

**Tuesday / 11:30 – 13:00**

**Room: Philips Hall**

**MJPO: Planning, implementing and evaluating the Dutch Defragmentation Program**

**Moderator: Nico Jonker, Province Noord-Holland, Netherlands**

**MJPO: The founding and future of a national defragmentation programme**

*Adam Hofland (Rijkswaterstaat, Department Programmes, Projects, and Maintenance, Netherlands)*

After almost 15 years, the defragmentation programme MJPO is about to finish. This presentation will demonstrate the organisational successes and risks that come up when founding, managing and executing a massive programme such as the MJPO and its future. The presentation will focus on the following topics: (1) A brief history: setting up the programme and finding funds; (2) Dealing with political changes and parliamentary as well as media attention; (3) Success factors and risks of program management; (4) The start of a network: cooperation between government, universities, and contractors.

**Monitoring the progress of execution of the Dutch National Defragmentation Program within the Dutch railways: A multi-annual analysis of the amount of planned, changed and laid out measures**

*Camiel Meijneken, Louis Latorre Geurts (ProRail, Netherlands)*

ProRail, the Dutch railroad authority, has been involved in the Dutch National Defragmentation Program (MJPO) since the start. Within this program 145 new fauna-passages were foreseen, 116 were actually built. When we analyse and visualize this on a geographic level, we discovered that, especially within the range of the small measures, it was not possible to build the intended fauna-

passage at most locations. The primary reason for this is the lack of needed space beneath the railroad tracks and above the local (ground)water levels. Other reasons are the absence of permission from landowners or the withdrawal of promised (co-)financing.

**Many roads to cross - Evaluating the economic costs and ecological benefits of the habitat defragmentation programme for Dutch infrastructure**

*Frans J. Sijtsma, Eelke van der Veen (University of Groningen, Netherlands); Arjen van Hinsberg (Netherlands Environmental Assessment Agency, Netherlands)*

In this paper, we evaluate the economic costs and ecological benefits of the Dutch habitat defragmentation programme (MJPO). In the MJPO programme, 300 million Euro was spent in the period 2004-2018 to make many roads easier to cross by animals. We especially aim to make progress on the measurement of biodiversity effects of greener transport infrastructure. We apply a triangulation approach to estimate biodiversity impacts in a variedly rich manner and use a specially designed software tool to calculate biodiversity impacts in a systematically structured way.

**Restoring biodiversity and tackling defragmentation in the Province of Noord-Brabant**

*Wiel Poelmans (Province of Noord-Brabant, Netherlands)*

Provinces are entirely responsible for the restoration of biodiversity. Around 2,600 measures are proposed in the Province of Noord-Brabant to restore the approximately 1,100 threatened species in the province. This is a tremendous challenge. A three-way strategy has been developed to achieve this goal. The National and Provincial Executives have executed a defragmentation programme

for their road network. These days, species such as beavers and badgers are spreading again across the Province of Noord-Brabant, as a result of nature policy and defragmentation. Otters are expected to spread as well. Therefore, new defragmentation programmes are inevitable.

**The Green Connection ('De Groene Schakel'), a solution for infrastructure and nature**

*Arend van Dijk, Maarten Broos (Province Noord-Holland, Netherlands)*

How does an infrastructural project result in quality improvement of nature, an integral solution for infrastructure and environment, better traffic flow, a fast bus connection and a continuous nature area? The infrastructure project 'HOV in 't Gooi' bundles traffic flows and realises the nature connection 'Groene Schakel' to connect the isolated natural areas in 'Gooi' and 'Utrechtse Heuvelrug'.

