INITIATION OF ROAD ECOLOGY PROGRAM AT ESCOLA SUPERIOR DE AGRICULTURA LUIZ DE QUIROZ (ESALQ), UNIVERSITY OF SÃO PAULO, PIRACICABA, BRAZIL

Report to Funding Organization:

Coordination for the Improvement of Higher Education Personnel (CAPES), Ministry of Higher Education, Brazil

Prepared by:

Dr. Marcel P. Huijser,
Western Transportation Institute – Montana State University
PO Box 174250, Bozeman, MT 59717-4250, USA

And

Dr. Katia Maria P. M. B. Ferraz, ESALQ – University of São Paulo
Av. Pádua Dias, 11 - Caixa Postal 09, 13418-900 - Piracicaba - SP – Brazil

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DISCLAIMER STATEMENT

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1. INTRODUCTION

1.1. Background

The transportation infrastructure network has increased tremendously across the world over the last century. A well-developed transportation infrastructure network allows to the safe and efficient transportation of people and goods and it is associated with economic growth and development. While roads and railroads form an essential link between cities and villages, they also cut through agricultural and natural areas and wildlife habitat. Wildlife-vehicle collisions result and a subset of these collisions, particularly those involving large mammals, pose a threat to human safety and have a substantial economic impact (Huijser et al., 2009; 2013). While the concern for human safety is a major driver for mitigation measures in some regions (e.g. North America) the impacts of transportation infrastructure on wildlife may also require mitigation. The impacts on wildlife are diverse and may include (based on Forman et al., 2003; Beckman et al., 2010) (Figure 1):

- Habitat loss. The road surface and roadbed destroy or affect natural vegetation, soil and hydrology. The vegetation in the right-of-way may also have been seeded with non-native species and may allow for invasive species to spread alongside the transportation corridor and into the adjacent landscape. The clear zone immediately adjacent to the pavement allows drivers an opportunity to regain control of their vehicle after having left the road surface. The vegetation in the clear zone is mowed and cut frequently as larger trees and shrubs form obstacles that may result in a more serious crash.
- Direct wildlife road mortality. Wildlife-vehicle collisions are not only a threat to human safety. The animals involved typically die as the result of a crash.
- Barrier to wildlife movements. Most animal species do not cross the road as often as they cross natural terrain and only a portion of the crossing attempts is successful. This leads to smaller and more isolated habitat patches that can affect the population survival probability of a species in an area.
- Decrease in habitat quality in a zone adjacent to the road. Noise, light, air and water pollution, and increased access for humans into areas adjacent to roads can affect the habitat quality in a zone adjacent to transportation infrastructure. Depending on the parameter and species concerned the road effect zone may vary between a few meters up to several kilometers.
- Right-of-way habitat and corridor. The vegetation in the right-of-way is subject to severe disturbance (soil, hydrology, mowing or cutting, seeding of non-native species etc.). Non-native and invasive plant and animal species can use the transportation corridor to spread alongside the infrastructure and can also spread into the surrounding areas. If the transportation corridor is surrounded by natural vegetation with little disturbance, the habitat and the species in the right-of-way can be considered a problem (Huijser et al., 2006). On the other hand, if the surrounding landscape is heavily impacted by humans already (e.g. (sub)urban and agricultural areas), then the narrow strip alongside roads and railroads can be a refugium for native species and because of the linear nature of transportation infrastructure right-of-ways may form efficient corridors connecting the remaining habitat patches in the fragmented landscape (Huijser et al., 2006).

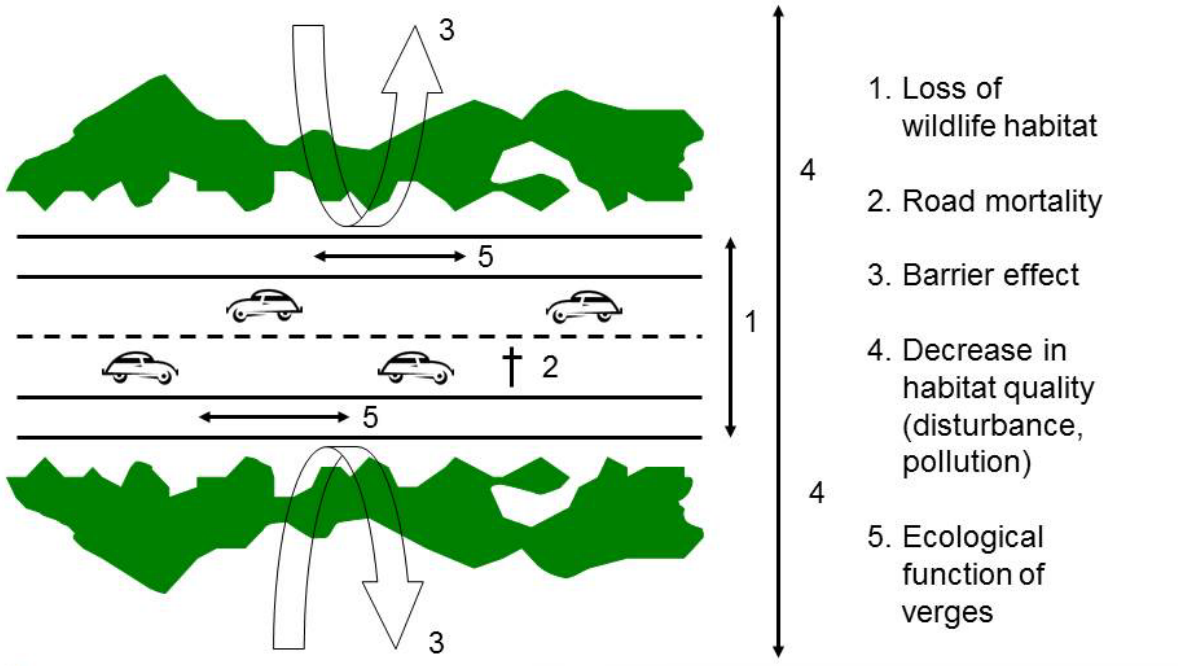


Figure 1: The effects of roads and traffic on wildlife.

While mitigation (reducing the severity of an impact) is common, avoidance is better and should generally be considered first (Cuperus et al., 1999). For example, the negative effects of roads and traffic may be avoided if a road is not constructed, or the most severe negative effects may be avoided by re-routing away from the most sensitive areas (Figure 2). If the effects cannot be avoided, mitigation is a logical second step. Mitigation is typically done in the road-effect zone (Figure 2) and may include measures aimed at reducing wildlife-vehicle collisions and reducing the barrier effect (e.g., through providing for safe wildlife crossing opportunities) (Huijser et al., 2008; Clevenger & Huijser, 2011). However, mitigation may not always be possible or the mitigation may not be sufficient. Then a third approach may be considered: compensation or off-site mitigation. Compensation may include increasing the size existing habitat patches, creating new habitat patches or improving the connectivity between the habitat patches that would allow for larger, more connected, and more viable network populations. Finally, in some situations a combination of avoidance, mitigation, and compensation may be implemented.

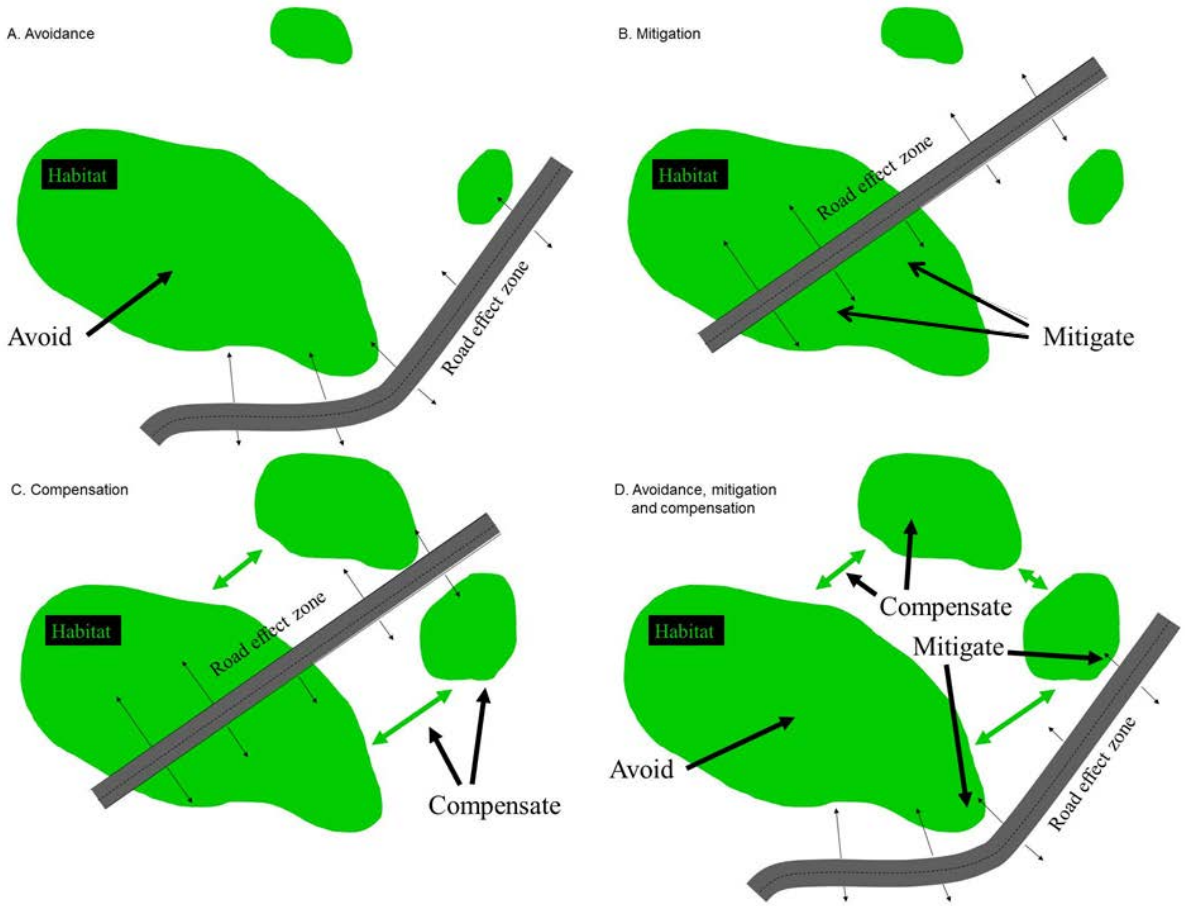


Figure 2: A three step approach: A. Avoidance, B. Mitigation, C. Compensation, D. Combination of avoidance, mitigation and compensation.

While there are several dozens of types and combinations of mitigation measures aimed at reducing wildlife-vehicle collisions and providing safe crossing opportunities for wildlife, there are only a few measures that are substantially effective: wildlife fencing in combination with wildlife underpasses and overpasses and, though more experimental, also animal detection systems (see e.g. Huijser et al. 2008; Clevenger & Huijser, 2011). We refer to these publications for a general overview. In essence, wildlife fencing is one of the most effective ways to keep large animals off the road; collisions with large mammals are typically reduced by 79-99%. It is considered bad practice though to increase the barrier effect of roads and traffic for wildlife without also providing for sufficient safe and suitable wildlife crossing opportunities. For relatively high traffic volume (>15,000 vehicles/day) a physical separation of vehicles and wildlife is almost always desirable. This can be achieved by providing underpasses and overpasses. At relatively low traffic volume (e.g. < 3,000 vehicles/day) one may consider at grade crossing opportunities (basically a gap in the fence on both sides of the road), but additional measures including advisory or mandatory speed limit reduction and traffic calming measures (e.g. speed bumps or bulb outs), and measures that encourage the animals to cross the road straight (e.g. wildlife guards or electric mats embedded in the road on either end of the gap) may be important to achieving a substantial reduction in large mammal-vehicle collisions.

Animal detection systems may also be used at gaps in fences, but these systems are still mostly experimental rather than a robust mitigation measure that can be expected to function as intended immediately after installation. Animal detection systems can also be implemented as a stand-alone mitigation measure and can also substantially reduce collisions with large mammals (range 58-99%). While the implementation of these types of mitigation measures costs money, there are many road sections where it is more costly to have wildlife vehicle collisions continue to occur than to implement mitigation measures (Huijser et al., 2009; 2013).

Brazil is a large country and its road network is about 1,580,964 km long, excluding urban areas. About 212,798 km is paved and 1,368,166 km is unpaved (World Fact Book, 2013). The railroad network in Brazil is about 28,538 km long. Brazil may also have higher biodiversity than any other country on the planet, and is among the countries with the highest number of endemic species. The rapid economic development in Brazil, including road and railroad construction, is likely to severely impact human safety as well as biodiversity.

1.2. Goals and Objectives

The goals of the visiting professorship for Dr. Marcel P. Huijser were to:

- Bring road ecology expertise to Brazil
- Help develop science based guidelines for the design and implementation of mitigation measures aimed at reducing wildlife-vehicle collisions and increasing safe crossing opportunities for wildlife along roads and railroads in Brazil.

The specific objectives were to

- Teach a road ecology course to students (Master of Science level) and other interested individuals (scientists, policy makers, consultants) at ESALQ, University of São Paulo, Piracicaba.
- Advice students during the early phase of their road ecology research projects.
- Write and submit one or more peer-reviewed scientific road ecology articles based on existing data through collaborations with Brazilian scientists.

1.3. Organization of the Report

The report is organized based on the following activities:

- Road ecology course for post-graduate students.
- Advice to students in the early phase of their road ecology research projects
- Peer-reviewed scientific articles through collaboration with Brazilian scientists.
- Guest lectures and workshops for various organizations

2. ROAD ECOLOGY COURSE

The 8 credits (120 hours) road ecology course was taught by Dr. Marcel Huijser at ESALQ, University of São Paulo, Piracicaba between 29 September 2014 and 24 October 2014 (see Appendix A1 for announcement and description, and Appendix A2 for declaration). The road ecology course was attended by 14 students (Table 1).

