, it is possible to use this environmental loss for scientific gain as for research and epidemiological surveillance of wild species.

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Comportamento Animal

USE OF CUVERTS AS FAUNA PASSAGES FOR VERTEBRATES IN THE PAN AMERICAN HIGHWAY CROSSING THE CONSERVATION AREA GUANACASTE, COSTA RICA

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Wildlife passages are techniques used for decades to mitigate road impacts. The passages connect habitats, populations and increase driver safety while reducing wildlife mortality in road crossing Animal and vehicle collisions are reduced as long as passages link landscapes or habitats and allowing wildlife dispersal, move and meet their vital requirements. The most common structures classified as fauna passages include: overpasses, bridges for wildlife, expanded bridges and oversized culverts. We evaluated whether vertebrates species and individuals living on either side of the Área de Conservación Guanacaste (ACG) highway used culverts found beneath the road to move from one side of the road to the other and avoid being hit by a car. A camera-trap auto shooting Stealth-Cam or Scout Guard equipped with infrared and motion sensors was placed at the entrance of each culvert, so the photo capture angle was oriented for capturing the image of species from small vertebrates (mice) to larger mammals (deer). The cameras recorded data continuously for three months during the dry season and three months in the rainy season. To avoid pseudo-replication and ensure species and individual data independence, records was assumed and another after six hours. We used MARK 6.1 program to calculate the occupancy rate (crossing culverts) for each group (birds, mammals, reptiles and amphibians). In addition, extinction probability of no species using culverts of and colonization or specie of highest reappearance of crossing culverts of highest record was estimated using models occupancy multiple stations in the program PRESENCE. The use of 15 culverts located on the Pan American Highway as no specific passages of terrestrial vertebrates (fauna passages) is described by the occurrence of individuals and species composition in 277 events (number of

crossings) obtained by using cameras-trap. The proportion of crossing was 2% for amphibians, 4% for birds, 14% for reptiles and 80% for mammals. Table 1 shows the occupancy rate of culverts use for vertebrates depending on the type of culvert. The highest occurrence was recorded for medium-sized mammals.

Table 1. Detection probability (ρ) and occupancy rates (ψ) of vertebrate species, according to the type of culvert from the north highway crossing the Área de Conservación Guanacaste, Costa Rica.

DETECTION PROBABILITY						OCCUPANCY					
CULVERT	n	(ρ)	SE	LL(95%)	UL (95%)	AMPHIBIANS	BIRDS	REPTILES	MAMMALS (LARGE)	MAMMALS (MEDIUM)	MAMMALS (SMALLS)
Rectangular	6	0.08	0.02	0.03	0.12	0.17	0.42	0.24	1	0.57	0.38
Round A	3	0.04	0.01	-0.003	0.08	0.5	0	0.18	0	0.23	0.06
Round B	3	0.02	0	0.02	0.02	0	0.17	0	0	0.14	0
Elliptical	3	0.04	0.02	-0.02	0.11	0.33	0.42	0.58	0	0.06	0.56

LL= Lower limits, UL =upper limits

Species most frequently seen crossing included: the agouti (*Dasyprocta punctata*, n=114), garrobo (*Ctenosaura similis*, n=22), coati (*Nasua narica*, n=17), paca (*Agouti paca*, n=12) and ocelot (*Leopardus pardalis*, n=11). No differences between crossing was found between the dry and rainy seasons ($p = 0.54$), The occupation model showed that mammals had the highest records crossing and the occupancy rates (ψ) for garrobo, agouti, paca, coati, and ocelot were 0.4, 0.6, 0.2, 0.2 and 0.6 respectively. The probability of extinction (ε) for the same species was 0.64, 0.19, 0, 0.63 and 0.78 respectively. The probability of colonization (Y) for the agouti was 0.063 and for the paca was 0.061; for the other three species this parameter was not important. In short, all the parameters had a positive effect on the occupation of mammals in the fauna passages, except colonization. As the rainy season progresses, the number of mammals using fauna passages drops. We conclude that culverts work as "fauna passages" for many species of vertebrates that require road crossing in the ACG and can be a management tool to reduce the number of mammals killed on roads crossing protected areas of Costa Rica.

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CASE STUDY: EVENT RECORD ANURANS MORTALITY IN BR-448, RIO GRANDE DO SUL, BRAZIL

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The anurans are known as one of the most affected groups by constructions and traffic on roads. However, there are too few studies on this area, and most of them focuses on road-kill as the main cause of mortality on roads. Starting from analysis made in the construction of the BR-448 on the metropolitan region of Porto Alegre, in Rio Grande do Sul, it were recorded several cases of mortality on the paved road of individuals of the *Leptodactylus latrans* specie. In November and December of 2013 several specimens were observed on BR-448, where were not allowed the traffic of any kind of automobiles at time. It is noteworthy that most of the specimens were juvenile individuals of the specie, and none of them showed any sign of road-kill (Fig. 1).

Figure 1. Record of *Leptodactylus latrans* juveniles found killed in the BR-448. Photo: Silvia Aurélio.

Starting from the samples it was tried to correlate the mortality of the young specimens found a BR-448 with abiotic factors and the behavior of the anurans, to find out the reasons of the mortality of the specimens. It could be associated with the higher temperatures and precipitation registered, as well as the reproductive period and the recruitment of juveniles. Besides that, another important factor is the area next the road. Because it is a zone that after extensive rain periods, become temporarily a wetland that can call draw attention of many species that use this type of habitat as a reproduction site. The road in question divided the humid zone in two, it means that the specimens might have crossed the road more frequently during the reproductive period and after the development of the tadpoles into juveniles. During the inspections of the road, were observed before the registers of mortality, that after a period of heavy rains, the environment surrounding of BR-448 became flooded, drying a month later, which could have forced the juveniles to move up to areas that were still flooded. Desconsidering the death by road-kill, we could assume that the mortality of the anurans could be related with the dehydration caused by the intense and sudden variation of temperature between the environment that the animal was and the overheated asphalt. The process of dehydration could influence heavily on the anurans behavior that after reaching their maximum body temperature, have their respiration and mobility capability compromised causing their death. Studies revealed that some amphibians species can decrease gradually the consuming of oxygen as the temperature increase, in other words, their respiration would get compromised causing damage to all the other metabolic activities. Therefore, a series of correlated factors could have caused the mortality of the specimens, as the reproductive period, evaporative water bodies, recruitment period and mortality by dehydration. The search data presented are unique showing the relevance of the study. However, more studies are necessary to investigate the hypothesis here made and them indicates mitigating measures that could help in the preservations of the anurans population when subject to the road implantations.

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MOVEMENT OF TARANTULAS ON A BRAZILIAN RAILROAD

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Spiders can play an important ecological role in terrestrial ecosystems. They are recognized as the major group of terrestrial invertebrate predators and as so, they serve as agricultural pest controllers. Moreover, spiders can be considered a significant source of food for other animals such as birds and reptiles. However, little is known about the biology and ecology of arachnids. Theraphosidae family (Araneae, Mygalomorphae), popularly known as tarantulas, is considered a very primitive spider group with wide geographic distribution. Some authors refer to them as 'road-tarantulas' because during the reproductive period they can be often seen crossing roads. However, relationship between roads and animals in literature is focused on vertebrates. A recent review about the effects of roads on insects concludes that there is a lack of studies on arthropods, and highlights the need of further research on this group. Furthermore, railways do not have the same emphasis on road ecology, with scarce publications concerning them. To the best of our knowledge there are no studies that relate invertebrates and railways. In the present work we present the first data correlating spiders, an understudied group, and railroads. The study was conducted in Estrada de Ferro Carajás, Maranhão and Pará states, Northern Brazil, in a stretch of 871 km long, covered on foot by pairs of biologists. The data were collected from June 2011 to March 2016, divided into four samples per year, covering dry and wet seasons, totaling 15 samples. We found a total of 360 individuals of theraphosid spiders of at least 8 species, being 297 dead and 63 alive. All specimens were found intact on the railroad, suggesting that the tarantulas are not roadkilled. To evaluate the difference between male and female frequencies, we used binomial exact test. The variation in seasonality was calculated with multinomial exact test. We found significant difference

(p < 0,01) with males being dominant in comparison with females. The record of individuals was superior during the wet season, which is coincident with summer, when compared to the dry season or dry-wet/wet-dry transitions (p < 0,01) (**Fig. 1**). Our results show that males of Theraphosidae were significantly more frequent during the wet season.

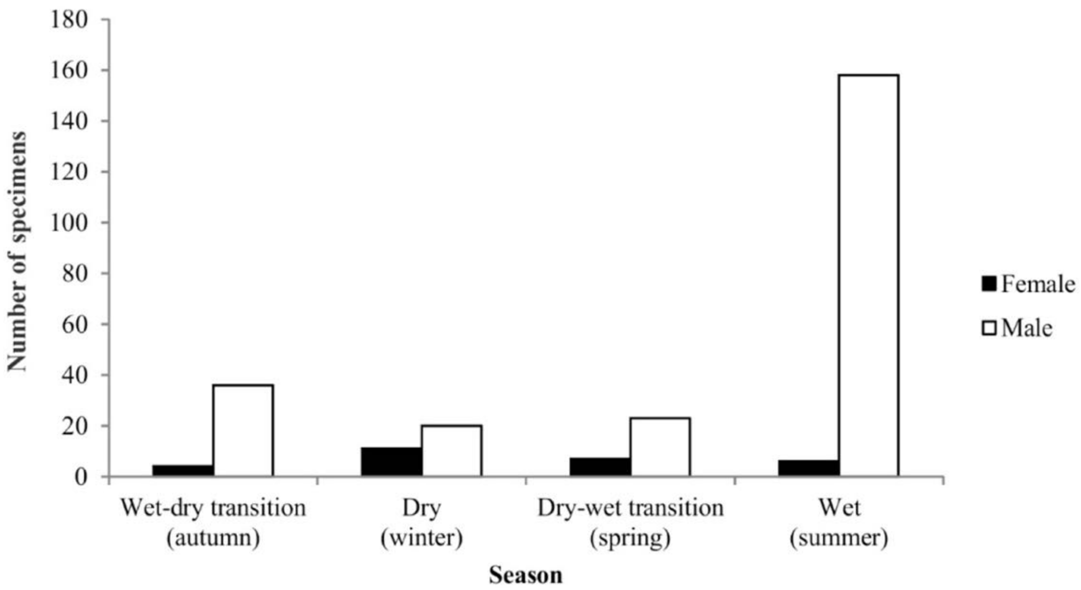

Figure 1. Frequency of male and female theraphosid spiders found on the railroad according to the seasons.