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**Room: Foyer**

**Road impacts: How individuals, communities and populations are affected**

**Moderator: Fernanda Zimmermann Teixeira, Federal University of Minas Gerais, Brazil**

**Understanding the population effects and individual behavioural response of Barn Owls *Tyto alba* to major road networks to inform mitigation requirements**

*John Lusby, Michael O'Clery, Olivia Crowe, Shane McGuinness (BirdWatch Ireland, Ireland); Vincent O'Malley, Sarah-Jane Phelan (Transport Infrastructure Ireland, Ireland)*

Mortality on roads is a significant cause of death and contributing factor in the decline of Barn Owl populations. Despite knowledge on the abiotic factors which

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influence collision, effective mitigation to reduce impacts of roads on Barn Owl populations remain outstanding. We assessed behavioural responses of Barn Owls to roads alongside data on mortality patterns. The movements of breeding Barn Owls, assessed using GPS technology, indicate that roadsides are an important foraging resource. Therefore, this study provides new insights on Barn Owl behaviour in relation to roads which can help to inform mitigation solutions. indicate that roadsides are an important foraging resource. This study provides new insights on Barn Owl behaviour in relation to roads which can help to inform mitigation solutions.

## Multi-species gene flow across several large-scale transportation infrastructures

*Remon Jonathan, Sylvain Moulherat, Jérémie H. Cornuau, Lucie Gendron (Terroïko, France); Murielle Richard, Michel Baquette, Jérôme G. Prunier (CNRS-Université Paul Sabatier, Station d'Ecologie Théorique & Expérimentale, France)*

We investigated how six types of Large-scale Transportation Infrastructures (LTIs) in southwestern France affected gene flow in four terrestrial species (snakes, amphibians, butterflies, and beetles). All species, except butterflies, were affected by at least one LTI. We determined that roads were the most detrimental type of LTIs. A motorway and a railway influenced gene flow in the two vertebrates. A gas pipeline impeded gene flow in the beetle, and a power line had no impact on any species. We indicate that species-specific mitigation measures on infrastructures are required.

## Life trait-based predictions of road-kill risk for birds and mammals in Brazil

*Manuela González-Suárez (Ecology and Evolutionary Biology, School of Biological Sciences, University of Reading, UK); Flávio Zanchetta Ferreira, Clara Grilo (Departamento de Biologia, Setor de*

*Ecologia, Universidade Federal de Lavras, Brazil)*

We identified general patterns associated with road mortality and generated predictions to understand spatial and species-level risks in Brazil. We used trait-based random forest regression models to explain road mortality rates for 170 bird and 74 mammalian species. We found that higher road mortality rates are related with body mass, earlier maturity ages, habitat generalism for birds and mammals. Spatial predictions identified high potential road mortality risk in Amazonia for birds and mammals, and high risk in Southern Brazil for mammals. We also found potential vulnerability to road mortality of several understudied species currently listed as threatened by the IUCN.

## Assessing the contribution of road traffic to declines in British bird populations

*Sophia Caroline Cooke, Andrew Balmford (University of Cambridge, UK); Paul Donald (Birdlife International, UK); Alison Johnston (Cornell University, USA); Stuart Newson (British Trust for Ornithology, UK)*

In the last forty years, many bird species have suffered severe declines across Great Britain, thought to be primarily a result of agricultural intensification. However, there is a strong correlation between these declines and increases in road traffic levels. Many studies have identified negative effects of roads on birds, via mechanisms such as avoidance of noise and light pollution, and collision mortality. However, no island-wide quantification of impacts on populations has been attempted yet. This research aims to undertake that quantification and estimate the impact of possible future changes in road density and traffic levels across Britain.

## Road and edge effects on a small mammal community in tropical forest fragments in the Brazilian Atlantic Forest

*Simone R. Freitas (Universidade Federal do ABC, Brazil); Everton Constantino (Universidade Estadual de Campinas, Brazil); Marcos M. Alexandrino (Department of Mathematics, Institute of Mathematics and Statistics, Universidade de São Paulo, Brazil)*

This study aims to: (1) evaluate the effect of roads on small mammal abundance, considering roads around the studied forest fragment; and, (2) evaluate which is more relevant to explain small mammal abundance in forest fragments: road effect, edge effect, or habitat area. The study area was a 10,000 hectares human-modified landscape, situated in southeastern Brazil. Road and edge effects were more relevant to explain the abundance of small mammals than habitat area. Because of the low traffic at the study site, we believe that barrier effect is the main road effect associated with small mammal abundance.