Table 1: Students who attended the road ecology course.

Name
Fernanda Delborgo Abra
Lilian Bonjorne de Almeida
Maisa Ziviani Alves
Julia Camara de Assis
Alan Eduardo de Barros
Alex Augusto de Abreu Bovo
Renata Bergamo Caramez
Larissa Oliveira Gonçalves
Marcelo Magioli
Renata Miotto
Bruna Oliveira
Miriam Lucia Lages Perilli
Ricardo Reale
Thaís Rovere Diniz Reis

There were several guest lecturers who contributed to the road ecology course (Table 2).

Table 2: Guest lecturers for the road ecology course.

Name	Affiliation
Fernanda Abra	PhD student at ESALQ and employee at Prime Engenharia
Simone Freitas	Universidade Federal do ABC
Ronaldo Morato	Centro Nacional de Pesquisa e Conservação de Mamíferos Carnívoros (CENAP)
José Luis Ridente	Prime Engenharia
Marcelo Ruil	engineer, consultant
Marco Antonio Marques de Sousa	Consultant
Bethanie Walder	Consultant

In addition, Milena Arthur and her colleagues at Centrovias and Paulo Ruffino and his colleagues from the Itirapina Ecological Research Station (Estação Ecológica de Itirapina) helped with the field trip to the area around Itirapina. During the field trip the students experienced three different road types: 1. Dirt roads in the Estação Ecológica de Itirapina; 2. A two lane road through the reserve; and 3. A 4-lane motorway (SP-225) with mitigation measures (wildlife fencing and wildlife and multi-functional underpasses) between Brotas and Itirapina.

The students were asked to fill out an evaluation survey for the road ecology course after completing the course (Appendix B).

3. ADVICE TO STUDENTS AND OTHER RESEARCHERS

Dr. Marcel P. Huijser is or was a committee member for three students during his stay in Brazil. In addition, he advised several of the students on their MSc or PhD theses who participated in the road ecology course (see chapter 2). Furthermore, he advised Mozart Caetano de Freitas Junior and Ricardo Arrais on their draft manuscript "Overlooked threat: The impact of railways in the conservation of medium and large mammals in Brazil". In addition, Dr. Marcel P. Huijser participated in the examination of PhD. candidate Giordano Ciocheti at the Universidade Federal de São Carlos, São Paulo. The title of his thesis is “Spatial and temporal influences of road duplication on wildlife road kill using habitat suitability models”. Finally, Dr. Marcel P. Huijser participated in discussions with the Dr. Andreas Kindel and his research group (including Fernanda Zimmermann Teixeira and Larissa Oliveira Gonçalves), Universidade Federal do Rio Grande do Sul, Centro de Ecologia, Núcleo de Ecologia de Rodovias e Ferrovias, Porto Alegre Rio Grande do Sul.

Table 3: Dr. Marcel P. Huijser is/was a committee member for the following students in Brazil.

Time period	Student name and title thesis
August-December 2014	Advised on PhD thesis Fernanda Delborgo Abra "Impacto de Rodovias nas Comunidades de Médios e Grandes Mamíferos e suas implicações para a conservação". ESALQ, USP, Piracicaba, São Paulo
August-December 2014, Defense 5 Dec 2014 (Appendix C1)	Advised on undergraduate thesis Ana Scivittaro Cruz “O licenciamento ambiental de Rodovias e medidas de mitigação para fauna silvestre: uma ferramenta para conservação da biodiversidade” Estudo de caso do Trecho Norte do Rodoanel Mário Covas". ESALQ, USP, Piracicaba, São Paulo
August-December 2014, Defense 5 Dec 2014 (Appendix C2)	Advised on undergraduate thesis Tamiris Chacon Deajute "Análise de modelos de passagem de fauna e cercas condutoras para animais silvestres em rodovias do Estado de São Paulo". ESALQ, USP, Piracicaba, São Paulo

4. PEER REVIEWED ARTICLES

Dr. Marcel P. Huijser is a co-author on four papers that are currently in analyses or draft stage (Table 4).

Table 4: Draft papers that Dr. Marcel P. Huijser is a co-author on.

Time period	Peer-reviewed papers (in analyses/draft stage)
29 Sep 2014 and beyond	Fernanda D. Abra, Vânia R. Pivello, Marcel P. Huijser, and Katia Ferraz. In prep. Effectiveness of wildlife fencing and wildlife underpasses in reducing road mortality and providing safe crossing opportunities along the SP-225 highway in São Paulo State, Brazil
29 Sep 2014 and beyond	Authors and order of authors not fully determined yet. In prep. Design recommendations for wildlife fencing and wildlife crossing structures along highways in Brazil
29 Sep 2014 and beyond	Miriam Lucia Lages Perilli et al. Road ecology related to vertebrates in Brazil: a literature review
29 Sep 2014 and beyond	Bruna G. Oliveira et al. In prep. Influence of dirt roads on the behavior maned wolves (*Chrysocyon brachyurus*)

5. GUEST LECTURES AND WORKSHOPS

Dr. Marcel P. Huijser was invited as a guest lecturer by various organizations (Table 5).

Table 5: Guest lectures and workshops provided by Dr. Marcel P. Huijser in Brazil.

Date	Activity	Location
4-Sep-14	Guest lecture for PRIME ENGENHARIA, "Ecological impacts of Infrastructure and Mitigation Measures"	São Paulo (Appendix D1)
5-Sep-14	Guest lecture for Departamento de Ciências Florestais "Why does road ecology matter to biological conservation?"	ESALQ, USP, Piracicaba, São Paulo (Appendix D2)
11-Sep-14	Lecture for DERSA "Road ecology: Engineering and Ecology Principles Working Together for More Sustainable Roads"	ARTESP, São Paulo (Appendix D3) Note: an article was published in "O EMPREITEIRO" (Appendix D4)
12-Sep-14	Introductory presentation for Graduate Program Committee "Road Ecology activities at ESALQ"	ESALQ, USP, Piracicaba, São Paulo (Appendix D5)
22-Sep-14	Introductory presentation for Board Departamento de Ciências Florestais "Road Ecology activities at ESALQ"	ESALQ, USP, Piracicaba, São Paulo (Appendix D6)
12-15 Nov 2014	Workshop - Impactos da rodovia BR-101 na Reserva Biológica de Sooretama: estudos, alternativas e mitigação "Human safety, biological conservation and economic considerations for upgrading existing highways"	Vitória, Espírito Santo (Appendix D7 and D8)
18-Nov-14	Provided full day workshop "Ecologio nas Estradas", organized by CART	UNIESP, Faculdade de Presidente Prudente, São Paulo (Appendix D9)
19-Nov-14	Provided full day workshop "Ecologio nas Estradas", organized by CART	Universidade Sagrado Coração, Bauru, São Paulo (Appendix D9)
26-Nov-14	Guest lecture "Why does road ecology matter to biological conservation?"	Universidade Federal do Rio Grande do Sul, Centro de Ecologia, Núcleo de Ecologia de Rodovias e Ferrovias, Porto Alegre Rio Grande do Sul (Appendix D10)

1-2 Dec-2014	Key note speaker at ECOTRANS conference "Human safety, biological conservation and economic considerations for wildlife highway mitigation"	CETESB, São Paulo (Appendix D11)
4-Dec-14	Guest lecture "Why Does Road Ecology Matter to Biological Conservation?"	Departamento de Genetica e Evolução, Universidade Federal de São Carlos, São Paulo (Appendix D12)
4-Dec-14	Guest lecture "Why Does Road Ecology Matter to Biological Conservation?"	Departamento de Ecologia da UNESP, Campus de Rio Claro, São Paulo (Appendix D13)
3, 8, 9, 10-Dec-14	Road ecology course (including workshop and field excursion) for CETESB	CETESB, São Paulo and SP-225 near Brotas and Itirapina (Appendix D14 and D15)

6. SUGGESTIONS FOR ROAD ECOLOGY PRACTICES IN BRAZIL

6.1. Transportation Mode, Highway Location and Footprint in Relation to (Re)Construction or Duplication

As Brazil is upgrading or building major infrastructure there is an opportunity to reassess which transportation mode is most suited. A motorway is not necessarily the best alternative in all situations. For example, when natural resources need to be transported in relatively uninhabited or undeveloped areas, a railroad may be far less damaging to both the natural environment and indigenous people than a road with associated human disturbance and development.

If a highway is upgraded or built it may be an opportunity to assess if the highway can be built away from or around the most sensitive areas. However, this only makes sense if the "old" road that may cut through a sensitive area is removed altogether and replaced by the new highway that avoids these sensitive locations. Otherwise it may make more sense to explore the effectiveness of mitigation and compensation measures for the route through the sensitive area.

If a highway route goes through a sensitive area it may be worthwhile to explore if the footprint of the road can be reduced (for the road section through the sensitive area). For example, instead of a 4-lane motorway everywhere, the highway section through the sensitive area may be reduced to a 2-lane highway or a "super 2" (one lane in each travel direction plus a passing lane for one direction). This is especially important if the sensitive area is relatively small to begin with or if a lower design speed is desired for the road section through the sensitive area.

Suggestions:

1. Carefully (re)consider if infrastructure is needed and if it is needed, what type of transportation mode is most appropriate. Simply building highways and railroads without consideration of the natural environment or the interests of indigenous people is associated with immediate and future problems and costs.
2. Consider avoiding the most sensitive areas including removing "old" infrastructure from sensitive areas. This may result in the avoidance of the most sever impacts rather than needing to mitigate or compensate for these impacts.
3. If transportation infrastructure is (re)build in a sensitive area consider implementing effective mitigation and/or compensation measures. If the measures are not effective in addressing the impacts, then reconsider the location of the transportation infrastructure and consider avoiding these areas by rerouting the infrastructure.
4. If transportation infrastructure is (re)build in a sensitive area consider a reduced footprint and reduced design speed for the section in the sensitive area.

6.2. Wildlife Warning Signs

One of the most commonly applied measures to attempt to reduce wildlife-vehicle collisions is to install wildlife warning signs (Figure 4). The abundance of wildlife warning signs is probably related to engrained practices and perceived low costs of the signs. Unfortunately most studies

indicate that standard and enhanced wildlife warning signs (see Figure 4) do not reduce wildlife-vehicle collisions. Wildlife warning signs that are specific in time and place can result in some reduction (temporary wildlife warning signs for migratory species) or a more substantial reduction (animal detection systems) in wildlife-vehicle collisions (Figure 4). If the objective is to reduce wildlife-vehicle collisions it is basically useless to install standard or enhanced wildlife warning signs. If the objective is to provide legal protection to transportation organizations in case of a collision, to provide information to the public and increase awareness of the problem, and to potentially increase public support for other mitigation measures that are effective in reducing wildlife-vehicle collisions, then one may consider using standard or enhanced wildlife warning signs.

Suggestions:

1. If the objective is to reduce wildlife-vehicle collisions then accept that standard or enhanced wildlife warning signs are not an effective mitigation measure.
2. Warning signs that are more specific in time and place can somewhat (temporal warning signs for migratory species) or substantially (animal detection systems) reduce wildlife-vehicle collisions. However, large migratory species may not be abundant in the tropics or subtropics. Furthermore, animal detection systems come with a range of limitations (e.g. mostly used on low volume roads (e.g. <5,000 vehicles per day), and the design (reliability), implementation and maintenance of these systems is likely to be very challenging. Therefore, learn about the limitations and risks associated with animal detection systems before initiating their implementation.

Figure 3: Four different types of wildlife warning signs.

6.3. Speed Management

Speed management is often suggested as a strategy to reduce wildlife-vehicle collisions. However, speed management is complex and it is important to distinguish between three types of "speed":

1. The design speed of a highway. This is used by engineers who then calculate the associated road characteristics such as lane and shoulder width, curvature and sight distance. These characteristics physically allow drivers to drive a certain speed in a safe and responsible manner.
2. The posted speed limit. This is the legal speed limit depicted on signs. This is typically a little lower than the design speed of a road.
3. The operating speed of the vehicles. This is the speed that drivers actually drive. Most drivers drive a speed (operating speed) that is close to the design speed of a road. Drivers respond far less to the posted speed limit.

If the posted speed limit is substantially reduced for a road section through a sensitive area, and if the design speed remains the same for this road section, the following scenario is likely:

1. Most drivers will ignore the lower posted speed limit and continue to drive a speed close to the design speed of the highway.
2. However, some drivers will adhere to the lowered posted speed limit.
3. The mix of fast and slow moving vehicles on a highway is referred to as "speed dispersion" and this is associated with dangerous driving behavior (e.g. irresponsible maneuvers to overtake slow vehicles) and an overall increase in crashes.

For these reasons alone, it is never a good idea to implement a posted speed limit that is substantially lower than the design speed of a highway.

Transportation agencies typically respond to drivers who ignore the posted speed limit and who drive a speed that is close to the design speed of a road by increasing enforcement of the lowered posted speed limit (e.g. through radar measurements of vehicle speed and fining the speeders). If the radar posts are at fixed locations, drivers who travel the road section regularly will quickly learn about the location of the radar posts and lower the speed of their vehicle only in the immediate vicinity of the radar posts. This leads to further speed variation and associated risks, additional use of fuel through braking and acceleration, and the road sections in between the radar posts do not actually have slower moving traffic.

Finally, drivers that do get "caught" are likely to experience the situation as "unjust". One cannot reasonably be expected to drive "slow" on a highway that has "wide" lanes, "wide" shoulders, "gentle" curvature and "long" sight distances. This is likely to eventually result in pressure to make the posted speed limit more consistent with the design speed of the road.

Suggestions:

1. It is not an effective or wise mitigation strategy to implement a posted speed limit that is substantially lower than the design speed of a highway.
2. Only consider lowering the posted speed limit if the design speed is reduced accordingly.