Several studies concerning various theraphosid spiders attest that the sexual period consists of only two months, normally in summer, when the seasonal movement of adult males is related with weather conditions and breeding. Those findings are coincident with our results. Theraphosid females live for several years, tending to dwell permanently in burrows, while adult male behavior differs from females and juveniles. Males normally reach maturity at 2 years of age, living just few months as adults, when they start to wander seeking a partner to mate. This activity generates a high energy cost and risk, and in that period they seldom forage. At the end of the reproductive season, male tarantulas usually lose body mass, resulting in a reduction of abdomen size and consequent death. That said, we can infer that the findings of theraphosid spiders on the railroad are a result of normal wandering behavior of this group, although further studies researching the movement of tarantulas in vegetated areas adjacent to railroads are necessary to confirm our assumption.

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PRELIMINARY STUDY ON THE DIET OF *CORAGYPS ATRATUS* (BLACK VULTURE) FOUND ROADKILLED IN THE SEMIARID REGION OF NORTHEASTERN BRAZIL.

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The black vulture *Coragyps atratus* is found from Brazil, Bolivia and Peru to Central America and Mexico. It is distributed across all Brazil, except in wide forested areas with low anthropization. This species is easily spotted in large groups frequenting dumpsters, landfills or in areas where decomposing animal carcasses can be found. Called "environmental cleaners" due to being carnivorous and scavengers, black vultures are also found along the roads in search of carcasses. Diet of birds can show a great diversity, varying with the environment and the position in the food web. Among the scavengers, the black vulture feeds almost exclusively on dead animals. This work aimed to determine the diet of *Coragyps atratus* found roadkilled in the proximities of the Floresta Nacional de Açu (FLONA de Açu), a federal conservation unit in the Caatinga biome. Nine roadkilled black vultures were collected between October 2013 and October 2014 and taken to the Laboratório de Gestão e Conservação da Fauna Silvestres in the Universidade Federal Rural do Semiárido. Food content of the gizzards was analysed and separated by items, using a LUMEN WF 10x/22 stereo microscope when necessary. For all food contents, wet weight was obtained using an analytical balance, with a precision of 0.0001g. Items were identified to Class level and, if possibly, to species level. After identification, items were preserved in alcohol 70%. Occurrence frequency was determined as the proportion of gizzards in which each item was identified. Items with anthropogenic origin were present in 22% of the gizzards. Other items had different origins: bird (22%), insect (11%), mammal (100%), mineral (33%), reptile (11%), plant (33%) and other unidentified vertebrate animals (bone fragments, 11%) (Figure 1).

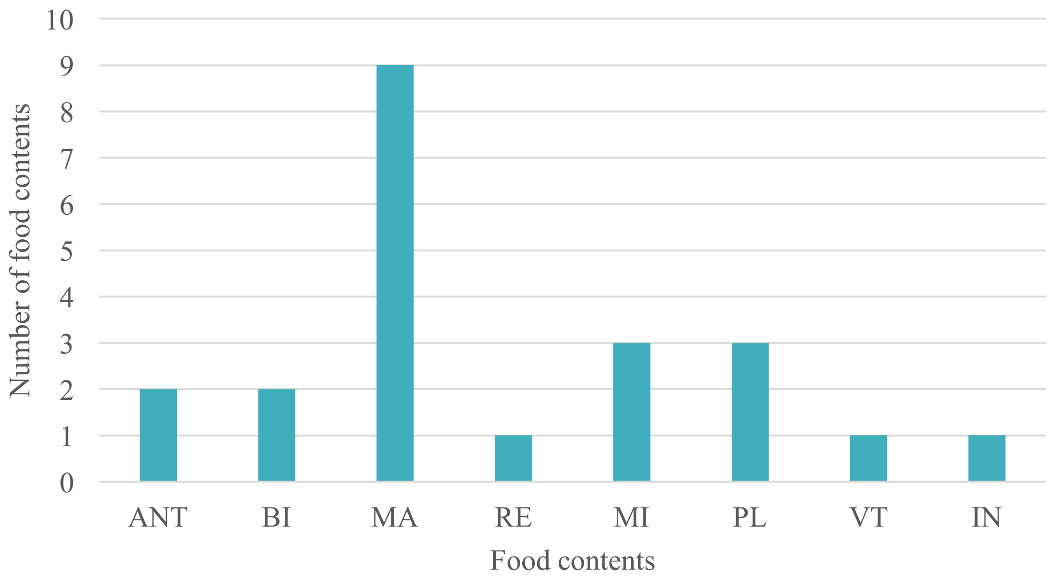

Figure 2: Number of times that each type of item was present in the food contents found in the gizzards of nine C. Atratus. Type of item based on its origin: ANT, anthropogenic; BI, bird; MA, Mammalia; RE, Reptilia; MI, mineral; PL, plant; VT, other vertebrates; and IN, Insecta.

Class Mammalia items were the most commonly found in the gizzard contents. Class Insecta items were the less common items and its ingestion may have been accidental. They were identified as larvae of the Order Diptera and were probably present in the gizzard because the vulture ate from a decomposing carcass. When comparing the contents of the nine gizzards, our study indicates that the majority of vultures presented a carnivorous scavenger behaviour. Although preliminary, these results indicate that the differences in the food contents between individuals may be related to the availability of resources, with roads providing an important source of food, in particular carcasses of roadkilled animals.

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IS MOVEMENT OF STREAM FISH DISTURBED BY ROAD CROSSINGS? A CASE STUDY USING OF PHOTO-IDENTIFICATION

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Road crossings are considered a fragmentation factor and depending on type of built physical structure and type of stream they can be potential barriers to the movement of fish species. Most studies demonstrating that fish populations are affected by road crossings are concentrated in Northern Hemisphere. However, in neotropical streams, where fish species diversity is high and life histories are distinct, there is need for more research to understand road crossing effects on fish movement. In this study, our aim is to assess whether road crossings can affect the upstream-downstream movement of siluriform fish *Rineloricaria aequalicuspis* (Loricariidae). Since January/2016 we are taking monthly data on the location of *R. aequalicuspis* individuals sampled upstream and downstream a road crossing in the Encantado stream, river basin Maquiné, Rio Grande do Sul, Brazil. The road crossing is a multiple box culvert, with upstream water retention and a 15 cm outlet perch; each culvert box (5) is four meters long (Figure 1). Downstream and upstream the road crossing we used fine-mesh gillnets to divide the stream in three 10-m sections (downstream D30, D20, D10; upstream U10, U20, U30). In each section, we sampled fish by kick-sampling, using a rectangular dip-net (80 x 40 x 40 cm with a 4 mm mesh). Each fish was measured, photographed and released at the same section it was captured. To assess recapture events, photographs were taken from each individual fish > 7.5 cm total length. Each photograph received a unique identification code and was stored in a digital image bank and was then compared to photographs taken at previous capture events. Use of individual photo-identification for this species has been previously validated and is software assisted (Wild-ID), although the final decision is made by the user. From the recapture data we were able to determine which fish moved from one stream section to another and if they

presented upstream/downstream displacement through the culvert. We estimated movement rate within the upstream and within downstream segments, and the proportion of culvert-passing movements relative to non-culvert-passing events. The net displacement (in 10 m units) of each individual between capture-recapture events was also calculated. To date we have captured 284 fish with 29 recapture events (10%). Only 11 recaptures represented movement events (i.e., capture and recapture occurred at different sections), while 18 recaptures did not indicate movement (capture and recapture occurred at the same section). Downstream the culvert, we observed similar movement rates both in the upstream and downstream direction (upstream, 4 fishes, net displacement = 10, 10, 20 and 20 m; downstream, 3 fishes, net displacement = 10, 10, 20 m). On the other hand, displacement was not recorded among the sections situated upstream the culvert. Only one fish passed the culvert on the upstream direction (net displacement = 20 m), and three fish passed the culvert on the upstream-downstream direction (net displacement = 30, 40 and 50m). Although based on limited data, these preliminary results suggest that the rate of fish passing downstream the culvert is similar to the rate of fish moving freely from one section to another. The larger net displacement in downstream movements suggests that water flow may facilitate downstream movement. On the other hand, the smaller rate of fish passing upstream through the culvert suggests it may be limiting upstream movements of *R. aequalicupis*. This limitation may be related to culvert features such as the high perch or internal substrate roughness or water flow in the culvert. These preliminary results must be reassessed after additional sampling, which will also allow the examination of movement patterns of *R. aequalicuspis* relative to its reproductive period, individual length and flow variation.