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**Room: Jupiter**

**Mitigation performance 1: Effectiveness of measures in reducing roadkill and barrier effect**

**Moderator: Marguerite Trocmé, Federal Road Office, Switzerland**

## Life and death along the highway: A study of badgers using GPS-collars and wildlife cameras

*Jaap L. Mulder (Bureau Mulder-natuurlijk, Netherlands); Nico Jonker (Provincie Noord-Holland, Netherlands)*

Badgers were studied along a highway, using GPS-collars and wildlife cameras. Mortality on the road was high on the unfenced part, and low on the fenced part of the highway. Badger group territories were lined up on both sides of the highway. Badger tunnels under

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the highway were especially used during spring, only to 'sniff out the neighbours'. Tunnels under lower grade roads were used on a daily basis. Badgers can survive in densely populated parts of the Netherlands thanks to measures that prevent their death on the roads.

## Road mortality mitigation: The effectiveness of Animex fencing versus mesh fencing

*John C. Milburn-Rodríguez, Jeff Hathaway (Scales Nature Park, Canada); Kari Gunson (Eco-Kare International, Canada); Dean Swensson, Steve Béga (Animex International, United Kingdom)*

Fencing is one of the most effective mitigation measures used to reduce roadkill however, little research is known about what materials work best to exclude herpetofauna from roads and there are a lot of concerns surrounding the safety and effectiveness of mesh fencing. This research attempts to fill this gap of knowledge and evaluates the effectiveness of mesh and Animex fencing by investigating their suitability to be used as solutions to protect wildlife near roads.

## Effect of artificial light on wildlife use of underpasses

*Arianna Scarpellini (Stockholm University, Sweden); Kylie Soanes (Clean Air and Urban Landscapes Hub, Threatened Species Research Hub, National Environmental Science Programme, School of Ecosystem and Forest Science, University of Melbourne, Australia); Theresa Jones (The Behaviour and Evolution Group, School of BioSciences, University of Melbourne, Australia); Manisha Bhardwaj (Department of Ecology, Sveriges Lantbruksuniversitet, Sweden); Rodney van der Ree (Ecology and Infrastructure International Pty Ltd / School of Biosciences, University of Melbourne, Australia)*

This study investigated the response of terrestrial wildlife to artificial lighting at four underpasses in southeast Australia.

The animals' response to artificial lights was monitored with camera traps before, during, and after treatments. Artificial light reduced the mean crossing frequency of red foxes (*Vulpes vulpes*) at one site. No immediate negative effects of light treatment were found on eastern grey kangaroos (*Macropus giganteus*) or swamp wallabies (*Wallabia bicolor*), although their mean crossing frequency decreased following the second light treatment. These findings demonstrate variation in species as well as in sites in the wildlife response to nocturnal lighting.

## Traffic noise and light as potential explanations for suppressed use of wildlife crossing structures

*Amy Collins, Annabelle Louderback-Valenzuela, Mia Guarnieri, Parisa Farman, Fraser Shilling (Road Ecology Center & Department of Environmental Science and Policy, University of California, USA); Benjamin Banet, Harrison Knapp, Travis Longcore (School of Architecture, Spatial Sciences, and Biological Sciences, University of Southern California, USA); Winston Vickers (Wildlife Health Center, University of California, USA)*

Wildlife crossing structures (WCS) over or under highways are proposed as a solution for road-related habitat fragmentation and wildlife collisions. To test the efficacy of WCS, road-related negative impacts that could cause animals to avoid WCS, such as noise, need to be considered. We found that traffic noise caused a measurably lower use of WCS use among sensitive species. We found some indication of traffic light effects, but more research is needed. Adequate screening of nearby habitat from noise and light effects could increase WCS use.