3. Depending on the purpose of a highway, lowering the design speed and posted speed limit may be in direct conflict with the need for "efficient" transportation and this may therefore not be a viable strategy to begin with.

6.4. Wildlife Fencing

The purpose of wildlife fencing is to:

1. Keep wildlife off the highway and, as a consequence, reduce wildlife-vehicle collisions.
2. Funnel wildlife movements to safe crossing opportunities (e.g. wildlife underpasses or overpasses).

Wildlife fencing alone increases the barrier effect of highways and traffic for wildlife. As a general rule, wildlife fencing should never be implemented without also providing for effective and safe crossing opportunities for wildlife (see next section).

It is essential to define the target species before designing wildlife fencing. The climbing, jumping, and digging capabilities of the target species as well as their strength (e.g. push or ram through fencing) needs to be considered. These species characteristics influence fence height, the type of fencing material (e.g. mesh-wire, chain-link, electric), the type of post (wood, metal, concrete), the strength of the material, as well as specific features to discourage climbing (e.g. outriggers) or digging (dig barrier). However, in some cases in Brazil "wildlife fencing" is not designed with specific species in mind. In some cases it is simply a livestock fence (same height) with chain-link attached to the posts instead of barbed wire (Figure 4) and this may not be a suitable barrier for the species that one desires to keep off the highway. For example, capybara (*Hydrochoerus hydrochaeris*) is one of the most commonly hit large mammal species in this region in Brazil. Capybara may require 1.80 m high fencing; much higher than standard livestock fencing. In other locations the design of wildlife fencing appears more appropriate (Figure 5).

Figure 4: "Wildlife" fence that is basically a livestock fence with chain-link attached to the lower portions of the fence posts, along SP-225, near Brotas, São Paulo, Brazil (© Marcel Huijser).

Figure 5: Wildlife fence at a stream and wetland that appears to have an appropriate height and sturdiness for various large mammal species in the area, SP-320 between Tanabi and Santa Fé do Sul, São Paulo, Brazil (© Marcel Huijser).

During the installation of wildlife fencing care should be taken not to leave gaps between the ground and the bottom of the fence, and, dependent on the target species and their climbing capabilities, a wildlife fence should typically maintain a certain minimum distance from trees and shrubs, including overhanging branches.

Fence maintenance appears to be a problem in most areas in Brazil (Figure 6-8). Without proper maintenance wildlife fencing becomes ineffective in keeping animals off the highway and directing them to safe crossing opportunities.

Figure 6: Damaged "wildlife fence" (i.e. this is essentially a livestock fence with chain-link attached to the lower portions of the fence posts), along SP-225, near Brotas, São Paulo, Brazil (© Marcel Huijser).

Figure 7: Disintegrated fence posts of a "wildlife fence" overgrown with vines (i.e. this is essentially a livestock fence with chain-link attached to the lower portions of the fence posts), along SP-225, near Brotas, São Paulo, Brazil (© Marcel Huijser).

Figure 8: Damaged "capybara fence" (though this fence is much too low to be an effective barrier for capybara), along Rodovia Presidente Dutra (BR-116 – SP-60), near Lavrinhas, São Paulo, Brazil (© Marcel Huijser). Note the bare spots in the vegetation on either side of the fence indicating that wildlife, presumably capybara regularly jump the fence at this location.

Most of the wildlife fencing in Brazil is relatively short. The road length fenced can be as little as just a few or only 100 m from each side of a wildlife underpass (Figures 9 and 10). Effective wildlife fencing (e.g. 80-100% reduction in wildlife-vehicle collisions) may need to be at least 3-5 kilometers in road length.

Figure 9: Very short wildlife fencing (almost nothing on this side of a culvert; about 10-20 m on the other side of the road), along the 2-lane road (Ayrton Senna) through the Itirapina reserve near Itirapina, São Paulo, Brazil (© Marcel Huijser). Note the cross indicating the site of a human fatality as a result of a collision with a capybara.

Figure 10: Well designed (height, sturdiness) wildlife fencing but only extending about 100 m from each side of a wildlife underpass, Parque Nacional de Aparados da Serra, Rio Grande do Sul, Brazil (© Marcel Huijser).

Suggestions:

1. Do not implement wildlife fencing without also providing for safe crossing opportunities for wildlife.
2. Before designing a wildlife fence decide on the "target species".
3. Base the design of wildlife fence on the biological characteristics of the target species.
4. Use material (fence posts, fencing material) that is consistent with the desired lifespan of the fence.
5. Oversee fence installation to make sure no gaps or other weak points in the fence result.
6. Implement fence maintenance programs, including for fallen trees and vines and other vegetation growing on and over fences (e.g. include maintenance requirements in contracts with toll road companies). Without fence maintenance wildlife fences typically become dysfunctional quickly.
7. When implementing wildlife fencing (in combination with safe crossing opportunities for wildlife) consider implementing the fencing over several kilometers of road length rather than at shorter road sections. If wildlife crossing opportunities are included, e.g. at least one large mammal crossing opportunity once every 2 kilometers, make the wildlife fencing connect to the wildlife structures without gaps in between.
8. Wildlife fencing should cover the road length that may have a concentration of wildlife-vehicle collisions with the target species (i.e. "hotspots") and adjacent buffer zones to keep the animals from simply crossing the highway at the fence ends. The length of the buffer zone is at least partially influences by the home range size of the target species. For white-tailed deer in North America 1 km long buffer zones have been suggested (starting from each end of the hotspot).

9. Always install wildlife fencing on both sides of a highway, not only on one side.
10. Always try to have wildlife fencing start and end on opposite sides of the highway rather than in a staggered pattern.
11. Consider implementing wildlife guards (similar to cattle guards) or electric mats embedded in the roadway to reduce wildlife intrusions into the fenced road corridor at fence ends and at access roads.
12. Fence end treatments (e.g. wildlife guard or electric mat embedded in the pavement) are especially important if the mitigated road length is relatively short in relation to the mortality hotspot and suggested buffer zones. While fence end treatments are likely to reduce intrusions by wildlife into the fenced road corridor, they do not address potential "fence end runs" by wildlife.

6.5. Safe Crossing Opportunities for Wildlife

The purpose of safe crossing opportunities for wildlife is to:

1. Allow wildlife to safely cross to the other side of the highway.
2. Reduce intrusions by wildlife into the fenced road corridor by providing more convenient and safe crossing opportunities.

Similar to wildlife fencing, the number, location, type (e.g. overpass or underpass), and dimensions of safe wildlife crossing opportunities are at least partially influenced by the biological characteristics of the target species, their preference for different types and dimensions of safe crossing opportunities, and their conservation status. At grade crossing opportunities (e.g. a gap in a wildlife fence on both sides of the highway) should probably only be considered at low volume roads (e.g. < 5,000 vehicles per day). Higher volume highways typically require a physical separation of traffic and wildlife through the construction of wildlife underpasses or overpasses.

Most safe crossing opportunities for wildlife in Brazil are either wildlife underpasses or canopy crossings for arboreal mammals (Figures 11-13). The type and dimensions of wildlife underpasses is relatively limited. Most wildlife underpasses are concrete box culverts (a few meters wide, a few meters high) or bridges in combination with a stream or river. However, the type and range of wildlife crossing structures in other parts of the world is much wider than that.

Figure 11: Wildlife underpass (concrete box culvert), along SP-225, near Brotas, São Paulo, Brazil (© Marcel Huijser).

Figure 12: Multifunctional underpass (bridge) along Rio Jacaré-Pepira, SP-225 motorway, Brotas, São Paulo, Brazil (© Marcel Huijser).

Figure 13: Canopy crossing for arboreal mammals, near Porto Alegre, Rio Grande do Sul, Brazil (© Marcel Huijser).

It is best to construct wildlife crossing structures in such a way that it allows wildlife that approaches the road to see the sky and vegetation on the other side of the road through or across the structure. This means that the approach for wildlife should preferably be level (avoid steep slopes at the approaches (e.g. Figure 14-15)), and that two separate structures for the two travel directions should be designed as one wildlife crossing structure with a good line of sight for wildlife.

Figure 14: Wildlife underpass (concrete box culvert), along SP-225, near Brotas, São Paulo, Brazil (© Marcel Huijser). Note: this structure is along the "old" highway (now only one travel direction). The "new" two lanes are behind the photographer and are for traffic going in the other direction. However, the "new" roadbed is higher than the old roadbed, and the structure in the "old" highway is substantially lower than the structure under the new roadbed. This does not allow wildlife to see through both structures when they approach the highway, and it requires wildlife to descend into a dark cave (when coming from this direction).

Figure 15: Wildlife underpass (concrete box culvert), along SP-270, about 70 km south east from Presidente Prudente, São Paulo, Brazil (© Marcel Huijser). There is an uphill slope towards the right of the image. It would be better to have a level approach for wildlife when they approach the structure (no slope).

Suggestions:

1. Always consider implementing safe crossing opportunities for wildlife when installing wildlife fencing.
2. Wildlife crossing opportunities without (functional) wildlife fencing are likely to have fewer wildlife move through the structure.
3. Wildlife crossing structures without (functional) wildlife fencing are unlikely to substantially reduce wildlife-vehicle collisions. The primary measure to reduce wildlife-vehicle collisions is wildlife fencing, not wildlife crossing structures.
4. Before designing safe wildlife crossing opportunities, and before deciding on the number and location of the safe crossing opportunities, decide on the "target species".
5. Built a greater variety of types of wildlife crossing structures; not only wildlife underpasses and canopy crossings, but also vegetated wildlife overpasses. Of course it is important to do this with the biology of the target species in mind and at locations where it makes most sense.
6. Built a greater variety of dimensions for wildlife underpasses (e.g. include larger underpasses (e.g. about 7-10 m wide, 3-5 m high) and smaller pipes (e.g. 0.5-1.0 m in diameter). Of course it is important to do this with the biology of the target species in mind and at locations where it makes most sense.
7. Accompany the implementation of wildlife crossing structures with research to investigate wildlife use and learn about possible preferences of the different target species with regard to the type and dimensions of the crossing structures.
8. When duplicating a highway (i.e. making a 2-lane highway into a 4-lane highway), consider the structures for the two travel directions as one wildlife crossing structure rather than as two separate ones. This implies that the type and dimension of the crossing structures for the two travel directions should generally match, and that the structures should be at the same level allowing wildlife to see through both structures when they approach the highway.
9. Create a very gradual, preferably level, approach for wildlife when approaching wildlife crossing structures. Avoid steep slopes (uphill or downhill), allow wildlife to see the sky and vegetation through or across the structure.

6.6. Multi-Functional Crossing Structures

In fragmented landscapes streams and rivers may be the only remaining corridors with natural or semi-natural vegetation. This is especially true in Brazil where regulations generally require a zone with natural vegetation of native species in a zone adjacent to the streams and rivers (Figure 16). Thus it seems logical to try and make stream or river crossings also suitable for wildlife:

1. Aquatic wildlife: It is best to have a natural stream bottom (bridge or bottomless culvert) to allow for natural stream dynamics and stream characteristics, including water velocity in the structure (Figure 17).
2. Semi-aquatic wildlife: It is best to allow for sufficient space for a transition zone between land and water (riparian zone). Ideally there should be sufficient space for this zone to change its location depending on the water levels.
3. Terrestrial wildlife: It is best to allow for sufficient space (e.g. at least 2 m wide, 3-5 m high) to allow large mammals to cross through the structure.

Figure 16: The area around Jibóa, São Paulo, Brazil. The image shows streams and rivers with a buffer zone of native shrubs and trees in an otherwise intensively used agricultural landscape.

Figure 17: Multi-functional underpass (water, wildlife), central California, USA (© Marcel Huijser).

Allowing for a natural stream bed, riparian, and a terrestrial zone typically requires a larger structure than for hydrology alone. However, it is not only wildlife that benefits from larger structures. Extreme weather events with high levels of precipitation may occur more and more frequently in the future, and they may become the new norm rather than the exception. Having relatively large culverts and bridges makes it less likely that these structures will be blocked by debris and /or washed out as a result of the water pressure and a saturated road bed.

Dividing walls inside the structure (Figure 18) should be avoided if the function of the structure is not only to pass water but also to pass wildlife. Dividing walls reduce the ability for wildlife that approach the structure to see the sky and the vegetation on the other side of the structure.

Figure 18: Multi-functional underpass (water, wildlife) with a dividing wall (the structure basically consists of two box culverts), along SP-270, about 70 km south east from Presidente Prudente, São Paulo, Brazil (© Marcel Huijser).

Suggestions

1. At stream and river crossings, do build structures that provide space for aquatic, semi-aquatic and terrestrial species. Note that this also reduces the risks for failed structures during periods with high precipitation.
2. It is important to not only built wildlife crossing opportunities in low and wet areas. Also build wildlife crossing structures in high and dry habitat as different wildlife species have different habitat preferences.

3. Allow for a natural streambed and natural stream dynamics when possible (i.e. bridges or bottomless culverts).
4. Avoid dividing walls or pillars inside a structure; make it as open as possible to allow wildlife to see the sky and vegetation on the other side of the structure.

6.7. Construction Considerations

Road and bridge construction requires heavy equipment. In most cases almost all the vegetation is removed to allow for space for machines, and soil and hydrology may also be severely affected (e.g. Figure 19). However, if one of the functions of a bridge is to allow wildlife to cross under the road, then it makes sense to minimize the disturbance and keep the natural vegetation, soil and hydrology as much intact as possible. Some bridges along the Rodoanel Norte were (partially) designed to allow howler monkeys (*Alouatta clamitans*) to pass under the highway. Therefore it would be best to keep shrubs and trees intact as much as possible so that a canopy connection between both sides of the road is available immediately after construction. Now that the vegetation has been destroyed, the soil has been compacted, and hydrology has been altered it may take many years before an effective canopy connection is restored and before the howler monkeys can be expected to move between both sides of the highway.

Figure 19: Overspan bridge under construction, Rodoanel Norte, São Paulo, Brazil (© Marcel Huijser). Note that the vegetation has been removed, and that the soil has been compacted everywhere by heavy machines.