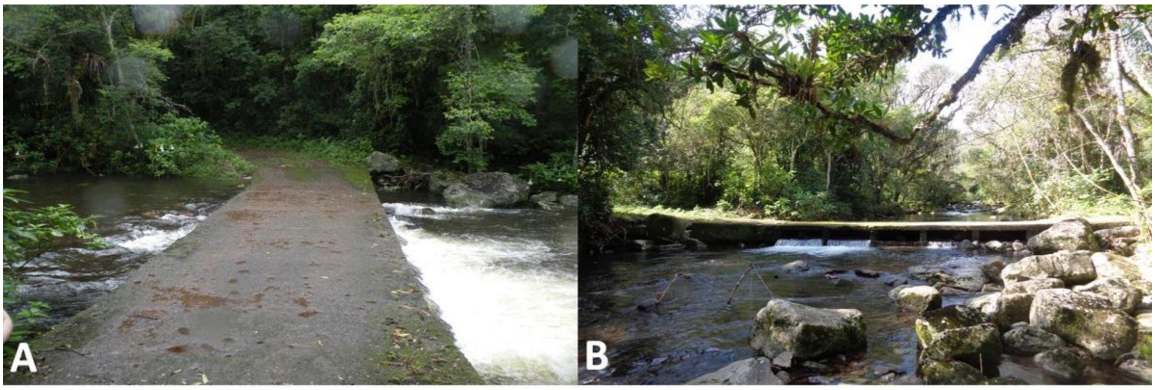
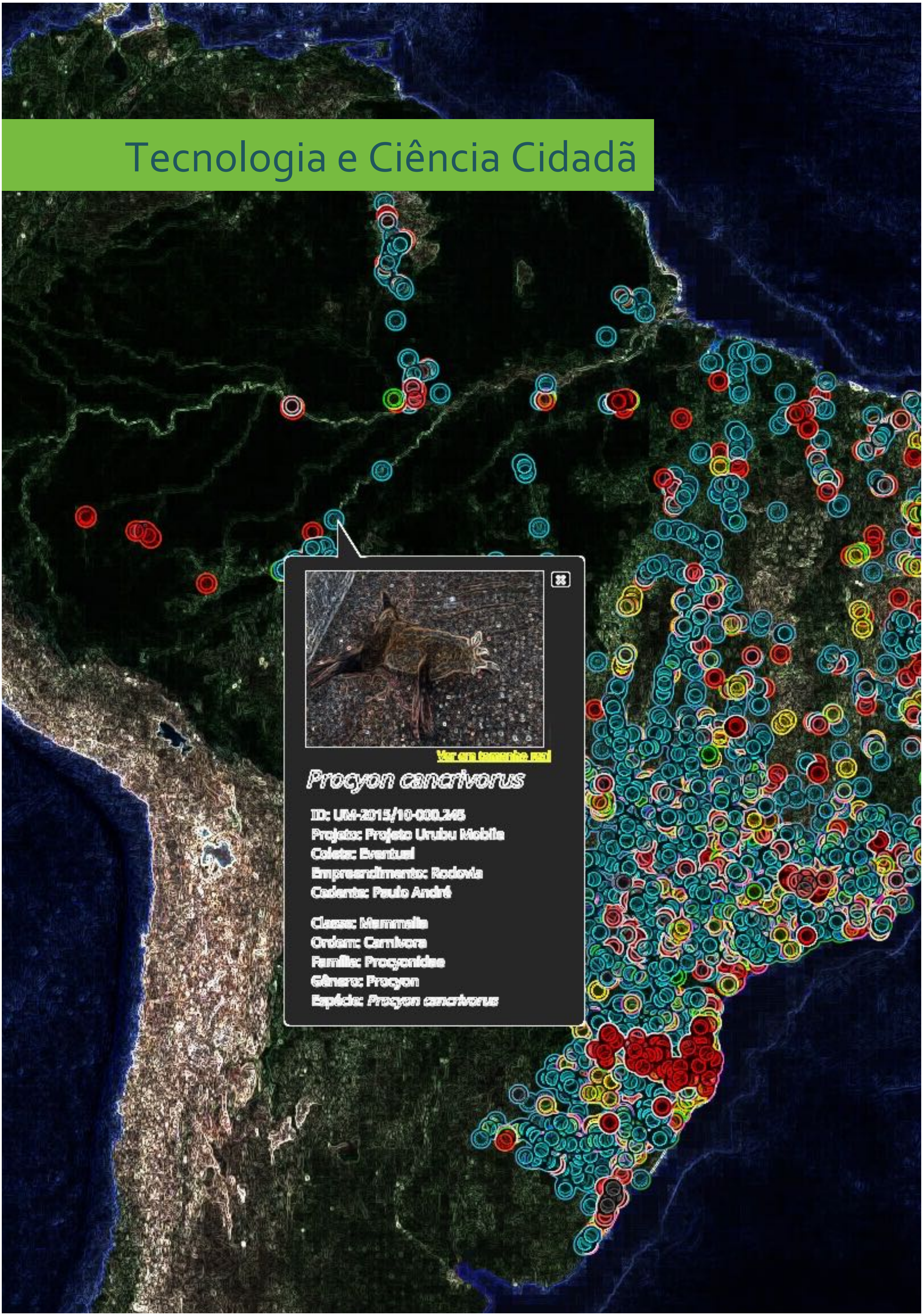


Figure 1. Road crossing in the Encantado stream. A. Crossing profile. B. Downstream view of the culvert outlet perch.

Tecnologia e Ciência Cidadã



SISTEMA URUBU: A TWO-YEAR BACKGROUND

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Citizen science has become an important tool for acquiring information that can help the conservation of species and ecosystems. In Road Ecology, citizen science was adopted in web-based systems of many countries (e.g. USA, Sweden, United Kingdom, Ireland, Belgium, South Africa and Czech Republic), allowing data report, especially for road-kill records. In Brazil, the Sistema Urubu was created in 2014 and it is the first initiative for grouping and systematizing road-kill wildlife data all over the country. An important difference between Sistema Urubu and other citizen science database is that the former is not only a database to store records of road-kill animals, but also a social network engaging people with conservation process. Also, Sistema Urubu created a way for qualifying data: volunteer experts, previously registered in the system, make the scientific identification of the animals, a process that allows the data to be safely used in different studies. The aim of this study is to describe the operation of Sistema Urubu from data collection to final identification of the species. We will also quantitatively describe the data obtained to date. Registers of road-kill vertebrates (mammals, birds, reptiles and amphibians) are sent by Urubu Mobile, an app developed for smartphones and tablet devices. When the user takes a photograph of a road-kill animal, the app links the photograph with date and geographic positioning system, after which the user can send the register. Another way the System receives data is from a system tool that allows the input (via Excel spreadsheets) of database from partners' research projects that use systematic road-kill monitoring. Then, the registers are made available for identification and they are only inserted in Sistema Urubu database after being classified for at least three validators and up to five of them. Once in the database, the system links spatially records to georeferenced information (biomes, states and protected areas) and generates automatic tables summarizing data according to its spatial characteristics. Data from 2014 to 2016 are presented here. Up

to May/2016, Sistema Urubu had 17550 users, from which 706 are data validators. Around 12000 animals were added to database, 51.0% mammals, 21.5% reptiles, 21.2% birds and 6.3% amphibians. For each taxonomic group, the most road-kill species were Crab-eating Fox (*Cerdocyon thous*, Canidae, Mammalia – 700 records), American Black Vulture (*Coragyps atratus*, Cathartidae, Ave – 127 records), Water Snake (*Helicops infrataeniatus*, Colubridae, Reptilia – 388 records) and Rufous Toad (*Rhinella rubescens*, Bufonidae, Amphibia – 79 records). Eighteen endangered species were recorded: Giant Anteater (*Myrmecophaga tridactyla*, Myrmecophagidae, Mammalia – 245 records), Lowland Tapir (*Tapirus terrestris*, Tapiridae, Mammalia – 65 records), Maned Wolf (*Chrysocyon brachyurus*, Canidae, Mammalia – 38 records), Hoary Fox (*Lycalopex vetulus*, Canidae, Mammalia – 37 records), Geoffroy's Cat (*Leopardus geoffroyi*, Felidae, Mammalia – 33 records), Jaguarundi (*Puma yagouaroundi*, Felidae, Mammalia – 22 records), Oncilla (*Leopardus trigrinus*, Felidae, Mammalia – 22 records), Pampas Cat (*Leopardus braccatus*, Felidae, Mammalia – 6 records), Buffy-tufted-ear Marmoset (*Callithrix aurita*, Callitrichidae, Mammalia – 4 records), Puma (*Puma concolor*, Felidae, Mammalia – 4 records), Tropical Forest Snake (*Calamodontophis paucidens*, Dipsadidae, Reptilia – 3 records), Margay (*Leopardus wiedii*, Felidae, Mammalia – 3 records), Giant Armadillo (*Priodontes maximus*, Dasypodidae, Mammalia – 3 records), Marsh Deer (*Blastocerus dichotomus*, Cervidae, Mammalia – 2 records), Lesser Nothura (*Nothura minor*, Tinamidae, Ave – 1 record), Short-eared Dog (*Atelocynus microtis*, Canidae, Mammalia – 1 record), Great-billed Seed-Finch (*Sporophila maximiliani*, Thraupidae, Ave – 1 record) and White-lipped Peccary (*Tayassu pecari*, Tayassuidae, Mammalia – 1 record). Mammal records are majority probably because they are easily seen on roads, since they tend to be bigger than other vertebrates. Analyzing the regions of the country, most records are from South (41.9%) followed by Southeast Brazil (32.0%). Rio Grande do Sul is the state with the major number of road-kills (3839 records) – most of them are from a three-year systematic monitoring of BR-471. Although North Region is the biggest in area, it accounts for only 4.2% of registered animals – probably because of lower densities of roads and people, and also there can be less app users living there. Considering Brazilian biomes, most records were from Atlantic Forest (38.8%), the most degraded biome and a biodiversity hotspot. Sistema Urubu also helped to identify road-kill animals in Protected Areas: 1226 records were tracked inside 118 Protected Areas in Brazil. Our results show that Citizen Science platforms in Brazil can be successful, although with a challenge in maintaining users engaged. Brazil is an enormous country and to obtain a representative database for all regions or biomes will take some time, in addition to investment, especially in advertisement and marketing. Road-kill is an important threat to biodiversity in Brazil but few conservation efforts have been developed to mitigate this impact. Data from Sistema Urubu is helping to fill this gap and has the potential to guide public policies. Besides some limitations, basic analyzes will help to highlight some doubts and indicates areas where efforts should be concentrated on.

Acknowledgments: We are grateful for the financial support provided by FAPEMIG (Process CRA–PPM-00139-14/453 and CRA–APQ-03868-10), CNPq (Process 303509/2012-0 and 401171/2014-0), Fundação Grupo Boticário Process (0945-20122), and Tropical Forest Conservation Act – TFCA (through Fundo Brasileiro para Biodiversidade – FUNBIO.