## Why wildlife-warning reflectors do not work and how they can still be useful

*Jens-Ulrich Polster (Technische Universität Dresden, Chair of Wildlife Ecology and Management, Germany); Christoph Schulze*

*(Technische Universität Dresden, Chair of Traffic and Transportation Psychology, Germany); Sven Herzog (Technische Universität Dresden, Chair of Wildlife Ecology and Management / Göttingen and Dresden Institute of Wildlife Biology, Germany)*

The biological effectiveness of wildlife-warning reflectors (WWR) concerning different animal species will be studied. Therefore, the reflection characteristics of nine WWR's were measured in a lighting lab, and a literature review on animal vision and colour perception was conducted. Based on this information, the WWR's visibility for wildlife animals was simulated. Except for concrete situations, the tested WWR's show a relatively low amount of optical reflection within its typical application field. Compared to other, for example, visual, acoustic, and olfactory stimuli in the situation of crossing a road by a wild animal, the effect is assumed to be negligible. However, an unknown effect on the driver cannot be excluded and may be the basis for positive results of long-term practical studies.

**Tuesday / 14:30 – 16:00**  
**Room: Foyer**

**Animal-vehicle collisions: Roadkill, hotspots and possible solutions**

**Moderator: Toine Morel, Rijkswaterstaat, Netherlands**

## Managing the timing and speed of vehicles reduces wildlife-train collision risk

*Casey Visintin, Rodney van der Ree, Nick Golding, Michael A. McCarthy (University of Melbourne, Australia)*

We created a modelling framework to assist managers to assess, plan and operate transportation systems intending to minimise wildlife-transport collisions. Our use of readily-available data and open-access software enables a wide-spread application of these methods. We studied train collisions with kangaroos in Australia to demonstrate our methods.

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## **Influence of lunar cycle on amphibian roadkill**

*Frederico Mestre, Helena Lopes, Tiago Pinto, Luís Guilherme Sousa, António Mira, Sara M. Santos (UBC – Conservation Biology Lab / CIBIO-UE – Research Centre in Biodiversity and Genetic Resources, Pole of Évora – Research Group in Applied Ecology, Department of Biology, University of Évora, Portugal)*

Amphibians are one of the groups most vulnerable to mortality on roads. We aimed to assess the influence of the lunar cycle on the number of amphibians killed on the road. Our results confirmed previous studies, that more amphibians are killed on roads during rainy and warmer nights. Lunar effects on number of roadkill were also detected for three species, although these effects were species-specific. Differences between species in the response to moonlight may be due to species' ecology and differences perceived in predation risk. Our work provides information to improve the timing of some temporary mitigation actions.

## **Animal-vehicle collision hotspots and assessment of mitigation measures in Lithuania**

*Andrius Kučas, Linas Balčiauskas (Nature Research Centre, Laboratory of Mammalian Ecology, Lithuania)*

Identification of animal-vehicle collision (AVC) hotspots is a most essential step for the effective application of mitigation measures. Identifying the most important sites for animal crossing mitigation measures should be based on yearly AVC hotspot (short significant road sections) recurrence. Location-based hotspot recurrence analysis will provide more stability to AVC mitigation measures than just risk for the drivers index alone.

## **Animal-vehicle collisions: Improvement of regression models with the use of cluster analysis**

*Richard Andrášik, Michal Bíl, Jiří Sedoník*

*(CDV – Transport Research Centre, Czech Republic)*

We present an idea on how to solve certain issues connected with the application of crash-prediction models. In general, two principal types of traffic crash causes exist: "global" and "local" causes. The local causes induce the formation of clusters, spatially distinct places with crash concentrations along roads, whereas the global causes do not. We further demonstrate that traffic crashes, which were caused by global causes, only occur spatially randomly along roads.