It is possible to minimize vegetation removal and soil and hydrology impacts during the construction of a bridge (Figure 20). It requires restrictions for where machines and personnel can go. In the case of the desert vegetation under the bridge in Arizona it may take many hundreds of years for the vegetation to recover after a disturbance. Given the fact that a bridge may only have a life span of 75 years, the vegetation under the bridge would never have a chance to recover. Therefore it makes sense to minimize impacts to the vegetation and soil to begin with.

Figure 20: Overspan bridge shortly after construction, Tonto National Forest, Arizona, USA (© Marcel Huijser). Note that the impacts of the construction on the vegetation and soil have been minimized.

Suggestion:

1. Minimize the impact on natural vegetation, soil and hydrology while constructing wildlife or multi-functional crossing structures.

6.8. Median (Jersey) Barriers

In most cases there is sufficient space in the median to allow for a slope that triggers vehicles that have left the pavement to roll before they end up in the lanes of oncoming traffic. However, in some situations there may simply not be enough space (e.g. canyon, river) to allow for a wide median. In other cases the economic or social costs of acquiring right-of-way are high resulting

in a narrow right-of-way and the absence of a wide median. Concrete median (or Jersey) barriers can then be used as an alternative to keep vehicles from crashing into oncoming traffic (Figure 21).

Figure 21: Concrete median (Jersey) barriers along along SP-225, near Itirapina, São Paulo, Brazil (© Marcel Huijser).

By definition, median barriers increase the barrier effect of the highway and traffic for wildlife. It is unclear though if wildlife mortality changes as a result of the presence of the barriers. It may be that individual animals are less likely to cross the road as they cannot see the other side of the road because of the median barriers (fewer wildlife-vehicle collisions). On the other hand, individual animals that do attempt to cross the road may spend more time on the road trying to cross the median barriers and may therefore suffer increased risk of being hit by a car. This begs the question if mitigation measures should be implemented to reduce the barrier effect of the median barriers on wildlife and whether the risk of wildlife road mortality can or should be reduced.

In most cases concrete median barriers are implemented along relatively wide and high volume highways (at least several tens of thousands of vehicles per day). One could argue that it is undesirable to have (large) mammals cross such busy roads, let alone to try and encourage wildlife to cross these highways by creating openings in the median barriers. Therefore it seems more practical to accept that highways with median barriers are or should be considered to be an almost absolute barrier to many wildlife species, and that wildlife fencing in combination with

wildlife underpasses or overpasses should be considered in locations with a high number of wildlife-vehicle collisions or along road sections that bisect nature reserves or other sensitive areas.

Suggestions

1. Recognize that median (Jersey) barriers increase the barrier effect of the highway and traffic for wildlife.
2. Investigate the effect of the barriers on the number of wildlife-vehicle collisions.
3. In areas with a concentration of wildlife-vehicle collisions or in sensitive areas (e.g. nature reserves) consider the implementation of wildlife fencing and wildlife crossing structures (underpasses and overpasses).

6.9. Road Run-off Management

Drainage can be hard to combine with a wildlife fence as it may result in an opening in the fence allowing certain species to access the fenced road corridor. In the images below the drainage is positioned right above multifunctional underpasses (water, wildlife) (Figure 22-23). There are pros and cons associated with this approach:

Pros:

1. This may reduce intrusions of wildlife into the fenced road corridor as it is harder for wildlife to access the gap under the fence.
2. Depending on the construction it may be harder for vegetation to eventually block the gap under the fence and plug the drainage gutter.

Cons:

1. If it is a multi-functional underpass including for water, it is best avoided to drain run-off from the road directly into a stream, or river. Road run-off likely contains pollutants (e.g. from road surface, particles from tires) and sediments which should not go directly into a stream or river. It is better to drain road run-off into (artificial) depressions where it can percolate into the soil (Figure 24). The soil and microbes can then filter out or break down the pollutants and sediments before they get into the stream.
2. If it is a multi-functional underpass including for water, it is best avoided to drain any unnaturally concentrated water directly into a stream. Concentrating water and dumping it into a stream or river increases peak flows and increases the risk of flooding downstream. It is especially important to keep unnaturally concentrated water out of rivers and streams in areas with severe rain events (heavy downpours) and when such events may become more common in the future (climate change). It is better to drain road run-off into (artificial) depressions where it can percolate into the soil (Figure 24). As a consequence it takes more time for the water to reach the stream and the water does not reach the stream all at the same time.
3. In other situations the underpass may not have a stream or river, and the structure may be only or mostly intended for wildlife. However, when it rains, it results in a temporary "waterfall" at the entrance of the underpass. It is unknown if this affects wildlife use. "Falling water" may deter wildlife during a rain storm, but a puddle (after a rain storm)

may be an attractant. However, because of the pollutants in road run-off it is not advisable to encourage wildlife to drink this type of water.

4. In a "dry" underpass a hard (potentially artificial) surface is needed to prevent erosion where the water hits the ground. However, the surface in front of and inside an underpass should preferably match the natural soil of the surroundings.
5.

Figure 22: Drainage from road under wildlife fence at underpass, SP-270 about 70 km south east of Presidente Prudente, São Paulo, Brazil (© Marcel Huijser).

Figure 23: Drainage from road under wildlife fence at underpass, SP-270 about 70 km south east of Presidente Prudente, São Paulo, Brazil (© Marcel Huijser).

Figure 24: Rolling dips (basins) adjacent to a two-lane road near Santa Fé do Sul, São Paulo, Brazil (© Marcel Huijser).

Suggestions:

1. Do not direct road run-off into streams, rivers or other natural waterbodies.
2. Do direct road run-off into (natural) depressions where it can percolate into the soil and where pollutants and sediments can be filtered out before the water reaches a stream.
3. Do direct road run-off into (natural) depressions where it can percolate into the soil so that it takes longer for the water to reach the stream thereby reducing the risks of flooding downstream.

6.10. Anti-Erosion Netting

During and after road (re)construction there is often bare soil on slopes and a high risk of erosion. To reduce the risk of erosion anti-erosion netting can be used. The anti-erosion netting is usually not removed after the new vegetation has stabilized the soil.

If plastic (or nylon) anti-erosion netting is used it can be a death trap for animals, specifically snakes. The mortality may be so high that it could perhaps even be a population sink for snakes. Plastic or nylon netting may act as a death trap for many years, potentially even decades. Therefore it is best to use netting made out of natural fibers instead. Natural fibers are likely to decompose within a year and stabilize the soil long enough for vegetation to return and take over its task.

Figure 25: Plastic (or nylon) anti-erosion netting, Parque Nacional da Serra da Bocaina, São Paulo, Brazil (© Marcel Huijser).

Figure 26: Snake mortality in plastic (or nylon) anti-erosion netting, Montana, USA (© Marcel Huijser).

Suggestion:

1. Do not use plastic or nylon anti-erosion netting; consider anti-erosion netting made out of natural fibers instead.

7. FUTURE PLANS

The road ecology course at ESALQ was well received by the students (see Appendix B). In addition, there are a number of students who have initiated MSc, PhD or other studies related to road ecology (see Chapter 4) and these students are interested in having further input from Dr. Marcel P. Huijser. In addition, a network was established of researchers and practitioners from both the public and private sector (see Chapter 3, 5) and there appears to be a great need for better design, implementation and maintenance of mitigation measures aimed at reducing wildlife-vehicle collisions and maintain a certain degree of habitat connectivity for wildlife (Chapter 6). The positive feedback regarding the activities developed by Dr. Marcel P. Huijser in São Paulo state (as well as several other states), with CAPES and ESALQ support, demonstrates that the objective of initiating a road ecology program and stimulating road ecology activities in Brazil was reached successfully. The feedback on the activities developed so far and the interest that was expressed in the development of a more permanent road ecology research program at ESALQ has motivated us to continue the partnership between ESALQ and the Western Transportation Insitute. Therefore Dr. Katia Ferraz (ESALQ, USP) and Dr. Marcel P. Huijser (Western Transportation Institute) are planning to write another grant proposal. The new proposal would contain the following elements:

1. A (yearly) road ecology course for post-graduate students. The new road ecology course would likely differ somewhat from the 2014 course:
    a. Greater effort to not only recruit biology/ecology students, but also civil engineers, hydrologists and spatial planners. This would lead to a greater and faster shift in road (re)construction practices and how this relates to road ecology in Brazil.
    b. Greater effort to invite civil engineers hydrologists and spatial planners as guest speakers. This would increase the attention to abiotic and planning processes related to road ecology.
    c. Increase the amount of time dedicated to the field trip and associated research activities.
2. Participating in (field) research activities with Brazilian researchers. Now that Dr. Marcel P. Huijser and Dr. Katia Ferraz have extended their road ecology network in Brazil it is possible to be more involved with (field) research activities rather than mostly conducting analyses and writing related to existing data.
3. Setting up a larger research program involving different research groups in different parts of Brazil representing different biomes. The research program would focus on the impacts of road and traffic on the natural environment (and potentially also on indigenous people) and avoidance, mitigation and compensation strategies aimed at reducing these impacts. This effort should result in practical guidelines and recommendations for road (re)construction projects in different biomes throughout Brazil.

8. REFERENCES

Abra, F.D. 2012. Monitoramento e avaliação das passagens inferiores de fauna presentes na rodovia SP-225 no município de Brotas, São Paulo. *Dissertação de Mestrado*. Universidade de São Paulo. São Paulo, SP, Brasil.

Clevenger, A.P. & M.P. Huijser. 2011. Wildlife Crossing Structure Handbook Design and Evaluation in North America. Department of Transportation, Federal Highway Administration, Washington D.C., USA. Available from the internet: http://www.westerntransportationinstitute.org/documents/reports/425259_Final_Report.pdf

Clevenger, A.P. & A.V. Kociolek. 2013. Potential impacts of highway median barriers on wildlife: State of the practice and gap analysis. Environmental Management 52: 1299–1312.

Cuperus, R., K.J. Canters, H.A. Udo de Haes & D.S. Friedman. 1999. Guidelines for ecological compensation associated with highways. Biological Conservation 90: 41-51.

Forman, R.T.T., D. Sperling, J. Bissonette, A. Clevenger, C. Cutshall, V. Dale, L. Fahrig, R. France, C. Goldman, K. Heanue, J. Jones, F. Swanson & T. Turrentine. 2003. Road Ecology: Science and solutions. Island Press, Washington, DC.

Huijser, M.P. & A.P. Clevenger. 2006. Habitat and corridor function of rights-of-way. Pages 233-254 in: J. Davenport & J.L. Davenport (Eds.): The ecology of transportation: managing mobility for the environment. Series: Environmental Pollution, Vol. 10. Springer, The Netherlands.

Huijser, M.P., P. McGowen, J. Fuller, A. Hardy, A. Kociolek, A.P. Clevenger, D. Smith & R. Ament. 2008. Wildlife-vehicle collision reduction study. Report to Congress. U.S. Department of Transportation, Federal Highway Administration, Washington D.C., USA. Available from the internet: http://www.fhwa.dot.gov/publications/research/safety/08034/index.cfm

Huijser, M.P., J.W. Duffield, A.P. Clevenger, R.J. Ament, and P.T. McGowen. 2009. Cost-benefit analyses of mitigation measures aimed at reducing collisions with large ungulates in the United States and Canada; a decision support tool. Ecology and Society 14(2): 15. [online] URL: http://www.ecologyandsociety.org/viewissue.php?sf=41

Huijser,M.P. F.D. Abra & J.W. Duffield. 2013.Mammal road mortality and cost-benefit analyses of mitigation measures aimed at reducing collisions with capybara (*Hydrochoerus hydrochaeris*) in São Paulo State, Brazil. Oecologia Australis 17(1): 129-146.

The World Fact Book. 2013. The world fact book, Brazil. https://www.cia.gov/library/publications/the-world-factbook/geos/br.html

APPENDIX A1: ROAD ECOLOGY COURSE DESCRIPTION

Road ecology course

Start date: 29 September 2014
End date: 24 October 2014

Total credits: 8
Total number of weeks: 4
Total hours: 120

Course instructors:
Marcel P. Huijser, PhD, visiting professor at University of São Paulo, ESALQ, Ciências Florestais, Piracicaba (CAPES grant), e-mail: mhuijser@coe.montana.edu
Katia Ferraz, PhD, University of São Paulo, ESALQ, Ciências Florestais, Piracicaba, e-mail: katia.ferraz@usp.br

This course is open to graduate students of the University of São Paulo and other universities.

Deadline registration for the course: 12 September 2014

The road ecology course will be taught in English. The students are expected to have basic knowledge and understanding of English. The students will need to participate in classroom discussions, give podium presentations to the class, and be able to write in English. However, in order to participate in this course the student's English does not have to be perfect. The course instructor (Marcel) will try to communicate as clear as possible, and it is perfectly fine to ask for clarification when needed.

The exact schedule for the lectures, field trip, and other course activities will be decided on based on other potential other obligations of the students.

Objective

The objective of this course is to contribute to educating students with regard to the impacts of roads and traffic on wildlife, human safety aspects of wildlife-vehicle collisions, and cost-effective strategies aimed at avoiding, reducing or compensating for these impacts.

Justification

The transportation infrastructure network has increased tremendously across the world over the last century. A well-developed transportation infrastructure network allows for the safe and efficient transportation of people and goods and it is associated with economic growth and

development. While roads and railroads form an essential link between cities and villages, they also cut through agricultural and natural areas, including wildlife habitat.

Brazil has one of the largest and fastest growing economies in the world. This is accompanied by a quickly expanding infrastructure network. At the same time Brazil probably hosts the highest biodiversity of any country in the world. With professionals that have good knowledge of the impacts of roads and traffic on wildlife, human safety aspects of wildlife-vehicle collisions, and cost-effective strategies aimed at avoiding, reducing or compensating for these impacts, Brazil has an opportunity to build more sustainable roads from the start.