CITIZEN SCIENCE FOR WILDLIFE CONSERVATION IN THE COLOMBIAN ROADS

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Road systems facilitate vehicle and pedestrian traffic, promoting competitiveness and territorial development. However, these systems are associated with direct impacts over biodiversity such as habitat fragmentation, run over wildlife and chemical and noise pollution. Concerned about this problematic, the Colombian Network of Run Over Wildlife Monitoring (in Spanish RECOSFA), with the support of the Sustainability Lab from the Instituto Tecnológico Metropolitano (ITM), is carrying out a research with the aim to gather information to promote actions that prevent and reduce run over wildlife. Therefore, this project is developing technical solutions that facilitate the articulation of the road network development with biodiversity conservations. To achieve this, the project is developing mechanisms to prevent and reduce run over wildlife in first, second and third road levels (according to the Colombian road classification that takes into account roads specifications and traffic). The aim of this citizen science project is to support wildlife conservation and management, involving volunteers in activities like data gathering and information dissemination with scientific based protocols. All activities involve information and communication technology with digitalized data like photos, videos and screenshots, while the education process is carried out using e-learning tools. Afterwards, the results and discussions are shared in scientific and public events in schools and colleges. However, the main divulgation and awareness tool is the webpage; where all interested people get updated information about the activities develop by the network. In order to assure citizens participation, the network create an App (RECOSFA) that is working in both mobile systems, Android and IOs. The goal of this App is to link as much citizens and researchers as possible interested in contributing to this topic. Currently, more than 200 people from different

states (departments in Colombia) have downloaded the App, performing 497 registers of run overs (467 valid). In addition, the methodology includes social networks strategies, including tweets with visual elements, links with partner associations and tags from outreach activities. Thanks to this, the network has 530 followers in Tweeter and 639 likes in Facebook, and the numbers are growing very fast. To disseminate scientific results, the network is taking part in national and international events, as well as organizing its own events at local level with the support of other institutions and researchers from all over the country. Furthermore, the strategy includes participation in the media, including press, television and radio. Finally, the most important outcome of this citizen science project is the community empowerment in the decision-making, helping to develop public policies that harmonized biodiversity conservation at landscape and regional level with the development of road networks. We consider that our initiative is promoting a sustainable development through democratization of science to solve particular environmental issues. We also confirm that policies established through citizen participation and knowledge sharing are most likely to be implemented because of the broader community support.

USING OPEN SOURCE GIS SOFTWARE TO ASSESS ROADKILL WILDLIFE IN THE CENTRAL ANDES OF ANTIOQUIA, COLOMBIA

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For a country like Colombia, considered one of the world's biodiversity hotspot, there is an urgent need to study the biodiversity loss by run over. For this purpose, researchers from the ITM have been working since October 2014 in a research project focused on the creation of a standardized method to assess the impact of run over on vertebrates in the Eastern region of Medellín, Colombia. This project aims to identify variables that affect run over and propose mitigation actions. The procedure to identify variables takes into account different aspects, like those related with the road administration (such as the frequency of animal corpse removal), road specifications (such as the type and width of the road, speed limits, and slopes, among others) and ecological (such as the surrounding land cover and the landscape metrics). Census are made twice a month and cover all the 159 km transect (of different types of roads) at speed of 30 km/h and with four observer at the same time. Data gathering is made using GPS units (Garmin GPSMAP 62S) and printed forms for other relevant information. Data processing includes a free open source software (FOSS). For this purpose, Quantum GIS (QGIS) offers a friendly interface that includes over 300 complements created by its growing community of developers. Its connection with different data formats allows and increases its interoperability among different software, including as well, the possibility to publish online maps with multiple possibilities. To stablish a standardized protocol to incorporate info to QGIS, all data coming from printed forms is digitized into cvs files of Excel, while those contained in GPS units is imported taking WGS84 as a coordinate

reference system. Image files are also integrated into database as archives that can be visualized in the published online maps. LANDSAT 8 imagery from January 27 of 2016 downloaded from USGS, is used to make more complex geoprocessing procedures with the help of the Semi-Automatic Classification plugin –SCP complement. A vector layer is built with the resulting image in order to show the classification of the different land cover types, a classification made by the "Mínimum Distance" algorithm. Afterward, a layer showing sensitive areas of run over is created and added to the land cover vector layer (Fig.1). Finally, the resulting map shows all related information, not only with land use but also with densities run over per kilometer for each municipality, in addition to the information associated with all the road attributes and climatic factors, among others. The described procedure enables us to say that FOSS tools, like QGIS, potentiate individuals and groups of researchers and institutions, improving productivity and lowering costs in wildlife conservation programs in countries like Colombia, where resources for conservation are scarce. Using this technology, we hope to model and predict run over wildlife, in order to take the conservation actions needed it to protect our vast and fragile biodiversity from the road impacts.

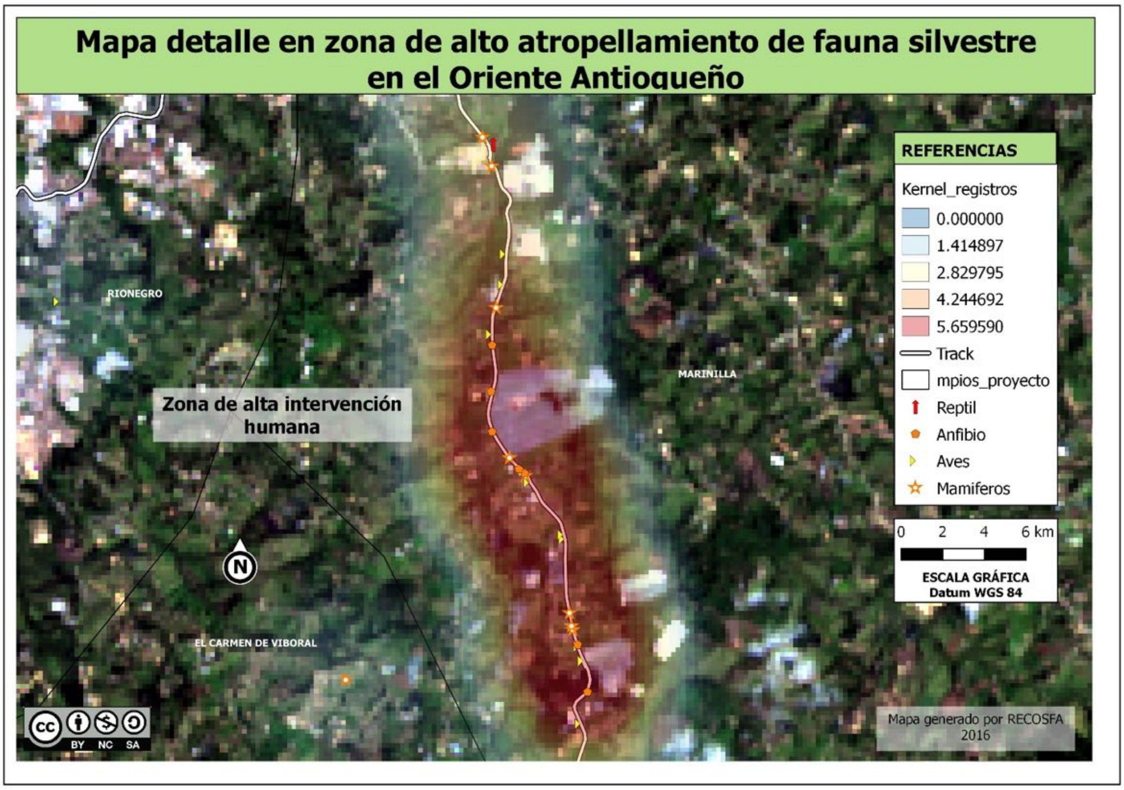

Figure 1. Map detail of areas of high run over wildlife.

DISTRIBUTION MODELS OF SIX CARNIVORES SPECIES ALONG THE BR-290 IN RIO GRANDE DO SUL STATE, BRAZIL

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Brazilian Pampa (28º 00' / 34º 00' S and 49º 30' / 58º 00' W) is the third largest biome in Brazil in terms of the percentage of endangered mammal species. Over time, this has been profoundly modified by human activities, mainly for agriculture and livestock, particularly cattle ranching and soy farming, promoting the mischaracterization about 51% of natural pastures of this biome. Currently, the roadkill has been adding to the causes of biodiversity loss of several species of vertebrates than other impacts, such as hunting and deforestation. This impact can have significant effects on the survival of wildlife populations, reducing populations and may also lead to its extinction, especially in cases of endangered or naturally rare species. The BR-290 is one of the main highways belonging to the road network of Rio Grande do Sul, with 726 km long, which crosses the state east-west. The purpose of this study was to estimate the potential areas for the distribution of canids and felids along the BR-290, based on occurrence records of these species and to propose priority areas for conservation actions through this highway. We used occurrence records of two canids (*Cerdocyon thous* and *Lycalopex gymnocercus*) and four small wild cats (*Leopardus geoffroyi*, *Leopardus wiedii*, *Leopardus colocolo* and *Puma yagouaroundi*). The records were obtained in opportunistic findings between 2013 and 2016, and from the literature. This records were used to modeling the suitability of the environment, using WorldClim database, with a resolution of (30 S), and shapes of vegetation and soil use available on Soma Brasil site. Modeling was performed using RStudio Software and was validated using 50% of records as training and 50% as tests. The quality of the models was evaluated by the use of ROC curve. To select the appropriate layers, which comprise 95% of variation, we used a PCA analysis. Finally, the Mahalanobis discriminant algorithm was chosen because it uses continuous and categorical data. Consensus maps based on

presence and absence were defined considering half of predictable adequability of the species along the BR 290. In the pre-modeling phase we found that altitude, soil use and vegetation responds by great part of occurrence despite of differences in the weight of these variables for each species. High scores of AUC (area under the curve) suggest good reliability of the models: *Cerdocyon thous* (0.982); *Lycalopex gymnocercus* (0.968); *Leopardus wiedii* (0.988); *Leopardus colocolo* (0.966); *Leopardus geoffroyi* (0.987) and *Puma yagouaroundi* (0.998). Both canids (*C. thous e L. gymnocercus*) seem less specific in relation to their occurrence along the road. The wild cats however were more restrictive, especially *P. yagouaroundi* and *L. geoffroyi.* In the consensus map, we found an area on BR-290 with high potential for all species, located between 53° 55'e 53° W; 30° 37' e 30° 35' S, a region known as "Serra do Sudeste". This region has rugged terrain (altitude between 200 and 500 m), consisting of a mosaic of herbaceous and shrub and forest formations. The soil is rocky, limiting agriculture, with common burning of woody vegetation to expand grazing areas. The actual number of roadkills affecting these species is certainly greater than the documented in the literature or by our data, which indicates that this may be an important source of mortality for them. As conservation acts we suggest information boards and systems for speed control especially in the area of Serra do Sudeste. The implementation and monitoring of other systems as tunnels or bridges for fauna has to be thought. New studies about wildlife roadkill in this road, as well in other main highways of the region is also needed, together with campaigns for and environmental awareness, which is crucial for conservation.