## **Wildlife-vehicle collisions: What do we know and what should we aim for?**

*Andreas Seiler (Swedish University of Agricultural Sciences, Department of Ecology, Grimsö Wildlife Research Station, Sweden)*

Wildlife-vehicle collisions are on the rise despite numerous attempts to mitigate the problem. Why have we not succeeded so far to reduce collision numbers and what should we do better? How much can we expect to achieve and what new methods should be in focus in future? I discuss these questions and attempt to provide answers based on international literature and 50 years of accident statistics in Sweden.

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**Room: Jupiter**

## **Mitigation performance 2: Effectiveness of measures in reducing roadkill and barrier effect**

**Moderator: Gerlies Nap, Province Noord-Holland, Netherlands**

## **How road mitigation can reduce road kill: a meta-analysis**

*Trina Rytwinski, Lenore Fahrig (Carleton University, Canada); Kylie Soanes (University of Melbourne, Australia); Jochen A.G. Jaeger (Concordia University Montreal, Canada); C. Scott Findlay (University of Ottawa, Canada); Jeff Houlahan (University of New Brunswick*

*at Saint John, Canada); Rodney van der Ree (Ecology and Infrastructure International / University of Melbourne, Australia); Edgar A. van der Grift (Wageningen Environmental Research, Netherlands)*

We present the first meta-analysis of the effectiveness of road mitigation measures in reducing road kill. Overall, mitigation measures reduce road kill by approximately 40% compared to controls. Fences, with or without crossing structures, reduce road kill by 54%. We found no detectable effect on road kill of crossing structures without fencing. Relatively expensive mitigation measures reduce large mammal road kill much more than inexpensive measures. There are insufficient data to answer many of the most urgent questions that road planners ask about the effectiveness of road mitigation measures. The complete paper available in *PLoS One* 2016 11(11): e0166941, doi:10.1371/journal.pone.0166941.

## **How effectively can we mitigate the barrier impacts of roads on wildlife movement? A global assessment and meta-analysis**

*Kylie Soanes (The University of Melbourne, Australia); Trina Rytwinski, Lenore Fahrig (Carleton University, Canada); Jochen Jaeger (Concordia University Montreal, Canada); C. Scott Findlay (Institute of the Environment & Ottawa-Carleton Institute of Biology, Canada); Jeff Houlahan (University of New Brunswick at Saint John, Canada); Fernanda Teixeira (Federal University of Minas Gerais, Brazil); Aurora Torres (German Centre for Integrative Biodiversity Research, Germany); Rodney van der Ree (Ecology and Infrastructure International, Australia); Edgar van der Grift (Wageningen Environmental Research, Netherlands)*

Evaluating the effectiveness of road mitigation is critical if we are to ensure that conservation goals are met, and financial investments have been worthwhile. We assessed the global evidence for the effectiveness of mitigation intended

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to reduce the barrier effect of roads on wildlife using meta-analysis. While more than 400 studies focused evaluating barrier mitigation, fewer than 50 studies evaluated effectiveness. The lack of comparison with 'unmitigated' data is a key factor limiting our ability to evaluate the effectiveness of wildlife mitigation, leaving us unable to answer some of the most pressing questions asked by road planners and agencies.

## **Fences and beyond: The importance of addressing fence-end effects in road-kill reduction studies**

*Edgar A. van der Grift (Wageningen Environmental Research, Wageningen University and Research, Netherlands)*

Roads may result in increased mortality of wildlife through wildlife-vehicle collisions. Fencing appears to be one of the more effective ways to reduce such road-kill. Most studies, however, do not address possible fence-end effects, i.e. elevated road-kill immediately adjacent to fence-ends. If such effects occur the effectiveness of fences in reducing road-kill may be overestimated. We demonstrate the importance of data collection at fence-ends in evaluation studies to make correct inferences about road mitigation effectiveness.