Course summary

This course illustrates the relationship between highways and traffic, wildlife, and human safety. Road ecology has important implications for biological conservation as direct mortality and habitat loss and fragmentation are among the greatest threats to the persistence of species in the landscape.

During the course we will discuss the impacts of roads and traffic on human safety and wildlife and we will explore different strategies to address these impacts. The course relates to different road categories ranging from low volume dirt roads to major motorways and it includes impacts on both the abiotic (noise, chemical pollutants, light, dust) and the biotic environment (e.g. plant, animals, humans). While a substantial amount of time is dedicated to mitigation measures aimed at reducing the impacts of roads and traffic on the natural environment, a three step approach is advocated: avoidance, mitigation and compensation. The course will explore different techniques to identify and prioritize road sections that may require action. While some measures are both in the interest of human safety and wildlife, the course participants will investigate potential differences between approaches based on human safety versus biological conservation. The course will highlight mitigation measures deemed effective in reducing wildlife-vehicle collisions (direct wildlife mortality) and maintaining a certain degree of habitat connectivity for wildlife. These mitigation measures include, but are not restricted to wildlife fencing, wildlife underpasses and overpasses, and animal detection systems. Finally the course includes illustrations of cost-benefit analyses of mitigation measures aimed at reducing collisions with large mammals that are a threat to human safety.

The course consists of lectures, reading assignments, class discussions, and small projects you will have to write a small article about (case study). The course will probably include a field trip to visit motorways, highways and dirt roads in the region. The field trip will be the base for the case studies which include writing a short article and presentations to the class.

This lecture is recommended for graduate students in biology (especially ecology), civil engineering, forestry, landscape planning, and landscape architecture. There will not be a written test. Instead you will be rated based on your short article on your case study, the presentation of the case study to the class, and your participation in group discussions.

Course instructors: Marcel Huijser - Mini Curriculum

Marcel Huijser received his PhD in Road Ecology (2000) from Wageningen University, the Netherlands. For almost 20 years Marcel has worked on issues related to infrastructure and wildlife. He spent the past 12 years at the Western Transportation Institute at Montana State University. He has worked on road ecology projects in Europe, North America, Asia and South America. His research focuses on wildlife-vehicle collisions and mitigation measures aimed at reducing these collisions, providing safe crossing opportunities for wildlife, improving human safety, and cost-benefit analyses for the implementation of effective mitigation measures. He is currently a visiting professor at the University of São Paulo (ESALQ, Piracicaba).

APPENDIX A2: ROAD ECOLOGY COURSE, ESALQ, USP

UNIVERSIDADE DE SÃO PAULO
ESCOLA SUPERIOR DE AGRICULTURA "LUIZ DE QUEIROZ"
DEPARTAMENTO DE CIÊNCIAS FLORESTAIS
Av. Pádua Dias, 11 • Cep 13418-900 • Piracicaba, SP • Brasil
Fone (19) 3429 4110 • Fax (19) 3422 1733

DECLARAÇÃO

Declaro, para os devidos fins que, Marcel Pieter Huijser ministrou a disciplina de Pós-Graduação EC05045 – Ecologia de Rodovias e a Conservação da Biodiversidade na ESALQ/USP no período de 29 de setembro de 2014 a 26 de outubro de 2014, totalizando 120 horas-aula.

Piracicaba, 12 de dezembro de 2014.

Katia Maria P. M. B. Ferraz

APPENDIX B: EVALUATION ROAD ECOLOGY COURSE BY THE STUDENTS

Note: the survey contained several “control” questions to check the awareness level of the students entering their responses.

Evaluation road ecology course ESALQ

How would you rate the road ecology course?

Answer Options	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Response Count
The course met my (student) general expectations	0	0	0	0	9	9
The course covered the topics you (student) expected to be covered	0	0	0	3	6	9
The topics were covered with sufficient depth and detail	0	0	0	2	7	9
The course matches what you (student) think you need to know in the "real world"	0	0	0	5	4	9
The instructions on what was expected of you (student) during the course were clear	0	0	0	1	8	9
The instructor (Marcel) listened to your questions	0	0	0	1	8	9
The instructor (Marcel) answered your questions	0	0	0	1	8	9
The instructor (Marcel) stimulated discussion during the classes	0	0	0	1	8	9
The instructor (Marcel) explained the thinking behind statements	0	0	0	1	8	9
The instructor (Marcel) treated the students with respect	0	0	0	0	8	8
The instructor (Marcel) kept the temperature in the classroom at a comfortable level through skilled use of the remote control for the air conditioning	2	0	3	1	3	9
The "summary-at-the-end-of-the-day" sessions with your class mates were useful	0	0	0	3	6	9
I (student) found it useful to have access to the PDFs of the presentations	0	0	0	0	9	9
I (student) found it useful to have access to relevant papers	0	0	0	0	9	9
The assignment to work on your own paper/presentation was useful	0	0	0	1	8	9
The field excursion to Itirapina was useful	0	0	0	2	7	9
Though the class was taught in English I (student) was able to understand it well enough	0	0	0	3	6	9
I (student) liked the course concentrated in 4 weeks rather than spread out over the semester	0	0	1	2	6	9
I (student) liked classes concentrated in 2 consecutive days per week	0	1	0	5	3	9
I (student) prefer more pernilongos in the classroom	9	0	0	0	0	9
I (student) will probably recommend the road ecology course to other students	0	0	0	0	9	9
					answered question	**9**
					skipped question	**0**

Evaluation road ecology course ESALQ

The guest lectures by the following people were useful

Answer Options	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Response Count
Simone Freitas	0	0	4	3	1	8
Bethanie Walder	0	0	0	0	9	9
Marco Antonio de Sousa	0	0	1	4	4	9
Chupacabra Sangue	4	1	2	0	0	7
Fernanda Abra	0	0	0	1	8	9
Ronaldo Morato	0	0	3	5	1	9
Marcelo Ruil	1	0	0	3	4	8
Jose Luiz Ridente	0	0	0	4	4	8
					answered question	9
					skipped question	0

Suggestions for the guest speakers listed above or suggestions for inviting additional guest speakers (names, topics)

- “I think it was good to hear from engineers and other professional who’s the main concerns may not be the wildlife. So we could understand a bit the main issues and lack of specific knowledge they might have. Also it was possible to see the points of possible miscommunication due the fact that biologists and engineers may use the same words with different technical meaning. I think that was important to understand how important a clear communication and dialogue is to get optimal results.”
- “Maybe invite people from CODASP, IPT, DER, ARTESP and concessionaire.”
- “Maybe Alex Bager. Ask Ronaldo Morato to talk more about roads”
- “I thought that Ronaldo's presentation did not improve or add things to topics discussed in the course. And unfortunately I didn't watch Simone's presentation.”
- “Road engineer - restrictions to under and overpasses; and also someone to talk about how much money could be available to mitigation measures for a "small" road as SP-225 and a big one as Rodoanel highway”

Evaluation road ecology course ESALQ

What time of the year is preferable for the road ecology course to be taught? (You can indicate multiple months)

Answer Options	Response Percent	Response Count
No preference	66.7%	6
January	0.0%	0
February	0.0%	0
March	11.1%	1
April	22.2%	2
May	22.2%	2
June	11.1%	1
July	22.2%	2
August	22.2%	2
September	11.1%	1
October	11.1%	1
November	0.0%	0
December	0.0%	0
answered question		9
skipped question		0

Evaluation road ecology course ESALQ

For the next course we are considering staying at the Itirapina ecological research station for a week, potentially have excursions and enough time for real data collection efforts in the mornings and classes in the air-conditioned classroom at the station in the afternoons. Data collection efforts are probably more effective in small groups (3-5 people) than in a large group (10 or more people). Therefore we are considering dividing the class in small groups each morning for data collection efforts. Each group would have an instructor or monitor.

Answer Options	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Response Count
Should we increase the length of the field trip from 2 days to 5 days?	0	0	1	0	8	9
Should we have excursions/ data collection in the early mornings and classes in the afternoons?	0	0	2	5	2	9
Should we have small groups for data collection efforts?	0	0	1	2	6	9
Should we increase the UV radiation and temperature during the field trip?	7	0	1	0	1	9
					answered question	9
					skipped question	0

Evaluation road ecology course ESALQ

Where do you think we should eat?

Answer Options	At research station (prepare ourselves)	In field (prepare ourselves at research station, bring in field)	Go to restaurant	Response Count
Breakfast	8	1	0	9
Lunch	2	5	2	9
Dinner	6	1	2	9
			answered question	9
			skipped question	0

If you have any other thoughts with regard to the excursion and data collection efforts in Itirapina or suggestions for the logistics, please describe below.

- "We can go to different places like: Itirapina or Luis Antônio Reserve and meet a real construction like Rodoanel Trecho Norte. And I think it´s a good idea to open spots for monitors, they are important to help student in the field and prepare materials. Next year university can provide money for food and place to sleep. About research is necessary to create small groups and give just 4-5 ideas, I think people can concentrate effort in some important themes. The professor can work with this idea in the beginning of the course, then student can start to think what they want to work."
- "Perhaps, in order to further optimize field work, become more specific and clear what each one or each group should do in the field. Maybe outlining or plotting proposals and previous projects before going into the field. This can be accomplished by great experience with Marcel and Bethanie Ecology Road, and also open to students who already have some experience in the field."
- "Should contract someone to prepare all meals since I suggested them to be eaten at the research station for a greater participants interaction."

What did you like best about the course?

- "It is very applicable."
- "The information was amazing, I loved to know different papers, graphs, the discussions were very good and the field work was practical, this is important for students, we never keep in touch with reality."

- "The course presented a broad overview of road ecology research around the world."
- "It really opened my mind. Now I see that road Ecology is much more than just road kills and I really loved it! The teachers were the best part of the course for sure. Your knowledge and desire to spread it were wonderful!"
- "I liked the structure of the course. Some mixed methods like discussions, guests, individual projects and several types of classes. I think the idea to bring other people to interact and discussed the main concerned here in Brazil was so nice!"
- "The classes were extremely important, enlightening and informative. Really, for me internalize knowledge about the enormous importance of the ecology of Roads in my area of expertise. Marcel and Bethanie are fantastic people! Surely, their personalities were factors that contributed to the further success of the course. Professor Katia and Fernanda Abra were also really important to the success achieved in this first course!"
- "Real examples of road mitigation"
- "The interaction among students and instructor (and other participants, not the pernilongos though)"

What changes would you recommend to the course?

- "I think the changes and adjustments will happen naturally. I believe that in a few years more and more studies related to Road Ecology will happen in Brazil. And these new information may help to produce and adjust technical guidelines related to Road Ecology."
- "The course was really nice, I think the field work should be more planned and take more time! We can go to different places, including a real construction like rodoanel trecho norte."
- "Increase the period at Itirapina station. Present the schedule of the course emphasizing that the classes will be on Mondays and Tuesdays only."
- "Only the ones in the field, and less mosquitos too, please!"
- "As you suggested, the field trip can be longer. And I think we could talk more about mitigation measures for other animal groups, like amphibians and reptiles."
- "If possible, it was longer and more durable."
- "Concentrate the whole course in four weeks of 8 hours: two of lectures, one in field and plus one of discussions on collected data on field."

What are the strengths of the main instructor (Marcel)?

- "Marcel has a very good sense of humor and is a very pleasant person to deal with. He is a very good lecturer but also paid careful attention to the student questions. He managed very well the class, balancing control and participation. He was also very creative and clearly enjoyed the process related to discuss research questions."

- "Marcel is very didactic, brought a lot of good information, he has the ability to communicate with student, is funny but teach with sincerity. I never filled a form like this one after a course, this thing show to me that the professor really care about the quality of teaching, and I feel respected like student."
- "Marcel taught in a very didactical way. The presentations could be easily to be understood. Additionally he was very opened for discussions during the classes."
- "His mood, his desire to make things happen in Brazil and his wife. =)"
- "Marcel is very didactic teacher (It is unbelievable that he had never taught). He can associate easily the things that we had in class with the "real world". He organized all things in the best way."
- "Many points: their knowledge about the subject is huge, vast, giant! Has a teaching that few teachers have. Patience and determination that few people possess."
- "His opening for discussion and to student opinions"
- "Clear communication, enthusiasm and excellent and vast reference literature"

What suggestions do you have to improve Marcel's teaching?

- "I believe it is good to Brazilian students to be challenged to take the course in English and I also believe that the course should remain in English. But I liked to see that Marcel and Bethanie are improving their Portuguese because that will be very helpful in the situations where guest speakers have difficult with English, or when the Brazilian students got too excited and sudden start to talk in Portuguese :)"
- "Keep on encouraging discussions during the classes."
- "Take off the air control of his hands!!!! I think Marcel is a very good teacher, I was surprised to know that this was his first time."
- "Your classes were very rich and diverse. It is very difficult suggesting things for improving them!"
- "I have no suggestion. For me, it's perfect."
- "You did an excellent job, continue following your intuition and keep a flexible schedule. also keep the summary activity in small groups in the end of each day, even if students prefer to go home, that is a good way to make the take home messages of the day evident and clear"

What could the course do to help stimulate further research, development and implementation of measures aimed at reducing wildlife-vehicle collisions and maintaining habitat connectivity across roads and highways for wildlife in Brazil?

- "Technically, I believe it is important to produce some sort of guides to the engineers (perhaps it can involve biologists and also people from the government and private companies connected to the managements of roads). And it is important as well to publish the applied knowledge in scientific articles which give them even more credibility."