Planejamento

EATING BY THE EDGES – ROAD PROJECTS AND VEGETATION SUPPRESSION IN SÃO PAULO STATE

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Highways are important components in the landscape of São Paulo (SP) State. The building of railways promoted land occupation and the State development; however, those early highways became obsolete with the use of motor vehicles. Thenceforth an intricate road network has been built over the last century decades to facilitate the traffic of cars and trucks, which caused intense fragmentation of the native vegetation. Nowadays agriculture, urban expansion and housing developments are the main factors that increase the demand for road network expansion. As a result of the already existing dense volume of roads throughout the State, most projects that are subjected to environmental licensing in SP today concern the opening of small areas for access, or improvements and duplication of highways already in operation; thus, they do not interfere abruptly in the landscape. But this type of project also generate negative environmental impacts on vegetation, even if to a lesser degree compared to the opening of new roads. In this study we quantified and evaluated the native vegetation legally removed in 2014 for smaller projects such as highway improvement and duplications. We analyzed every authorization for vegetation suppression issued by São Paulo State Environmental Agency (CETESB). In 2014, 23 authorizations were issued for 20 road projects, comprising an area of about 89 ha of vegetation removed from the remaining fragments of native vegetation in SP, being 99% of the Atlantic rainforest biome. A general pattern of native vegetation suppression for highways duplication and improvement projects is the reduction of the fragment area through deforestation by the edges. Considering that more than 80% of the Atlantic rainforest fragments are lower than 50 ha, the results we found show that minor changes in the

existing highways – despite being dispersed in various projects across the State – were responsible for the loss of a significant area of native vegetation. This case study we present for the year 2014 is the likely pattern for the recent years. Apart from the obvious drop in the original area of refuges and habitats for wildlife, the reduction of fragment size may lead to a cascade of secondary impacts such as local extinctions, loss of ecosystem services – local climate regulation, pollination, dispersal, nutrient cycling – and likely increase in the density of species well-adapted to edges. Especially in the countryside, where there is little remaining native vegetation, fragment size – instead of connectivity – has proved to be more related to species richness and abundance. We also emphasize that proposals to compensate vegetation suppression made by the entrepreneurs usually consist of planting native trees in locations far from the area directly affected, implying that such mitigation measures will not actually mitigate local negative impacts caused by the reduction of the remaining fragments. Some consequences would be the permanent loss of habitats and of landscape connectivity. Several studies have drawn attention to the importance of small fragments on maintaining the landscape functionality through corridors and mosaics of habitats, thus guaranteeing to some extent the local biodiversity. We show here that the sum of small portions of vegetation suppressed for highway improvement/ duplication not only represents a considerable extent but also that such areas are especially important for connectivity, and are part of the last native remnants, frequently located in APPs ("Permanently" Protected Areas). We argue that studies focusing locational and technological alternatives should be done even for smaller projects in the already existing highways, in order to avoid at most the suppression of native vegetation remnants.

Table 1. Vegetation type and respective area (ha) of native remnants removed for highway improvement/ duplication in São Paulo State, in 2014. The successional stage of vegetation and its location in Permanently Protected Area (APP – determined by Brazilian federal law nº 12.651/2012) are considered.

Vegetation physiognomy	Successional Stage	APP		Total
		Inside	Outside	
Woodland Savanna (*Cerradão*)	-	0,01	0,22	0,23
Savanna (*Cerrado* sensu stricto)	-	0,01	0,626	0,636
Deciduos Forest (*Floresta Estacional Decidual*)	pioneer	0,78	-	0,78
Semideciduous Forest (*Floresta Estacional Semidecidual*)	pioneer	7,78	-	7,78
	initial secondary	5,14	4,11	9,25
	medium secondary	1,1	0,9	2,0
Dense Ombrophilous Forest (*Floresta Ombrófila Densa*)	pioneer	7,1	-	7,1
	initial secondary	14,15	7,99	22,14
	medium secondary	19,02	4,47	23,5
Mixed Dense Ombrophilous Forest (*Floresta Ombrófila Mista*)	pioneer	0,03	-	0,03
	initial secondary	0,04	0,15	0,19
	medium secondary	0,02	0,3	0,32
Swamp Forest (*Floresta Paludosa*)	-	14,48	-	14,48
Fluvial vegetation (*Várzea*)	-	0,8	-	0,8
Total		70,46	18,77	89,27

WHICH AND HOW ROAD EFFECTS ON WILDLIFE ARE CONSIDERED IN ENVIRONMENTAL IMPACT ASSESSMENTS

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Roads are recognized as the main factor of landscape degradation, causing several impacts and severely compromising wildlife conservation. Among the main impacts caused by roads is wildlife mortality due to vehicle collisions. Removing individuals from populations reduces their genetic diversity and the population persistence as well. Road construction, paving and widening require the approval of an environmental impact assessment (EIA), which is the main document for impact assessment of activities during environmental licensing and it has the role of avoiding, minimizing, mitigating or compensating potential impacts. EIAs of high quality are a pre-requisite for effectiveness in decision making. A step in this process is to assess and predict all potential impacts of an activity and to have consistency between the different sections of the EIA. Considering the importance of road effects on wildlife and the objective of avoiding and minimizing them through environmental licensing, we present an analysis of 10 EIAs of Brazilian roads, considering the fauna impacts. Specifically, we evaluated (1) if the impacts recognized in road ecology literature are identified and assessed in studies, (2) if the mitigation propositions are based on information presented on the EIA, and (3) if the assessment of road mortality impact is of good quality. Based on road impacts on fauna listed in road ecology literature, we built a checklist and verified if each impact in checklist was identified, analyzed and predicted in the EIAs' baseline studies (1). To evaluate if mitigation measures propositions were based on information presented on the EIA (2), we compared the presence of the impacts among baseline

studies, impact matrix and proposition of mitigation measures. To evaluate the quality of mortality assessments (3), we created detailed criteria related to the fundamental questions for decision making about mitigation measures of this impact (who, how many, where and when animals are killed). For the first and last analyses, we adopted scores corresponding to presence/absence of impacts (objective 1), quality and effectiveness in the approach of mortality assessment (objective 3), with scores varying from 0 to 3, zero indicating absence of any approach and three indicating that the question was addressed with suitable methods. We calculated relative scores for each study and for each criterion. In the second analysis (objective 2), we verified the coherence among the baseline studies, impact matrix and proposition of mitigation measures related to the presence/absence in each section, without scores. No EIA addressed all impacts of the checklist and the mean relative score of studies was 45% (±19.27), which is the first evidence of studies' low quality. Detailing the analysis, it was evident the lack of consistency between baseline studies, impact matrix and proposition of mitigation measures. In several cases the impact was addressed in the baseline study, but it was not cited in the impact matrix or in mitigation measures proposition. In only 27% of the cases an impact was cited in all three sections and in 29.5% of the cases impacts were absent in all sections. When we explored specifically how road mortality was assessed, half of the studies had relative score lower than 20% and no one was higher than 44.44%, which indicate that either the questions were not addressed in the study or they were inadequately addressed. No EIA evaluated the temporal pattern of mortality and they did not justify this absence, although all studies have lasted at least one year with the usual justification of the need to incorporate and evaluate the temporal variation. The lack of connection between the impacts discussed in road ecology literature and the ones presented in EIAs may be due to the absence of integration among researchers, environmental managers, technicians and environmental consultants, or even due to not understanding what should be presented in an EIA. Results obtained indicated that, different from what is expected and determined by legal requirements, mitigation measures are proposed without a good support on evidence presented in baseline studies that could justify the decisions made. Road impacts on wildlife are superficially assessed in EIAs. Quantitative analyses to predict intensity, extension or duration of the impacts are missing, which is probably related to the licensing process being considered only a legal pre-requisite for project approval, instead of a fundamental step in decision making to minimize impacts and promote sustainability. However, as important as systematically analyzing the studies and highlighting the existing weaknesses, new strategies and criteria to qualify future studies are needed. EIAs have been conducted without the clarity of why information is being collected, or without any clear questions to be answered. To reverse this scenario, we recommended that the terms of reference (TRs) that guide environmental studies clearly state which questions should be answered about the impacts in baseline studies, recommending how this information should be obtained, considering costs, deadlines, and, specially, the relevance of this information for decision making. Finally, it is necessary an approximation between academia and environmental managers and the qualification of the professionals involved in the environmental licensing. Versão em português em: http://www.ufrgs.br/nerf/index.php/producao

Workshop “Instrução Normativa do IBAMA N°13 de 2013”

Coordenadores: Roger Borges da Silva (MRS Estudos Ambientais) & Larissa Carolina Amorim dos Santos (COTRA/DILIC/IBAMA)

Caga horária: 20h

Local: Anfiteatro Magno Antônio Patto Ramalho (Ramalhão) – Departamento de Biologia DBI/UFLA

Histórico Pré-Workshop

O ICMBIO e o CBEE organizaram o primeiro Plano de Ação Nacional focado em impactos, o PAN para Conservação da Fauna Afetada por Infraestrutura Viária – PAN ESTRADAS. A primeira reunião foi realizada em setembro de 2015.

Os Planos de Ação estabelecem políticas públicas que devem ser adotadas por diferentes segmentos da sociedade para promover a conservação e a recuperação da população de uma determinada espécie ou grupo de espécies ameaçadas, ou ainda, dos ecossistemas onde elas vivem.