## **Prioritizing road sections for wildlife fencing: Lengths, thresholds, and trade-offs**

*Ariel Spanowicz, Jochen A.G. Jaeger (Concordia University, Department of Geography, Planning and Environment, Canada); Fernanda Zimmermann Teixeira (Road and Railroad Ecology Lab, Federal University of Rio Grande do Sul, Brazil)*

Wildlife fencing is the most effective measure for reducing roadkill. To determine optimal locations for fencing we explored how the choice of scales and confidence levels affects the results of a roadkill hotspot analysis. Our study shows how identifying roadkill hotspots, warm spots, and cold spots at multiple

scales allows for a more comprehensive approach for prioritizing road sections for wildlife fencing. We propose an Adaptive Fence Implementation Plan to prioritize road sections and discuss the existence of thresholds in the total length of fencing needed, the importance of considering the fence-end effect, and the FLOMS trade-off: "Few-Long-Or-Many-Short fences".

## **Effectiveness of wildlife fencing and crossing structures in reducing collisions with large mammals and providing habitat connectivity for deer and black bear along US Hwy 93 North, Montana, USA**

*Marcel P. Huijser, Elizabeth R. Fairbank, Jeremiah P. Purdum, Tiffany D.H. Allen (Western Transportation Institute, Montana State University, USA); Whisper Camel-Means (Confederated Salish & Kootenai Tribes, USA); Amanda R. Hardy (National Park Service, Biological Resources Division, USA)*

We investigated the effectiveness of wildlife fences and wildlife crossing structures in reducing collisions with large mammals and providing habitat connectivity for deer and black bear. Large-mammal vehicle collisions were substantially reduced, but since large mammal-vehicle collisions increased in the unmitigated road sections, we conclude that historic wildlife-vehicle collision data are not a good predictor for collisions after highway reconstruction. We also found that deer and black bear highway crossings remained similar or increased after highway reconstruction.

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**Room: Philips Hall**

**Transportation policies for greener infrastructure**

**Moderator: Lars Nilsson, Trogon Consulting, Sweden**

## **Influencing international transportation policy and practice for more wildlife-friendly roads**

*Rob Ament (Western Transportation Institute, Montana State University, USA)*

In 2016, the IUCN (International Union for Conservation of Nature) launched the *Connectivity Conservation Specialist Group (CCSG)* and charged it with developing a new conservation area for the world's governments – *Connectivity Conservation Area (CCA)*. There was a need identified to assure the adverse impacts of roads and rails on CCAs be addressed. Thus, a *Transport Working Group* has formed to advise and provide guidance on addressing the impacts of transportation infrastructure on such issues as wildlife movement and mortality within CCAs. This is believed to be the first green transport group ever formed by the IUCN to develop systemic guidance.

## **Environmental impact assessments: When to monitor the effects of implemented plans and programs?**

*Håvard Hjernstad-Sollerud, Astrid Brekke Skrindo (Norwegian Public Roads Administration, Climate, and Environmental Assessment Section, Norway)*

Environmental impact assessments are an essential tool for sustainable road development. Their ability to do so rests on understanding the effects of implemented plans and programs (e.g., road development). This requires studies with high-quality results, something that is often lacking in studies on the environmental effects of single road development projects. We believe the solution to this problem is determining first the suitability of a road development project for research, using criteria that define the possible study complexity. This gives information about the type of needed research, and if the project is suited for research in the first place.