- "This course was so important for me, for sure this will help me and my colleagues to look differently impacts of roads and traffic cause in environment. This course is completely different from others and bring us special news. I feel much more prepared to discuss stuff related with road ecology. More than that I think this course was the beginning of a new field of applied knowledge in Brasil. I would like to make other courses and continue to study road ecology. We don´t have Brazilian professors working with road ecology, Marcel should come back next years and continue to teach other students!"
- "Perhaps before the classes begin, it could be asked for each student to think a little about their own study sites and the relation with roads. Additionally it could be sent some papers to be read before the beginning of the classes (revision papers about structures, for example). Maybe this could help students to think a little about their own study sites and what could be done to modify the potential impacts related to roadkills."
- "I think that the classes stimulates further research already. The events you are organizing, with concessionaires and people who works with it but are not biologists, are the first step to achieve this aims, in my opinion."
- "I think the course stimulated students to work with road ecology here in Brazil and that is the best way to help the research of the theme."
- "I believe that the principal started: increase the number of people with real interest in the area. This can lead to change future generations or even current rulers and people of power. But something that sounds good is to conduct short courses and lectures for managers of highways, concessionaires, researchers and professionals."
- "Keep happening at this and other universities."

APPENDIX C1: UNDERGRADUATE THESIS ANA SCIVITTARO CRUZ

UNIVERSIDADE DE SÃO PAULO
ESCOLA SUPERIOR DE AGRICULTURA "LUIZ DE QUEIROZ"
Av. Pádua Dias, 11 Caixa Postal 9 - Piracicaba / SP 13418-900
Departamento de Ciências Florestais
Fone (19) 21058623 – Fax (19) 21058601
http://www.lcf.esalq.usp.br/ - E-mail: lcf.esalq@usp.br

DECLARAÇÃO

Declaramos, para os devidos fins, que o **Dr. Marcel Huijser**, atuou como membro da banca avaliadora, no dia 05/12/2014, da aluna Ana Paula Scivittaro Cruz, do Trabalho de Conclusão de Curso de Gestão Ambiental, intitulado *"O licenciamento ambiental de Rodovias e medidas de mitigação para fauna silvestre: uma ferramenta para conservação da biodiversidade" - Estudo de caso do Trecho Norte do Rodoanel Mário Covas"*.

Piracicaba, 05 de dezembro de 2014.

Prof. Dr. Mario Tomazello Filho
Chefe do Departamento de Ciências Florestais
ESALQ/USP

APPENDIX C2: UNDERGRADUATE THESIS TAMIRIS CHACON DEAJUTE

UNIVERSIDADE DE SÃO PAULO
ESCOLA SUPERIOR DE AGRICULTURA "LUIZ DE QUEIROZ"
Av. Pádua Dias, 11 Caixa Postal 9 - Piracicaba / SP 13418-900
Departamento de Ciências Florestais
Fone (19) 21058623 – Fax (19) 21058601
http://www.lcf.esalq.usp.br/ - E-mail: lcf.esalq@usp.br

DECLARAÇÃO

Declaramos, para os devidos fins, que o **Dr. Marcel Huijser**, atuou como membro da banca avaliadora, no dia 05/12/2014, da aluna Tamiris Chacon Deajute, do Trabalho de Conclusão de Curso de Gestão Ambiental, intitulado "*Análise de modelos de passagem de fauna e cercas condutoras para animais silvestres do Estado de São Paulo*".

Piracicaba, 05 de dezembro de 2014.

Prof. Dr. Mario Tomazello Filho
Chefe do Departamento de Ciências Florestais
ESALQ/USP

APPENDIX D1: PRIME ENGENHARIA

PRIME Engenharia

Declaração

Declaro para os devidos fins que o senhor Marcel Huijser, bolsista da CAPES pelo Programa de Professor Visitante do Exterior participou do ciclo de palestras da Prime Engenharia em 04 de setembro de 2014 ministrando o tema de Ecologia de Rodovias com duas horas de duração.

Sendo o que tinha a declarar,

Cordialmente,

Eng. Carlos Henrique Aranha
Sócio Diretor

APPENDIX D2: DEPARTAMENTO DE CIÊNCIAS FLORESTAIS, ESALQ, USP

UNIVERSIDADE DE SÃO PAULO
ESCOLA SUPERIOR DE AGRICULTURA "LUIZ DE QUEIROZ"
DEPARTAMENTO DE CIÊNCIAS FLORESTAIS
Av. Pádua Dias, 11 • Cep 13418-900 • Piracicaba, SP • Brasil
Fone (19) 3429 4110 • Fax (19) 3422 1733

DECLARAÇÃO

Declaro, para os devidos fins que, Marcel Pieter Huijser ministrou a palestra intitulada "Why does road ecology matter to biological conservation?" no Departamento de Ciências Florestais da ESALQ/USP no dia 5 de setembro de 2014, com duração de 2 horas.

Piracicaba, 12 de dezembro de 2014.

Katia Maria P. M. B. Ferraz

APPENDIX D3: DERSA

APPENDIX D4: "O EMPREITEIRO"

Publication in a a widely circulated Brazilian engineering magazine. http://www.oempreiteiro.com.br/Publicacoes/15240/o_fator_animal.aspx

O fator animal

Na hora de executar rodovias, é preciso considerar a fauna local e prever medidas de proteção e mitigação. O assunto foi tema de workshop *em SP*

Guilherme Azevedo

Medidas para a preservação da diversidade da fauna devem ser incorporadas desde o início da elaboração do projeto de empreendimentos lineares, como rodovias. O estudo das espécies preexistentes, de seu comportamento, é base inclusive para a escolha do traçado e de medidas para mitigar impactos da construção.

A disciplina que rege esse conjunto de medidas se chama ecologia de estradas (*road ecology*) e foi debatida em São Paulo no *workshop* "Ecologia de Rodovias: Princípios integrados de engenharia e ecologia para rodovias mais sustentáveis". O encontro foi organizado pela Desenvolvimento Rodoviário S/A (Dersa) e teve como destaque o pesquisador holandês Marcel Huijser, do Western Transportation Institute, departamento da Universidade do Estado de Montana (EUA). Marcel é um dos principais estudiosos e difusores no mundo dos princípios da ecologia de estradas.

A disciplina é relativamente nova no mundo; vigora de algumas décadas para cá, com especial força nos Estados Unidos, Canadá e em alguns países da Europa, como a Holanda, mas vem ganhando força com o avanço de normas ambientais cada vez mais severas na hora de executar empreendimentos rodoviários, por exemplo. Na abertura do *workshop*, Pedro da Silva, diretor de engenharia da Dersa, engenheiro responsável pela elaboração e coordenação de grandes projetos da empresa, como o trecho norte do Rodoanel Mário Covas (SP-21), em construção, frisou as novas condições e condicionantes: "A construção era o início, o meio e o fim do projeto. Hoje, se a construção for o meio de tudo, eu diria que já é uma vantagem". Pedro da Silva garantiu que na Dersa não há hoje obra que não leve em conta, desde o início, os aspectos ambientais e sociais envolvidos em cada projeto. "Se não tiver a vertente social e a vertente ambiental, a obra não sai." E assumiu, como benefício obrigatório: "Uma obra não pode ser uma cicatriz, ela tem de conviver com o que está ali".

Marcelo Arreguy Barbosa, gerente ambiental da Dersa, foi o segundo a falar para o auditório formado por profissionais da própria empresa e de companhias de serviços de engenharia, entre as quais participantes de empreendimentos sob a supervisão e gestão da Dersa. Barbosa listou medidas que a empresa vem adotando nos projetos, como o acompanhamento e gestão dos impactos sobre a fauna e a flora de cada sítio e a adoção de medidas para mitigar e compensar possíveis danos. "Temos de nos preparar para fazer com que nossas rodovias permitam o fluxo seguro da fauna sem afetar as plataformas rodoviárias", exemplificou. Para ter uma noção do tamanho do problema, segundo estimativa do Centro Brasileiro de Estudos em Ecologia de Estradas, da Universidade Federal de Lavras (MG), 15 animais silvestres morrem atropelados nas estradas brasileiras por segundo; 1,3 milhão por dia; e 475 milhões por ano. Efetivamente, uma tragédia ecológica. Qualifique esta conta com o fato de muitas dessas colisões se darem com animais de porte considerável, como capivaras (que ainda andam em grupos), e temos aí um quadro de insegurança também humana, com impactos econômicos igualmente consideráveis.

A colisão com capivaras (*Hydrochoerus hydrochaeris*) é hoje a mais

O pesquisador Marcel Huijser: Defesa de princípios sustentáveis

Passagem para fauna sobre rodovia dentro do Parque Nacional de Banff, no Canadá. Importa o convívio harmonioso da rodovia com seu entorno

Imagem do projeto do Olin Studio para a passagem animal no interior do Parque Nacional White River, no Estado do Colorado (EUA)

Mais de um milhão de animais silvestres morrem atropelados todos os dias nas estradas brasileiras, contabilizam especialistas. Na foto, onça-parda atropelada na BR-459, em Minas Gerais

Foto: Sidney Severino de Campos/Divulgação

frequente, pelo menos em sete rodovias do Estado de São Paulo, conforme estudo realizado por Marcel Huijser, Fernanda Abra (USP) e John Duffield (Universidade de Montana, EUA).

Passagens para fauna

Passagens para a travessia segura da fauna foram aliás o principal tema da palestra do holandês Marcel Huijser. Jeito despojado, barba por fazer, calçado apropriado para longas caminhadas nos pés, ele começou nos lembrando de uma pré-condição, até evidente, mas tantas vezes ignorada: "O ambiente não é algo que a gente adiciona ao projeto. Ele é a condição, não pode ser negligenciado".

O pesquisador defendeu a participação de ecologistas desde a fase de projeto de empreendimentos lineares (rodovias e ferrovias) e a busca do maior número possível de informações sobre os animais de cada região atravessada. Para a elaboração de medidas de proteção e mitigação, situou, é preciso conhecer quais são as espécies que naquele lugar vivem, como se comportam, como interagem.

A escolha dos locais para a instalação de passagens deve obrigatoriamente nascer da observação e identificação dos pontos onde hoje ocorrem atropelamentos e acidentes com animais, ensinou Marcel. "Não importa o que se vai construir, se se construir no lugar errado."

A estrutura das passagens pode variar na largura, na forma, no material empregado, em sua constituição, em suma. Entretanto, seja de que dimensão e forma for, deve conter as mesmas condições do ambiente do entorno, em termos de vegetação e clima, por exemplo. Um animal não atravessará uma rodovia por uma passagem apenas porque queremos. Daí, pontuou o ambientalista, a existência de uma taxa até engraçada: a de aceitação ou rejeição dos animais, descoberta com o monitoramento (muitas vezes com a instalação de câmeras de vídeo) de fora e não de dentro das passagens. O monitoramento externo revela efetivamente o uso ou não da estrutura.

Há passagens para fauna de múltiplos tipos, específicas para alguns animais, muitas vezes, veados, onças, capivaras e até para pequenos répteis, como cobras e sapos. Podem ser aéreas, em forma de viadutos ou pontes, como uma obra de arte especial mesmo; ou subterrâneas, como túneis e dutos.

Outro recurso utilizado é evitar a travessia pura e simples com o cercamento lateral das rodovias. Isso tem sua validade, sim, explicou o estudioso, mas precisa levar em conta o comportamento das espécies existentes no local. Porque, dependendo da espécie, a cerca pode ser um malefício, como fator de isolamento de grupos. "Não é só cerca pela cerca."

Otimismo

Marcel ainda se mostrou otimista com o futuro da ecologia de estradas no Brasil. Segundo ele, as chances de evolução por aqui são até maiores do que as nos Estados Unidos, por exemplo, onde, disse, só se tomam medidas para proteger animais quando eles põem em risco a segurança dos motoristas. "No Brasil existe uma grande preocupação com a conservação da biodiversidade, não só com o usuário. É uma preocupação mais ampla", elogia, com o conhecimento de quem está ajudando a formar novos ecologistas de estradas no Brasil, ministrando aulas em universidades, como a USP.

"Transbugio"

Aquela que é considerada "a primeira passagem aérea para fauna na história das rodovias brasileiras", nas palavras de Marcelo Arreguy Barbosa, gerente ambiental da Dersa, atenderá aos nossos irmãos símios e deverá estar pronta até o fim do ano. Ela se localizará no km 25,8 da rodovia dos Tamoios (SP-99, conexão entre o Vale do Paraíba e o litoral norte paulista), no trecho duplicado do planalto.

Segundo a Dersa, a passagem superior para os macacos que habitam a região será executada com concreto armado e vigas pré-moldadas, como na construção de uma obra de arte convencional. A estrutura terá comprimento de 40 m e largura de 11,5 m. O tabuleiro será preenchido com uma camada de 1 m de solo e grama. Para conduzir os animais até a passagem, serão instaladas cercas de direcionamento nos dois lados da rodovia. O custo estimado é de R$ 2,43 milhões.

A escolha do local se baseou em observação empírica, embora sem estudo mais conclusivo. "Deduzimos que ali seria o melhor local", defendeu Barbosa. A "Transbugio", como a chamou carinhosa e divertidamente Pedro da Silva, diretor de engenharia da Dersa, precisou de empenho para ser aprovada e incluída no projeto final. Afinal, é algo ainda com que muitos de nossos gestores, engenheiros e empreiteiros não estão lá muito acostumados a lidar, mas estão descobrindo que é muito importante, até para a nossa própria preservação. O planeta dos macacos é o nosso também. ***(Guilherme Azevedo)***

O estudioso sublinhou ainda o fato de a disciplina que defende não se resumir a medidas de mitigação, mas sobretudo incorporar a reflexão sobre o tipo de transporte, forma e local de sua instalação: "Um dos grandes desafios globais é agora pensar sobre que transporte nós precisamos, em que locais: precisa estar lá? É realmente necessário? É uma rodovia? Uma ferrovia? Uma hidrovia?", descreve. "Temos de pensar em qual meio é mais eficiente e menos agressivo ao meio ambiente."