O PAN Estradas, porém, tem a peculiaridade de ter sido adotado para elencar ações e estratégias visando minimizar os impactos de um agente antrópico específico – as rodovias e ferrovias – que ameaça a fauna silvestre nativa ao longo de seus traçados. Essa característica lhe confere uma importância ainda maior no cenário nacional.

Este PAN contou com a participação de um grande número de atores de diferentes segmentos da sociedade (p.ex. ANTT, DNIT, IBAMA, ICMBIO, PRF, Ministério Público, CFBio, academia, empresas de consultoria, entre outros) e estruturou um plano estratégico de ações que deverão ser realizadas nos próximos cinco anos.

Em um segundo encontro ocorrido entre os dias 16 e 18 de dezembro de 2015, o Grupo de Assessoramento Técnico (GAT) do PAN - Estradas, concluiu o planejamento das atividades e definiu as ações prioritárias para os próximos cinco anos. Divididas nos eixos temáticos Pesquisa, Políticas Públicas, Gestão da Informação, Educação Ambiental e Capacitação de Recursos Humanos, as ações têm como objetivo reduzir os impactos de rodovias e ferrovias sobre a fauna nativa.

Dentre as inúmeras ações definidas, uma delas foi a revisão e adequação da Instrução Normativa do Ibama nº13 de 2013. Pretendia-se fechar uma nova minuta em novembro de 2016, durante o 1º Congresso Iberoamericano de Biodiversidade e Infraestrutura Viária (CIBIV), em Lavras, Minas Gerais, onde, logo após, ocorreria a primeira reunião de monitoria do PAN-Estradas, realizada pelo GAT.

Em 04 de janeiro de 2016, iniciou-se um grupo de discussão online que colheu contribuições de profissionais envolvidos com o tema, os quais foram amplamente convidados a se juntar a este fórum de maneira que o trabalho fosse o mais colaborativo possível. Ainda, todos os membros tinham completa liberdade para transmitir novos convites agregando outros participantes.

Os convidados puderam contribuir em todos os "artigos" da atual IN 13/13, ou, caso tivessem interesses pontuais, puderam também enviar contribuições específicas somente aos temas que lhes conviesse.

Para tanto, e afim de organizar a compilação das contribuições, tópicos foram definidos e, cada uma das contribuições, deveria encaixar-se nesta estrutura, a qual também estava disponível online na pasta de trabalho, sob o nome de 'contribuições.docx'. Este documento era aberto e podia ser visualizado e editado por todos os participantes do grupo, sendo atualizado em tempo real.

Neste grupo online estiveram inscritos os seguintes profissionais:

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No dia 31 de julho de 2016 foram encerradas as contribuições e discussões online, a fim de realizar a compilação de todos os subsídios propostos.

Workshop

Nos dias 05, 06, 07, 08 e 09 de novembro de 2016, durante a programação do 1º Congresso Iberoamericano de Biodiversidade e Infraestrutura Viária (CIBIV), aconteceu a oficina de discussão presencial e indicação da minuta definitiva da Instrução Normativa readequada.

Ao longo destes cinco dias foram apresentados todos os tópicos abordados no período de discussão online. Somado a isso, por meio de Grupos de Trabalho, também foram realizados debates, alinhamentos e novas contribuições, os quais foram consolidados pelos participantes no documento final anexo.

Neste grupo presencial estiveram inscritos os seguintes profissionais:

Roger Borges da Silva – MRS Estudos Ambientais

Larissa Carolina Amorim – IBAMA/DILI/COTRA

Giuliana Berghella – IBAMA/DILI/COTRA

Cristiane Lopes – IBAMA/DILI/COTRA

Juliana Rocha – IBAMA/DILI/COTRA

Diogo Ferreira – IBAMA/DILI/COTRA

Fernanda Góss Braga – Conselho Federal de Biologia

Hélio Secco – CONCREMAT Engenharia

Reginaldo Cruz – Biota Soluções Ambientais

Nidiane Goloti – PROSUL Engenharia e Meio Ambiente

Rubem Dornas – Amplo Engenharia

Raimunda Souza – PROSUL Engenharia e Meio Ambiente

Jennifer Barros – CBEE

Pryscilla Lombardi – Rumo Logística

Francini Garcia

MINUTA PROPOSTA

O PRESIDENTE DO INSTITUTO BRASILEIRO DO MEIO AMBIENTE E DOS RECURSOS NATURAIS RENOVÁVEIS - IBAMA, nomeado por Decreto Publicado no Diário Oficial da União de 17 de maio de 2012, no uso das atribuições que lhe conferem o art. 22, parágrafo único, inciso V do Decreto nº 6.099, de 26 de abril de 2007, que aprovou a Estrutura Regimental do IBAMA, e tendo em vista o disposto na Lei nº 6.938, de 31 de agosto de 1981, na Resolução do CONAMA nº 237, de 19 de dezembro de 1997, e a Lei Complementar nº 140, de 08 de dezembro de 2011, resolve:

Art. 1º Estabelecer os procedimentos para padronização metodológica das amostragens de fauna exigidas nos estudos ambientais necessários para o licenciamento ambiental de rodovias e ferrovias.

Art. 2º Para os efeitos desta Instrução Normativa, são estabelecidas as seguintes definições:

I. Área de Estudo: área geográfica na qual são realizados os levantamentos da fauna para fins de diagnóstico ambiental, onde deverão estar contemplados todos os sítios amostrais.

II. Diagnóstico: caracterização da fauna existente em determinada área no momento presente.

III. Campanha: conjunto de atividades desenvolvidas para o levantamento primário da fauna, com duração temporal delimitada, com o objetivo de coletar as informações necessárias para a elaboração do diagnóstico ambiental.

IV. Monitoramento: processo de coleta de dados, estudo e acompanhamento contínuo e sistemático da fauna, com o objetivo de identificar e avaliar as condições da mesma em um determinado momento, assim como padrões espaço-temporais.

V. Sítio amostral: espaço geográfico dentro da Área de Estudo onde são alocadas as unidades amostrais.

VI. Unidade amostral: unidade na qual são executados os métodos para observar e medir as características quantitativas e qualitativas para cada grupo faunístico. As unidades amostrais podem ser parcelas de área fixa, de área variável ou unidades amostrais não-superficiais, como pontos e linhas amostrais.

Art. 3º A padronização metodológica de que trata essa Instrução Normativa deverá se estender para a fase de monitoramento até edição de norma específica, acrescida dos Programas do Plano Básico Ambiental, contemplando grupos específicos de fauna a partir do diagnóstico resultante do estudo ambiental.
Parágrafo único. O Ibama, mediante decisão motivada, poderá optar por metodologias mais simplificadas ou até mesmo dispensar o empreendedor da necessidade da realização de monitoramento de grupo específico, em função dos resultados apontados pelo diagnóstico.
DAS CAMPANHAS E DA PERIODICIDADE DA AMOSTRAGEM DE FAUNA
Art. 4º O empreendedor deverá realizar 4 (quatro) campanhas ao longo de 12 (doze) meses, com periodicidade trimestral.
§ 1º Caso seja possível justificar que um número menor de campanhas abranja toda sazonalidade, o empreendedor poderá solicitar avaliação do Ibama.
§ 2º O espaçamento das campanhas amostrais deverá ser fixo, podendo haver flexibilidade máxima de adiantamento ou atraso de início das campanhas em 1 (uma) semana, de modo a não comprometer a avaliação da variação ambiental.
§ 3º As campanhas de amostragem de vertebrados terrestres deverão ter 7 (sete) dias efetivos de execução por sítio amostral, desconsiderando o tempo gasto para a mobilização e desmobilização da equipe e equipamentos, caso as condições climáticas possibilitem a execução da campanha.
§ 4º Deverão ser apresentados os dados climáticos da região no período de realização das campanhas, incluindo índice pluviométrico, temperatura média e outros dados relevantes que possam influenciar a atividade ou o comportamento dos diferentes grupos faunísticos.
DA DELIMITAÇÃO DA ÁREA DE ESTUDO E DEFINIÇÃO DOS SÍTIOS AMOSTRAIS
Art. 5º O empreendedor deverá propor a delimitação da Área de Estudo - AE referente ao Meio Biótico, a qual deverá abranger as áreas utilizadas como referência para o diagnóstico a ser realizado, pendendo tal delimitação de aprovação pelo Ibama.
Parágrafo único. Nos casos de implantação deverá ser estabelecida uma faixa na qual deverão estar englobadas todas as alternativas locacionais.

Art. 6º A definição dos quantitativos e da distribuição dos sítios amostrais deverá ser realizada com base nas fitofisionomias mais representativas existentes ao longo do empreendimento, refletindo a heterogeneidade da paisagem (mosaico) existente na região e contemplando, preferencialmente, áreas interceptadas e/ou mais próximas ao empreendimento.
§1º Deverá ser apresentada carta-imagem ou ortofotocarta, georreferenciada e atualizada, com localização dos sítios de amostragem, após vistoria de campo e validação das informações.
§2º Deverão ser previamente autorizados os potenciais sítios de amostragem, não limitados pelo esforço amostral mínimo exigido.
§3º Os sítios amostrais poderão ser independentes entre si (não sobrepostos) em relação aos grupos faunísticos, métodos e esforços.
§4º É estritamente necessária a aprovação pelo Ibama, antes da realização dos levantamentos de fauna, da quantificação e distribuição dos sítios amostrais a serem empregados durante as atividades.
DOS GRUPOS FAUNÍSTICOS OBJETO DE AMOSTRAGEM
Art. 7º Deverão ser objeto de amostragem os seguintes grupos faunísticos: I - invertebrados bentônicos II - anfíbios; III - répteis; IV - aves; V - quirópteros; VI - pequenos mamíferos não-voadores; VII - médios e grandes mamíferos;
§ 1º A amostragem de invertebrados bentônicos deverá ser realizada nas sub-bacias incidentes na área de estudo, naqueles corpos d'água interceptados pelo traçado do empreendimento. O número de sítios amostras será definido mediante aprovação do Ibama.
§ 2º A amostragem específica de quelônios e crocodilianos poderá ser dispensada quando inexistirem sítios de desova e/ou reprodução na área de estudo do empreendimento.