## **Frontiers for conservation: Targeting European borders as conservation areas**

*Fernando Ascensão (CIBIO/InBio, Centro de Investigação em Biodiversidade e Recursos*

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*Genéticos, Universidade do Porto, Portugal); Marcello D'Amico (Department of Environmental Chemistry, Institute of Environmental Assessment and Water Research IDAEA (CSIC), Spain); Rafael Barrientos (Departamento de Ciencias de la Vida, Universidad de Alcalá, Spain); Eloy Revilla (Department of Conservation Biology, Estación Biológica de Doñana (EBD-CSIC), Spain); Henrique M. Pereira (German Centre for Integrative Biodiversity Research (iDiv), Martin Luther University Halle-Wittenberg, Germany)*

It is widely known that political borders should not hamper wildlife. Conservation actions involving several countries are known to bring large-scale benefits to nature while helping to resolve social and political conflicts. We provide an assessment of the potential for European political borders to function as fundamental conservation and connectivity areas. We do this by evaluating and comparing the number and size of roadless areas within countries and along their borders. We further discuss how focusing on conservation action at borders can form a 'win-win' situation with advantages for both biodiversity and human peace.

## **Integrating road ecology into wind-turbine ecology in Ontario, Canada**

*Kari E. Gunson (Eco-Kare International, Canada)*

In 2012, the Ontario Government gave Gilead Power approval to build an industrial wind farm that included nine turbines and associated access roads. However, Ostrander Point has the Threatened Blanding's Turtle that occurs along the last undeveloped shoreline of Lake Ontario. The Prince Edward County Naturalists appealed the decision and won because the turbines will cause severe and irreversible harm to the turtle. The case was based on the fact that roads would increase road-kill, predation, and poaching. They won this case on road ecology science alone. It is a testament to

the fact that policy and science for wind ecology is only beginning.

## **Road networks in Latin America: Research efforts, mitigation and policy towards better governance**

*Anthony P. Clevenger (Western Transportation Institute, Montana State University, USA); Fernando Pinto, Clara Grilo (Departamento de Biologia, Setor de Ecologia, Federal de Lavras, Brazil); Alberto Gonzalez Gallina (Instituto Nacional de Ecologia, Mexico); Diego Varela (Instituto de Biologia Subtropical, Centro de Investigaciones del Bosque Atlántico, Argentina); Juan Carlos Jaramillo Fayed (Facultad de Ciencias Exactas y Aplicadas, Instituto Tecnológico Metropolitano, Colombia); Andreas Kindel (Road and Railroad Ecology Group, Federal University of Rio Grande do Sul, Brazil); Fernanda Teixeira (Environmental Systems Analysis and Modeling Graduate Program, Federal University of Minas Gerais); Road and Railroad Ecology Group, Federal University of Rio Grande do Sul, Brazil); Daniela Araya (Panthera, Costa Rica); Esmeralda Arevalo (Universidad Latina de Costa Rica, Costa Rica); Juan Carlos Bravo (Wildlands Mexico, Mexico); Tom Langen (Departments of Biology & Psychology, Clarkson University, USA); Coral Pacheco, Juan de Dios Valdez (Depto de Biología, Universidad Juarez Autonoma de Tabasco, Mexico); Esther Pomareda (Centro de Rescate Las Pumas, Costa Rica); Celso Poot (Belize Zoo and Tropical Education Centre, Belize); Adriana Rico (Instituto de Ecología, Universidad Mayor de San Andrés, Bolivia)*

Growing highway construction in Latin America has generated increasing interest in research, technology transfer and new policy frameworks. Our aim is to showcase research efforts and different partnerships working towards road mitigation and better governance. We present results of an extensive literature review of effects of roads in Latin America. National networks are forming to change practices and policies. Mitigation projects are growing exponentially throughout Latin America. Lessons learned from model projects will be presented. We

conclude by identifying future challenges and needs for improving national and transboundary planning, policies and frameworks in a rapidly changing Latin American landscape.