Se alguém ainda considera a ecologia de estradas uma questão menor ou menos importante, quando confrontada com a necessidade sempre urgente de executar e melhorar a infraestrutura, Marcel mostrou dados que indicam economia com a simples observação de passagens para fauna, haja vista a expressiva redução de colisão de animais com veículos e fatalidades humanas. Ecologia de estradas tem, sim, adequada relação custo-benefício. Há, contudo, ainda um outro ganho, menos numérico mas não menos importante: a preservação de espécies ainda desconhecidas, ou mal estudadas, mediante medidas ambientalmente corretas, na hora de edificar empreendimentos lineares. É um patrimônio de um país, possibilidade de ganhos concretos.

De tudo dito e ouvido, ficou uma convicção, portanto: o melhor mesmo é consultar um ecologista na hora de planejar e também na hora de executar uma nova estrada ou ferrovia. Combinado?

As perspectivas favoráveis à concessão

*Ricardo Pinto Pinheiro**

A ABCR conta com 53 empresas associadas, responsáveis, em conjunto, pela gestão de cerca de 8% da malha rodoviária brasileira pavimentada, ou seja, 16,3 mil km. Segundo as pesquisas da CNT, estas são as melhores rodovias do País. Isso mostra a maturidade e a importância do programa, que completará 20 anos em 2015. Ainda em 2014 devemos ter novas concessionárias em atuação, considerando as licitações já promovidas em São Paulo e no Paraná, e as definidas no âmbito federal, além das tratativas estaduais em andamento no Mato Grosso e no Mato Grosso do Sul. Isso mostra que cresce a percepção nos vários níveis de governo sobre a competência e eficácia de empresas privadas na gestão rodoviária.

Pesquisas, publicações, congressos e informações tornaram a ABCR uma referência no setor de infraestrutura rodoviária, sempre em defesa das concessões como fator imprescindível para a modernização e ampliação da rede de rodovias. Vencida esta etapa, a entidade vem buscando ampliar sua articulação institucional, em defesa de suas associadas e da expansão do setor, e da superação de resistências pontuais em alguns estados. A Empresa de Planejamento e Logística criou condições para o governo federal trabalhar com visão de mais longo prazo e, com isso, o programa de concessões vem crescendo para as regiões Norte e Centro-Oeste.

Após os bem-sucedidos leilões do final de 2013, o governo federal decidiu licitar mais cinco trechos rodoviários em 2014, incluindo a Ponte Rio-Niterói, cujo contrato de concessão expira em maio de 2015 e será relicitada com a inclusão de novas obras de acesso.

Os outros trechos são especialmente importantes para a movimentação da produção agropecuária e preveem investimentos da ordem de R$ 17,8 bilhões durante o período de concessão, concentrados especialmente nos primeiros cinco anos. Somados aos projetos de São Paulo e do Paraná, teremos sete novas concessionárias, sem contar ainda as previstas nos estados do Centro-Oeste. Além disso, há outros trechos em avaliação para novas concessões, a ser viabilizados na forma de parcerias público-privadas (PPPs), o que indica também estarmos entrando numa nova fase de desenvolvimento do setor.

O Brasil precisa de mais e melhores rodovias e nosso papel é mostrar que só vamos contar com elas por meio de significativos investimentos da iniciativa privada, isoladamente ou associada ao poder público, como passou a ser a regra em todo o mundo. A sociedade está cada vez mais consciente de que o único caminho possível a adotar, em relação às rodovias, é o mesmo conceito vigente para outros serviços, como água, energia e telefonia, qual seja: quem usa paga.

*Ricardo Pinto Pinheiro é presidente-executivo da Associação Brasileira de Concessionárias de Rodovias (ABCR)

APPENDIX D5: GRADUATE PROGRAM COMMITTEE, ESALQ, USP

UNIVERSIDADE DE SÃO PAULO
ESCOLA SUPERIOR DE AGRICULTURA "LUIZ DE QUEIROZ"
DEPARTAMENTO DE CIÊNCIAS FLORESTAIS
Av. Pádua Dias, 11 • Cep 13418-900 • Piracicaba, SP • Brasil
Fone (19) 3429 4110 • Fax (19) 3422 1733

DECLARAÇÃO

Declaro, para os devidos fins que, Marcel Pieter Huijser ministrou a palestra intitulada "Road Ecology activities at ESALQ" para a Coordenação do Programa de Pós-Graduação Interunidades em Ecologia Aplicada (PPGI-EA) na ESALQ/USP no dia 12 de setembro de 2014, com duração de 1 hora.

Piracicaba, 12 de dezembro de 2014.

Katia Maria P. M. B. Ferraz

APPENDIX D6: BOARD DEPARTAMENTO DE CIÊNCIAS FLORESTAIS, ESALQ, USP

UNIVERSIDADE DE SÃO PAULO
ESCOLA SUPERIOR DE AGRICULTURA "LUIZ DE QUEIROZ"
DEPARTAMENTO DE CIÊNCIAS FLORESTAIS
Av. Pádua Dias, 11 • Cep 13418-900 • Piracicaba, SP • Brasil
Fone (19) 3429 4110 • Fax (19) 3422 1733

DECLARAÇÃO

Declaro, para os devidos fins que, Marcel Pieter Huijser ministrou a palestra intitulada "Road Ecology activities at ESALQ" para o Conselho do Departamento de Ciências Florestais da ESALQ/USP no dia 22 de setembro de 2014, com duração de 1 hora.

Piracicaba, 12 de dezembro de 2014.

Katia Maria P. M. B. Ferraz

APPENDIX D7: WORKSHOP - IMPACTOS DA RODOVIA BR-101 NA RESERVA BIOLÓGICA DE SOORETAMA

UNIVERSIDADE FEDERAL DO ESPÍRITO SANTO

Vitória, 12 de Dezembro de 2014

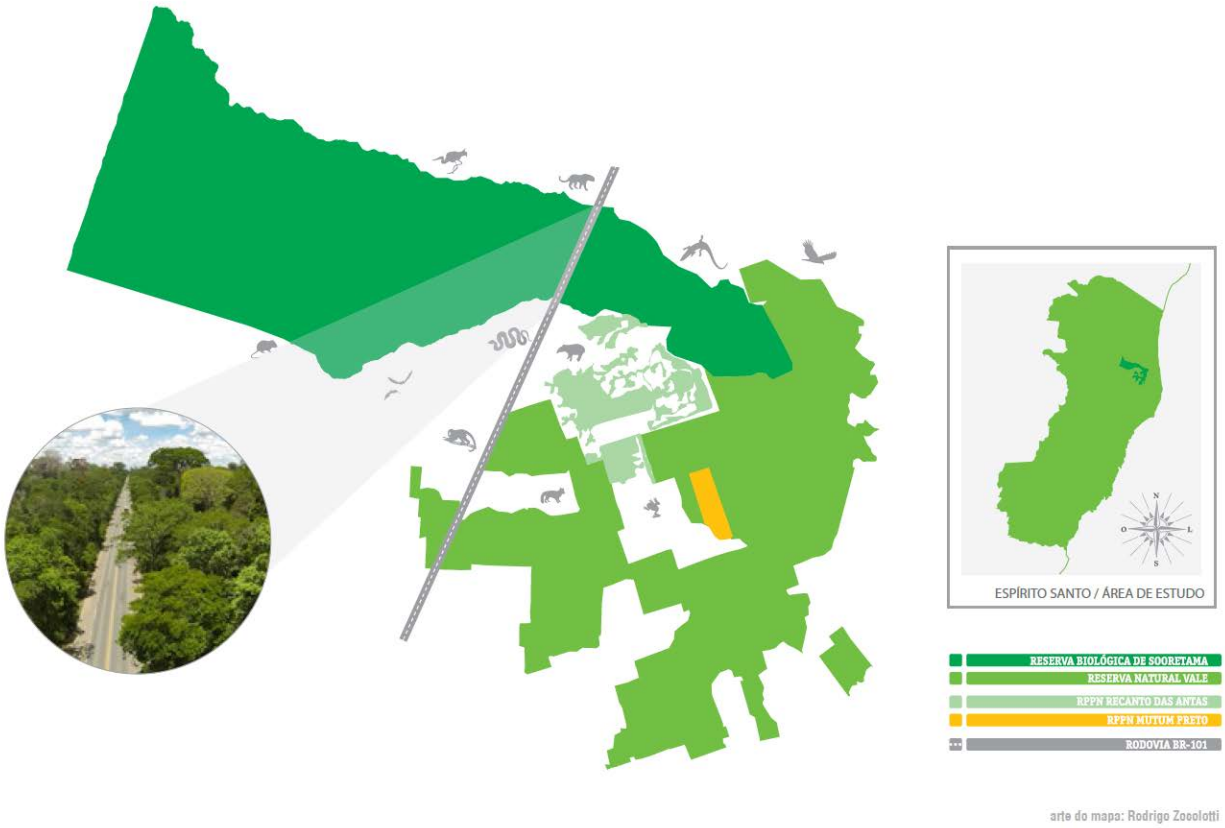
DECLARAÇÃO

Declaro que o Dr. Marcel Huijser participou, na qualidade de convidado, do "Workshop Impactos da Rodovia BR-101 na Reserva Biológica de Sooretama: Estudos, Alternativas e Mitigação", que ocorreu de 12 a 15 de novembro de 2014, durante a 11ª Semana Estadual de Ciência e Tecnologia, na Universidade Federal do Espírito Santo, em Vitória – ES. O Dr. Marcel proferiu a palestra "Human safety, biological conservation and economic considerations for upgrading existing highways", no dia 13 de novembro, e coordenou o grupo de trabalho sobre "mitigação", no dia 14 de novembro.

Aureo Banhos dos Santos
Professor Adjunto
Coordenador do Workshop Sooretama

Universidade Federal do Espírito Santo
Centro de Ciências Agrárias
Departamento de Biologia
Caixa Postal 16 – Tel/Fax. (28) 3552-8625
29500-000 – Alegre – ES – Brasil

APPENDIX D8: WORKSHOP - IMPACTOS DA RODOVIA BR-101 NA RESERVA BIOLÓGICA DE SOORETAMA


ESPÍRITO SANTO / ÁREA DE ESTUDO
RESERVA BIOLÓGICA DE SOORETAMA
RESERVA NATURAL VALE
RPPN RECANTO DAS ANTAS
RPPN MUTUM PRETO
RODOVIA BR-101
arte do mapa: Rodrigo Zocolotti

WORKSHOP

Impactos da Rodovia BR-101 na Reserva Biológica de Sooretama:

Estudos, alternativas e mitigação

Local: **Associação dos Docentes da Universidade Federal do Espírito Santo (ADUFES) - Campus de Goiabeiras/UFES, Goiabeiras, Vitória - ES.**

Confirmar presença com nome completo e instituição pelo e-mail **neel.ufes@gmail.com**

Mais informações: http://fb.com/neel.ufes

Programação
Aberta ao público

Dia 12/11 – Quarta-feira

09:00 - 09:10h - Abertura. Vídeo: "Riquezas perdidas"

09:10 - 10:10h - Palestra 1. A Reserva Biológica de Sooretama.
Palestrante: Ms. Marcel Redling Moreno (ICMBio)

10:10 - 12:00h - Mesa Redonda 1. Impactos das Estradas na Paisagem.
Participantes: Dr. Alexandre Rosa dos Santo (UFES); Drª. Fabricia Benda de Oliveira (UFES); Drª. Luciana Tomaz Dias (UFES); Dr. Milton Cezar Ribeiro (UNESP)

14:00 - 15:50h - Mesa Redonda 2. Impactos das Estradas nos Pequenos Vertebrados
Participantes: Dr. Charles Gladstone Duca Soares (UVV); João Luiz Rosetti Gasparini (FAUNA Consultoria em Meio Ambiente); Dr. Luiz Fernando Duboc (UFES); Dr. Yuri Luiz Reis Leite (UFES)

15:50 - 16:10h - Intervalo: Café com fotos

16:10 - 18:00h - Mesa Redonda 3: Impactos das Estradas nos Mamíferos de Médio e Grande Porte
Participantes: Drª. Ana Carolina Srbek Araújo (UVV); Drª. Andressa Gatti (Pró-Tapir); Dr. João Luiz Rossi Júnior (UVV); Dr. Sérgio Lucena Mendes (UFES)

Dia 13/11 – Quinta-feira

9:00 - 10:00h - Palestra 2. Opções de mitigações para o atropelamento da fauna da BR-101, Reserva Biológica de Sooretama.
Palestrante: Ms. Fernanda Delborgo Abra (ESALQ/USP)

10:00 - 11:00h - Palestra 3. Atropelamentos de Animais Silvestres na Amazônia Central
Palestrante: Dr. Marcelo Gordo (UFAM)

11:00 - 12:00h - Palestra 4. Levantamentos da Biodiversidade na avaliação de impactos
Palestrante: Dr. William Ernest Magnusson (INPA)

14:00 - 15:50h - Mesa Redonda 4. Estradas, Unidades de Conservação e Licenciamento Ambiental
Participantes: Antônio de Pádua Almeida (ICMBio); Jacques Augusto Passamani (IBAMA); Marcelo Deotti e Silva (IEMA); Carlos Alberto da Sila Junior (DNIT)

15:50 - 16:00h - Intervalo: Café com fotos

16:00 - 17:00h - Palestra 5 (Internacional). Human safety, biological conservation and economic considerations for upgrading existing highways
Palestrante: Dr. Marcel Huijser (Western Transportation Institute, Montana State University)

Dia 14/11 – Sexta-feira

9:00 - 10:30h - Apresentação do Projeto Modelo preditivo de impactos das estradas na biodiversidade: avaliação dos impactos da rodovia BR-101 sobre a fauna de vertebrados silvestres da Rebio de Sooretama.
Pesquisadores: Dr. Alexandre Rosa dos Santos (UFES); Dr. Aureo Banhos dos Santos (UFES); Dr. Charles Gladstone Duca Soares (UVV); Dr. João Luiz Rossi Júnior (UVV); Drª. Greiciane Gaburro Paneto (UFES)

Programação
Restrita aos especialistas convidados

Dia 14/11 – Sexta-feira

10:30 - 12:30h - Grupos de Trabalho
Grupo 1 - Estudos, Avaliação e Monitoramento
Coordenador: Dr. William Ernest Magnusson (INPA)
Relator: Dr. Aureo Banhos dos Santos (UFES)

Grupo 2 - Alternativas Alocacionais
Coordenador: Dr. Alexandre Rosa dos Santo (UFES)
Relator: Ms. Marcelo Renan de Deus Santos (IMD)

Grupo 3 - Mitigação
Coordenadores: Ms. Fernanda Delborgo Abra (ESALQ/USP) e Dr. Marcel Huijser (Western Transportation Institute, Montana State University)
Relatora: Dra Andressa Gatti (Pró-Tapir)

12:30 - 13:30h - Intervalo para almoço

13:30 - 17:00h - Grupos de Trabalho - Produção do Documento

Dia 15/11 – Sábado

9:30 às 12:00 - Grupos de Trabalho - Produção do Documento
Grupo 1. Relator: Dr. Aureo Banhos dos Santos (UFES)
Grupo 2. Relator: Ms. Marcelo Renan de Deus Santos (IMD)
Grupo 3. Relatora: Dra Andressa Gatti (Pró-Tapir)


foto: Leonardo Merçon


foto: Valdir Santos

APPENDIX D9: WORKSHOPS "ECOLOGIO NAS ESTRADAS" FOR CART

CART

UMA EMPRESA invepar RODOVIAS

Bauru, 11 de Dezembro de 2014.