§ 3º Deverá ser incluído estudo de ictiofauna em casos de empreendimentos localizados em áreas de potencial ocorrência de espécies de interesse especial para conservação, com a proposição de métodos e esforços a cargo do empreendedor.
§ 4º A coleta de espécimes só será permitida em casos excepcionais, expressamente indicados na Autorização de Captura, Coleta e Transporte de Material Biológico a ser emitida pelo Ibama.
DA FORMA DE APRESENTAÇÃO DOS DADOS SOLICITADOS
Art. 8º O empreendedor deverá apresentar, junto com a Ficha de Caracterização da Atividade (FCA), carta-imagem (impressa e em formato digital) em duas escalas espaciais distintas, contendo as seguintes informações:
a) eixo projetado do empreendimento; b) área de estudo; c) conjunto dos sítios amostrais; d) sítios amostrais que receberão métodos que envolvem captura; e) fitofisionomias e cursos hídricos a serem impactados; f) limites das terras indígenas e das unidades de conservação federais, estaduais e municipais, e respectivas zonas de amortecimento, especificando a distância dessas em relação ao eixo do empreendimento.
Parágrafo único. Deverão ser encaminhados os arquivos vetoriais espaciais dos elementos citados neste artigo, em formato ".shp" (incluindo arquivos associados) e ".kmz" ou ".kml" (Google Earth).
Art. 9º O empreendedor deverá apresentar toda a documentação necessária para a emissão da Autorização de Captura, Coleta e Transporte de Material Biológico para as amostragens de fauna, conforme IN IBAMA XX.
DOS MÉTODOS DE AMOSTRAGEM POR GRUPOS FAUNÍSTICOS
Art. 10 No levantamento de fauna para a elaboração dos Estudos Ambientais deverão ser utilizados os métodos e esforços amostrais descritos no anexo I desta IN.
DA AMOSTRAGEM DE ATROPELAMENTO DE FAUNA
Art. 11 Para os empreendimentos onde exista tráfego de veículos ou de composições ferroviárias deverão ser efetuadas amostragens mensais de atropelamento de fauna, 6 (seis) antes da LP e 6 (seis) antes da LI, como forma de avaliar os impactos sobre a fauna e subsidiar a proposição de medidas de mitigação.

§ 1º O espaçamento das campanhas amostrais deverá ser fixo, podendo haver flexibilidade máxima de atraso de início das campanhas em 1 (uma) semana, de modo a não comprometer a avaliação da variação sazonal.
§ 2º As amostragens deverão ser realizadas em veículo ou automóvel de linha com velocidade máxima de 40 km/h, para garantir que não haja perda de informações e que sejam facilitadas as eventuais paradas para identificação e registro de animais e vestígios.
§ 3º No caso de rodovias, estas deverão ser percorridas em um sentido e depois no outro, de modo a amostrar ambos os lados, não sendo aceitos intervalos entre os percursos.
§ 4º Visando uma estimativa mais precisa das taxas de atropelamento de fauna, deverá ser calculado, obrigatoriamente, um fator de correção a partir da comparação entre as taxas obtidas por meio das amostragens de carro/automóvel de linha e a pé. I- para a execução do monitoramento de atropelamentos a pé deverão ser selecionados aleatoriamente os trechos do empreendimento a serem percorridos. II- o número e a extensão dos trechos citados no inciso anterior deverão garantir a suficiência amostral necessária para fornecer a confiabilidade estatística aos dados obtidos.
§ 5º Visando ainda uma estimativa mais precisa das taxas de atropelamento de fauna, deverá ser calculada a taxa de remoção de carcaças para cada grupo taxonômico monitorado.
§ 6º Deverão ser apresentados os dados climáticos da região no período de realização das campanhas, incluindo índice pluviométrico, temperatura média e outros dados relevantes que possam influenciar a atividade ou o comportamento dos diferentes grupos faunísticos.
§ 7º Sempre que houver visualização ou indício de animal atropelado no empreendimento ou em sua faixa de domínio, o deslocamento deverá ser interrompido para que a equipe obtenha as informações constantes do "Formulário para Registro de Atropelamentos de Espécimes da Fauna", que deverá ser preenchido por completo.
§ 8º Todos os dados provenientes de cada "Formulário para Registro de Atropelamentos de Espécimes da Fauna" deverão ser compilados em planilha eletrônica única, de modo a possibilitar a alimentação de um banco de dados.
§ 9º Caso não seja possível a pronta identificação das espécies, os registros fotográficos deverão permitir a posterior identificação com auxílio de literatura especializada.

§ 10 Todo animal encontrado atropelado deverá ser marcado com tinta spray, visando evitar a recontagem.
§ 11 Deverá ser garantida ainda a sincronização entre o horário da câmera fotográfica e do GPS antes do início de cada levantamento no respectivo trecho.
Art. 12 O Anexo IX contempla a representação gráfica do disposto no artigo anterior.
DAS DISPOSIÇÕES FINAIS Ibama revisará
Art. 13 No caso de empreendimentos que já tenham sido total ou parcialmente licenciados por outros entes federativos, e que venham a ser avocados para o licenciamento ambiental federal, poderá ser estabelecido pelo Ibama um cronograma de transição, para adequação dos procedimentos e metodologias em curso àqueles dispostos nesta IN.
Art. 14 No caso de empreendimentos sujeitos a licenciamento ambiental simplificado, ou que estiverem em fase de regularização ambiental, já implantados e em operação, o Ibama poderá adaptar algumas das metodologias e procedimentos estabelecidos nesta IN, de modo a torná-las proporcionalmente adequadas à complexidade ou à situação do empreendimento.
Parágrafo único. O Ibama, mediante decisão motivada, poderá indicar metodologias mais simplificadas ou até mesmo dispensar o empreendedor da necessidade da realização de levantamento de fauna, para empreendimentos rodoviários e ferroviários que apresentem baixo potencial de causarem impactos ambientais negativos à fauna.
Art. 15 Esta IN deverá ser revisada após 2 (dois) anos de sua publicação, de modo a promover possíveis ajustes na sua aplicação.
Art. 16 O disposto nesta IN poderá ser utilizado no licenciamento ambiental de outros empreendimentos lineares, adaptando-se os métodos e procedimentos aqui estabelecidos às peculiaridades existentes nas demais tipologias.
Art. 17 Para os processos de licenciamento já em curso no Ibama, as regras contidas nesta IN valerão apenas para as fases de licenciamento subsequentes à que atualmente se encontra cada processo.
Art. 18 Esta Instrução Normativa entrará em vigor na data de sua publicação.

ANEXO I
Metodologias a serem executadas para cada grupo faunístico.
1. Invertebrados Bentônicos:
1.1. Deverão ser realizadas amostragens tréplicas de diferentes substratos nos corpos d'água selecionados, com o uso de amostradores apropriados ao ambiente local (tipo Surber, ou rede tipo D (malha de 500 micras) ou draga. A coleta deverá ser padronizada por área coberta (m²) em cada tipo de substrato, podendo haver combinação de amostradores. ROSENBERG, David M. et al. Freshwater biomonitoring and benthic macroinvertebrates. Chapman & Hall, 1993.
2. Répteis e Anfíbios:
2.1. Armadilhas de interceptação e queda ("pitfalls") - deverão ser estabelecidas no sítio amostral cinco unidades amostrais de "pitfalls" em forma de "Y", compostas por 5 baldes de 60 litros cada, distantes 10 m uns dos outros. Os baldes deverão ser interligados por uma cerca-guia de lona plástica com 50 cm de altura, que deverá ser enterrada à aproximadamente 5 cm de profundidade no solo e mantida em posição vertical por estacas de madeira às quais será grampeada. Os baldes deverão ser furados para evitar o acúmulo de água e morte dos espécimes. Deverá ser adicionado a cada balde um anteparo de isopor para abrigo e flutuação. As armadilhas deverão ser verificadas duas vezes ao dia, no meio da manhã e no meio da tarde. Nos períodos entre amostragens os baldes deverão permanecer fechados e com as cercas-guia recolhidas, ou seja, a estação só permanecerá apta à captura durante o período de campo. Esforço por sítio amostral: 7 dias x 20 baldes = 3360 armadilhas-hora. GIBBONS, J. Whitfield; SEMLITSCH, Raymond D. Terrestrial drift fences with pitfall traps: an effective technique for quantitative sampling of animal populations. Brimleyana, v. 7, p. 1-16, 1981.
2.2. Procura Visual limitada por tempo e Busca Auditiva - os pesquisadores deverão percorrer, diariamente, o sítio amostral durante três horas no período do amanhecer e três horas ao crepúsculo, vasculhando os microambientes acessíveis e registrando todos os espécimes avistados ou vocalizações. Esforço por sítio amostral: 6 horas x 7 dias = 42 horas. HEYER, Ronald et al. (Ed.). Measuring and monitoring biological diversity: standard methods for amphibians. Smithsonian Institution, 2014.
3. Crocodilianos e quelônios