À
CAPES – Coordenação de Aperfeiçoamento de Pessoal de Nível Superior

REFERÊNCIA: **ATESTADO DE REALIZAÇÃO DE ATIVIDADES**

Ilustríssimo(a) Senhor(a),

Vimos pela presente, na qualidade de signatária do Termo de Contrato de Concessão Rodoviária do Corredor Raposo Tavares nº 002/ARTESP/2009, atestar para os devidos fins que o Ph. D Marcel Huijser realizou:

- Palestra de Ecologia de Estradas, em Presidente Prudente/SP, no dia 18.11.2014, com duração de 8h;
- Palestra de Ecologia de Estradas, em Bauru/SP, no dia 19.11.2014, com duração de 8h;
- Visita às rodovias sob concessão da CART e discussões sobre medidas de mitigação de atropelamento de fauna, durante os dias 18 e 19.11.2014.

Na oportunidade expressamos o nosso respeito e distinta consideração.

Sem mais no momento, agradecemos a atenção e colocamo-nos a disposição para esclarecimentos adicionais.

Cordialmente,

Osnir Ormon Giacon
Coordenador de Meio Ambiente

CART Concessionária Auto Raposo Tavares S.A.
Avenida Issa Marar, 2-200 Pq. Residencial Samambaia – Bauru/SP - CEP:17 018-002

USC UNIVERSIDADE SAGRADO CORAÇÃO
Líderes com coração

Certificado

Certificamos que o **PhD MARCEL HUIJSER** ministrou o Evento: Workshop de Ecologia nas Estradas, devidamente registrado no livro RC-04, folha 123 sob código WEE/2014, realizado na Universidade Sagrado Coração no dia 19 de novembro de 2014, perfazendo um total de 6 horas.

Bauru, 19 de novembro de 2014.

Prof. Ms. Dorival José Coral
Coordenador Geral de Extensão

Ir. Jucélia Melo
Pró-reitora de Extensão e Ação Comunitária

APPENDIX D10: UNIVERSIDADE FEDERALDO RIO GRANDE DO SUL

UNIVERSIDADE FEDERAL DO RIO GRANDE DO SUL
CENTRO DE ECOLOGIA
Núcleo de Ecologia de Rodovias e Ferrovias
NERF

DECLARAÇÃO

Declaro para os devidos fins que o pesquisador Dr. MARCEL HUIJSER visitou o laboratório por mim coordenado (NERF) no período de 23 a 30 de novembro participando de duas expedições a rodovias no entorno dos Parques Nacionais da Lagoa do Peixe e Aparados da Serra para discussão de medidas mitigadoras de mortalidade de vertebrados e ministrou palestra no dia 26 de novembro no evento "Seminários de Ecologia de Rodovias", promovido conjuntamente pelo PPG-Ecologia da UFRGS e NERF.

Porto Alegre, 01 de dezembro de 2014.

Andreas Kindel

Prof. Andreas Kindel
NERF – Centro de Ecologia
UFRGS

Av. Bento Gonçalves, 9500 - Agronomia - Caixa Postal 15007 – CEP: 91.501-970 - Porto Alegre – RS
Fone: (051) 3308-6935 (gabinete) ou 3308-7623 (secretaria) - Fax: (051) 3308-7626 – e-mail: andreas.kindel@ufrgs.br

APPENDIX D11: ECOTRANS CONFERENCE

Ecotrans

1ª Conferência Paulista de Ecologia e Transportes

Programação

Programação preliminar – Sujeita a alterações.

01/12/2014 (Manhã) ecotrans

(https://cpetweb.files.wordpress.com/2014/10/01-manhc3a32.jpg)

8:30 – 9:30

Welcome Coffee e Credenciamento dos participantes

9:30 – 10:30
Abertura
Dr. Clodoaldo Pelissioni – Secretário de Logística e Transportes de São Paulo
Kátia Ferraz (Representante ESALQ)
Theodoro de Almeida Pupo Jr. (Diretor de Investimentos da Artesp)
Nilo Sergio Campos Horn (Grupo CCR)

10:30 – 12:00
Palestra de Abertura
PhD Marcel Huijser – Western Transportation Institute/Montana State University

Almoço (12:00 – 13:30)

01/12/2014 (Tarde) ecotrans

13:30 – 15:30
Painel I: Aspectos Ambientais em Empreendimentos Rodoviários

Dr. Pedro Romanini (Artesp)
José Francisco Guerra da Silva (DER)
Marcelo Arreguy (DIGAM/DERSA)
Carlos Henrique Aranha (Prime Engenharia)

Coffee Break (15:30 – 16:00)

16:00 – 18:00
Painel II: O Licenciamento Ambiental de Rodovias no Estado de São Paulo
Ana Cristina Pasini da Costa (CETESB)
Sra. Tathiana Bagatini e Sr. Fabio Penno Callia (Ibama)
Kátia Mazzei (Instituto Florestal)

02/12/2014 (Manhã) ecotrans

(https://cpetweb.files.wordpress.com/2014/10/02-manhc3a31.jpg)

8:30 – 9:00
Welcome Coffee e Credenciamento dos participantes

9:00 – 10:30
Painel III: Aspectos Ambientais em empreendimentos aeroportuários e hidroviários
M.Sc. Mariane Biz (Bióloga)
Dr. Guilherme Lima (Prefeitura de Campinas)
Dr. Marcelo Poci Bandeira (Departamento Hidroviário de São Paulo)

10:30 – 12:00
Painel IV: Fauna em Rodovias – Conservação da Biodiversidade e a Segurança do Usuário
Dr. Ronaldo Morato (ICMBio/CENAP)
Dra. Kátia Ferraz (ESALQ)
M.Sc. Fernanda Abra (ESALQ)
Dra. Renata Miotto (ESALQ)

Almoço (12:00 – 14:00)

02/12/2014 (Tarde) ecotrans

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14:00 – 16:00
Painel V: Ecologia de Rodovias: uma ciência multidisciplinar
Dr. Silvio Marchini (ESALQ)
M.Sc. Luciano Zandoná (Prefeitura de Guarulhos)

16:00 – 17:30

Painel VI: Estradas – Hidrologia e Geologia
M.Sc. Bethanie Walder
Dr. Silvio Ferraz (ESALQ)
Dr. Jairo de Almeida Machado (CODASP)

17:30 – 18:00
Encerramento

Realização

CCR (https://cpetweb.files.wordpress.com/2014/10/ccr-2.png)

(https://cpetweb.files.wordpress.com/2014/10/esalq.png)

ARTESP (https://cpetweb.files.wordpress.com /2014/10/logo-artesp.png)

GOVERNO DO ESTADO SÃO PAULO Secretaria de Logística e Transportes (https://cpetweb.files.wordpress.com/2014/10 /logistica_transportes_h_pr-cc3b3pia-cc3b3pia.png)

APPENDIX D12: UNIVERSIDADE FEDERAL DE SÃO CARLOS, SÃO PAULO

UNIVERSIDADE FEDERAL DE SÃO CARLOS
DEPARTAMENTO DE GENÉTICA E EVOLUÇÃO
Via Washington Luiz, Km. 235
CEP 13.565-905 - São Carlos - SP – Brasil

São Carlos, 04 de dezembro de 2014.

Vimos por meio desta, agradecer ao **Prof Dr. Marcel P. Huijser**, pela participação no **Ciclo Bio.C – Falando sobre Conservação e Biodiversidade**, promovido pelo Laboratório de Biodiversidade Molecular e Conservação do Departamento de Genética e Evolução da UFSCar, apresentando a palestra intitulada **"Why Does Road Ecology Matter to Biological Conservation "**, no dia 04 de dezembro de 2014.

Atenciosamente,

Prof. Dr. Pedro Manoel Galetti Junior
LabBMC

APPENDIX D13: DEPARTAMENTO DE ECOLOGIA DA UNESP, RIO CLARO, SÃO PAULO

unesp

UNIVERSIDADE ESTADUAL PAULISTA
"JÚLIO DE MESQUITA FILHO"
Instituto de Biociências – Câmpus de Rio Claro
Seção Técnica de Pós-Graduação

Rio Claro, 04 de Dezembro de 2014.

Certificado

Atesto, para os devidos fins, que Marcel Huijser ministrou a palestra "Why Does Road Ecology Matter to Biological Conservation?" no Seminário Charles Darwin de Ecologia & Evolução, dia 04 de dezembro de 2014, às 17h, no Anfiteatro Celina Foresti do Departamento de Ecologia da UNESP, Câmpus de Rio Claro.

Atenciosamente,

Prof. Dr. Milton Cezar Ribeiro
Departamento de Ecologia

LEEC

Instituto de Biociências – Departamento de Ecologia
Avenida 24-A nº 1515 - CEP 13506-900 – Rio Claro - S.P. - Brasil
Tel (19) 3526-4104 - http://www.rc.unesp.br

APPENDIX D14: ROAD ECOLOGY COURSE FOR CETESB

ESCOLA SUPERIOR DA CETESB
GESTÃO DO CONHECIMENTO AMBIENTAL

A CETESB - Companhia Ambiental do Estado de São Paulo confere a

MARCEL HUIJSER

este certificado de 32 horas de docência no Curso
"Ecologia de Rodovias no Licenciamento Ambiental: boas lições ao redor do mundo e potenciais aplicações para as práticas de ecologia de rodovias no Brasil"
realizado em São Paulo - SP, nos dias 03, 08, 09 e 10 de dezembro de 2014
Carga Horária: 32 horas

São Paulo, 10 de dezembro de 2014

Carlos Roberto dos Santos
Diretor de Engenharia e Qualidade Ambiental

Otávio Okano
Diretor-Presidente

CETESB

GOVERNO DO ESTADO SÃO PAULO
Secretaria do Meio Ambiente

APPENDIX D15: EVALUATION ROAD ECOLOGY COURSE FOR CETESB

ETG – Divisão de Gestão do Conhecimento
ETGD – Setor de Capacitação e Formação Continuada

RELATÓRIO DE AVALIAÇÃO DE CAPACITAÇÃO

Evento: Curso Ecologia de Rodovias no Licenciamento Ambiental: boas lições ao redor do mundo e potenciais aplicações para as práticas de ecologia de rodovias no Brasil	
Período: 03 de Novembro de 2014	**Local: Escola Superior da CETESB – Prédio 6**
Coordenação Técnica: Maria Silvia Romitelli – ID, Camilo Fragoso Giorgi – IETR, Gleice C. Sales Ferreira - IDAP	
Coordenação Executiva: Vera Lúcia Lagôa Ignácio / Sonia Ritt - ETGD	
Docentes: Marcel Huijser e Fernanda Abra	

Dos 29 treinandos, 21 responderam ao questionário, representando 72,4 % do total de participantes.

ESCALA UTILIZADA:
(1) RUIM (2) REGULAR (3) BOM (4) ÓTIMO

Avaliação Técnica do Curso / TPE	Média
1) Atendimento às expectativas	3,4
2) Conteúdo programático desenvolvido	3,6
3) Adequação da carga horária ao cumprimento da programação	3,3
Média Avaliação Técnica do Curso	**3,4**

Avaliação da Atuação da Area de Cursos	Média
4) Atendimento da equipe durante o curso	3,6
5) Qualidade do material de apoio (apostilas, CDs, exercícios e outros)	3,3
6) Infraestrutura (sala de aula e equipamentos; coffee break)	3,6
Média Avaliação da Atuação da Area de Cursos	**3,5**

Avaliação Geral do Curso / TPE	Média
7) Avaliação do Curso / TPE como um todo	3,4

Avaliação dos Docentes	Média
Domínio do conteúdo	3,9
Didática (clareza na exposição, utilização de recursos e procedimentos apropriados)	3,8
Cumprimento do horário	3,8
Média Avaliação dos Docentes	**3,8**
Média Geral	**3,5**

4- Comentários/Sugestões (na íntegra):

- Não houve apresentação da Fernanda Abra. Sem avaliação.
- Ótimo curso, apenas a tradução simultânea foi ruim.
- O tema é extenso e seria preciso mais tempo. A apresentação foi feita em ordem e até com slides diferentes daqueles que estão na apostila; isso atrapalhou às vezes. A apresentação da Betanie não está na apostila (e poderia estar). Não dei nota para a Fernanda porque ela não foi docente.
- A apresentação não estava conforme a apostila, atrapalhou um pouco o acompanhamento.
- Muito bom curso, se aplica totalmente à área.
- O material fornecido não estava condizente com a apresentação dele (do Marcel). A apresentação da Betanie não estava na apostila.