3.1. Levantamentos noturnos - para as amostragens de crocodilianos deverão ser realizados levantamentos noturnos, utilizando canoa com velocidade de 10 km/h, em todas as épocas do ano.
3.2. Caso se justifique a captura de indivíduos, o empreendedor deverá propor as metodologias de captura mais eficazes para o grupo, considerando as características do ambiente a ser amostrado.
3.3. Avistamento e mapeamento de praias - visando a amostragem de crocodilianos e quelônios termorregulando, deverão ser realizadas estimativas de abundância por avistamento e mapeamento de praias. A metodologia consiste em percorrer (com utilização de embarcações ou a pé), diariamente, no período diurno, todo o perímetro de margens dos rios interceptados pelo traçado do empreendimento. As margens deverão ser vistoriadas por dois observadores usando binóculos, fotografando-se, na medida do possível, todos os indivíduos amostrados. Os indivíduos devem ser contados e identificados taxonomicamente. Áreas de concentração deverão ser georreferenciadas. CANTARELLI, V. H. The Amazon turtles - Conservation and management in Brazil. Conservation, Restoration, and Management of Tortoises and Turtles. New York Turtle and Tortoise Society, New York, p. 407-410, 1997. RUEDA-ALMONACID, José Vicente et al. Las tortugas y los cocodrilianos de los países andinos del trópico. Serie de guías tropicales de campo, n. 6, p. 412-423, 2007. BALESTRA, Rafael Antônio Machado et al. Roteiro para Inventários e Monitoramentos de Quelônios Continentais. Biodiversidade Brasileira, n. 1, p. 114-152, 2016.
4. Aves:
4.1. Pontos de escuta - este método deverá permitir o levantamento de dados quantitativos e o cálculo do Índice Pontual de Abundância - IPA. A amostragem auditivo-visual deverá ocorrer no sítio amostral, em pontos fixos, distantes 500 m entre si. O período de amostragem em cada um desses pontos deverá ser de 10 minutos, ao longo de 4 dias. As amostragens diárias deverão se iniciar ao amanhecer, com a realização de seis pontos, e ao crepúsculo, com a realização de três pontos. Esforço por sítio amostral: 9 pontos (10´) x 4 dias = 36 pontos (10´). VIELLIARD, J. M. E. et al. Levantamento quantitativo por pontos de escuta e o Índice Pontual de Abundância (IPA). MATTER, SV; STRAUBE, FC; ACCORDI, I.; PIACENTINI, V, p. 47-60, 2010.
4.2. Lista de Mackinnon - consiste em registrar todas as espécies de aves vistas e/ou ouvidas ao longo de transectos no sítio amostral, percorridos de forma aleatória. Cada lista deverá ter número fixo de 10 espécies não repetidas. As amostragens diárias, ao

longo de três dias intercalados com as amostragens por Ponto de Escuta, deverão contemplar o amanhecer e o crepúsculo.

Esforço por sítio amostral: ≅ 3 horas x 3 dias = ≅ 9 horas.

SUTHERLAND, William J.; NEWTON, Ian; GREEN, Rhys. Bird ecology and conservation: a handbook of techniques. Oxford University Press, 2004.

5. Mamíferos não-voadores

5.1. Armadilhas de contenção viva (do tipo "live-trap") - deverão ser estabelecidas no sítio amostral duas linhas de armadilhas. Cada linha deverá ser composta por 20 armadilhas "Tomahawk" e "Sherman", iscadas, dispostas no solo e, quando possível, no sub-bosque, com espaçamento longitudinal de 20 m entre cada armadilha. As armadilhas deverão ser checadas duas vezes ao dia, no meio da manhã e no meio da tarde.

Esforço por sítio amostral: 2 linhas x 20 armadilhas x 7 dias = 6720 armadilhas-hora.

KIRKLAND, Gordon L. Guidelines for the Capture, Handling, and Care of Mammals as Approved by the American Society of Mammalogists. Journal of Mammalogy, v. 79, n. 4, p. 1416-1431, 1998.

5.2. Armadilhas de interceptação e queda ("pitfalls") - o método de distribuição dos "pitfalls" deverá usar o mesmo modelo adotado para os anfíbios e répteis.

5.3. Busca Ativa limitada por tempo – transectos aleatórios no sítio amostral deverão ser percorridos, em dois horários do dia, com caminhadas iniciadas ao amanhecer e ao entardecer, buscando contato visual, auditivo (vocalizações) e observação de vestígios (pegadas, pelos, fezes, marcações, tocas, restos de carcaças). Os vestígios e os espécimes observados deverão ser georreferenciados e, sempre que possível, fotografados para o registro e confirmação da espécie.

Esforço por sítio amostral: ≅ 3 horas x 7 dias = ≅ 21 horas.

BUCKLAND, Stephen T. et al. Introduction to distance sampling estimating abundance of biological populations. 2001.

WEMMER, Christen et al. Mammalian sign. Measuring and monitoring biological diversity. Standard methods for mammals. DE Wilson, F. Russell Cole, JD Nichols, R. Rudran y MS Foster (eds.). Smithsonian Institution, Washington, DC, p. 157-176, 1996.

5.4. Armadilhas fotográficas - deverão ser dispostas 6 armadilhas em cada sítio amostral. O local de instalação das armadilhas deverá ser ajustado em campo, de acordo com a experiência do profissional especialista, buscando primordialmente os trilheiros/carreiros da fauna, com obtenção das coordenadas geográficas. As armadilhas deverão ser programadas para registrar horário e data, com o objetivo de identificar o período de atividade das espécies.

TOMAS, W. M.; MIRANDA, G. H. B. Uso de armadilhas fotográficas em levantamentos populacionais. Métodos de estudos em biologia da conservação e manejo da vida silvestre, p. 243-267, 2003.
6. Quirópteros
6.1. Busca Ativa limitada por tempo – na área de estudo deverão ser percorridos transectos buscando abrigos artificiais (como túneis, forros de telhado, construções civis abandonadas, sob pontes) e também em abrigos naturais (cavidades naturais, folhas de helicônias, fendas em rochas e ocos de árvores). Esforço por sítio amostral: ≅ 2 horas x 7 dias = ≅ 14 horas.

Estratégia Nacional para Mitigação de Impactos da Infraestrutura Viária na Biodiversidade (BioInfra Brasil)

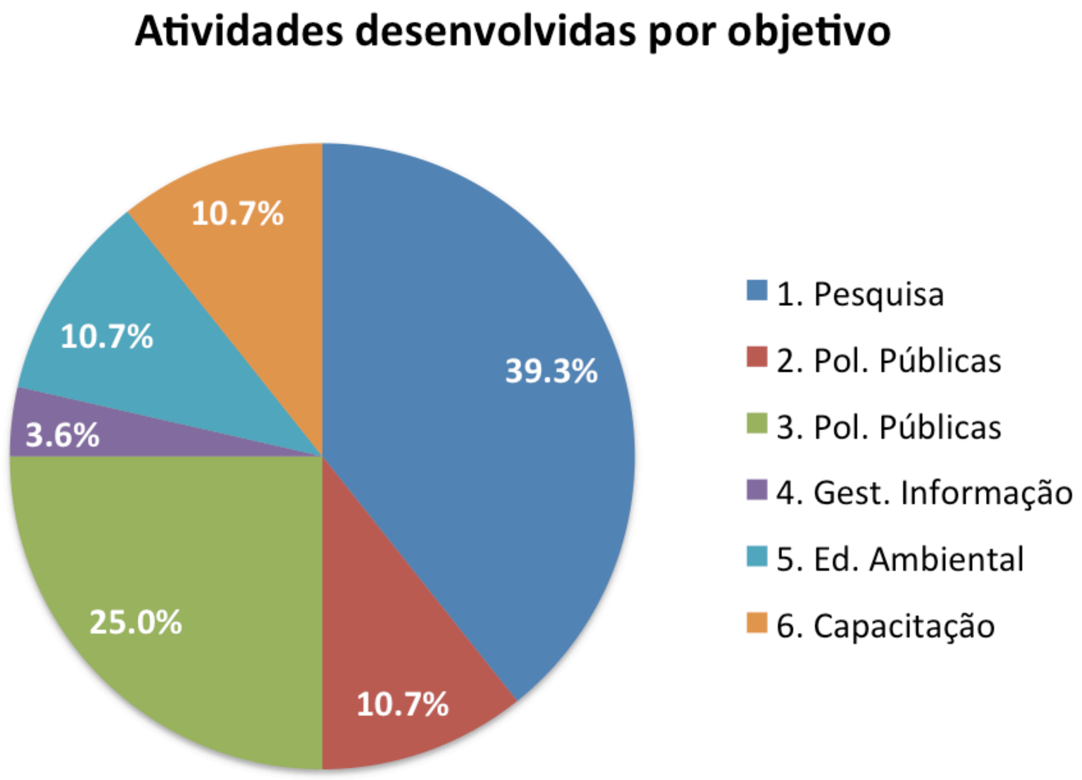
Primeiramente pensado como um workshop, a BioInfra Brasil surgiu a partir de uma atividade do Projeto Malha, financiado pelo FUNBIO/TFCA. Convites oficiais foram enviados diretamente para instituições representantes de órgãos governamentais, academia, terceiro setor, concessionárias, empresas de consultoria, dentre outros. Inscrições foram abertas para formalizar o interesse na participação. Devido ao limite de vagas, realizou-se uma seleção buscando garantir a representatividade de todos os diferentes setores.

A Oficina de Planejamento foi realizada nos dias 17 e 18 de setembro de 2015, em Brasília (DF), contando com a participação de 50 profissionais, entre especialistas, pesquisadores, representantes de órgão públicos e técnicos de 18 instituições. Nela, foi discutido o objetivo principal do documento, com a definição das ações a serem cumpridas em um prazo de seis anos (a partir de fevereiro de 2016).

A primeira reunião do Grupo de Assessoramento Técnico (GAT) ocorreu entre os dias 16 a 18 de dezembro de 2015, em Brasília (DF). Durante sua realização, o GAT revisou a matriz de ações e definiu produtos, metas e indicadores para cada uma das ações propostas, itens que comporão a avaliação anual da BioInfra Brasil. Fizeram-se presentes 15 representantes de oito instituições.

Durante a realização do I Congresso Iberoamericano de Biodiversidade e Infraestrutura Viária (I CIBIV), ocorreu a Reunião de Monitoramento do Primeiro Ano da BioInfra Brasil (10 e 11 de novembro de 2016), em Lavras (MG). Com a presença de 11 participantes de sete instituições, foi realizada uma análise do andamento das ações, bem como foram discutidas alterações de prazos para realização das ações e da estratégia, substituições de articuladores e ampliação da abordagem englobando a biodiversidade. A proposta da BioInfra Brasil tem foco na esfera federal. Estratégias Estaduais, que busquem atuar em nível regional, podem ser elaboradas no futuro.

O diagnóstico do primeiro ano de ações da Estratégia identificou que, apesar de inúmeros atrasos, foram iniciadas 28 atividades. A maioria das atividades iniciadas se referem ao objetivo 1, Pesquisa, mas todos os objetivos tiveram atividades em andamento e/ou concluídas. Na reunião foi estabelecido a inclusão de um novo objetivo (7), referente a ações de comunicação.



Em março de 2017 será publicado o Sumário Executivo da BioInfra Brasil e amplamente divulgado nas redes sociais do CBEE e dos demais parcerios.

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