**Thursday / 11:30 – 13:00**  
**Room: Foyer**

## **Road verges: Biodiversity potential and dealing with invasive species**

**Moderator: Rodney van der Ree, Ecology and Infrastructure International Pty Ltd, Australia**

## **Can linear transportation infrastructure verges constitute a corridor and/or a habitat for insects in temperate landscapes?**

*Sylvie Vanpeene (IRSTEA mediterranean ecosystems and risk research unit, France); Romain Sordello, Anne Villemey (UMS 2006 Patrimoine Naturel AFB-CNRS-MNHN, France)*

The potential of habitat or corridor for biodiversity of linear transportation infrastructure (LTI) verges for biodiversity remains controversial. That is why we performed the first synthesis of evidence about their potential as a corridor and/or habitat for insects in temperate landscapes. Meta-analyses revealed that insect abundance was similar in LTI verges than in compared habitats, and sometimes even higher (pollinators and primary consumers in non-highway road verges). In addition, the characteristics of the surrounding landscape seemed to influence on LTI verge biodiversity. Finally, a knowledge gap was identified regarding the role of the corridor of LTI verges.

## **Rare and endangered species in railway station dry grassland areas**

*Magnus Stenmark, Karin Norlin (Ecom AB, Sweden)*

Among the Swedish 1,400 railway stations, a majority has been surveyed for biodiversity potential. The results include a list

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of more than 2,000 species of insects and vascular plants having their habitat in these dry grasslands. About 100 of these are nationally red-listed species, mainly of bees, beetles, butterflies and vascular plants. The survey has also included a method identifying and ranking sites based on nature conservation values. High-ranked railway grasslands are subject to specific biodiversity action plants.

## Effects of management regimes associated with maintenance mowing along Hungarian roadside verges on ground-dwelling snails, slugs (Gastropoda), and arthropods (Osisidea: Isopods, Araneae, Carabidae)

*András Weiperth, Ildikó Szivák, Blanka Gál, Miklós Puky† (MTA Centre for Ecological Research); Diána Vona-Túri (Eötvös József Reformed Education Centre, Hungary); Tünde Szmatona-Túri (Forestry, Agricultural and Game Management Training School and Student Hostel of Mátra, Hungary); János Farkas (Department of Systematic Zoology and Ecology, Eötvös Loránd University, Hungary); Balázs Kiss, Ferenc Kádár (Centre for Agricultural Research, Hungarian Academy of Sciences, Plant Protection Institute, Hungary)*

The primary objectives of our study were to research the effect of different intensities of maintenance mowing management on the assemblage composition and the diversity of four ground-dwelling taxonomic groups along main roads. We hypothesised that regular maintenance has a positive effect on diversity, and is explained by the intermediate disturbance hypothesis. We also studied the impact of verge types and seasons on adequate maintenance intensity for the community composition and the diversity of four taxa together. We hypothesised that the native status and vegetation structure of verge types and sampling seasons would influence the optimal maintenance intensity.

## Expansion of alien invasive plants along the roadside: A remote sensing approach

*Patrícia Miguel Rocha Lourenço (Universidade de Évora, Portugal); Ana Cláudia Teodoro, João Pradinho Honrado, José Alberto Gonçalves, Mário Cunha, Rui Moura, Neftalí Sillero (Universidade do Porto, Portugal)*

Invasions by alien species are among the most important threats to ecosystems and human well-being. Remote sensing is an important tool to assess and monitor the dynamics of invasive plant species along the roadside. Here, we aim to characterise the spatial and temporal distribution of invasive plant species identified along the roadside, in one of the main transport/energy corridors linking Portugal to Spain. To identify the invasive plant species along the roadside, we conducted two sequential classifications by using multi-temporal aerial photos from 1995, 2010 and 2016. In general, the invasive plants' species increased between 1995 and 2016.

## Estimating the invasion risk to the German railway system for 123 invasive alien species

*Marion Leiblein-Wild, Sabrina Michael (German Federal Railway Authority (EBA), Germany); Pia Bartels (Federal Highway Research Institute (BASt), Germany); Michael Below (German Railways (DB AG), Germany); Daniel S. Esser (German Federal Institute of Hydrology (BfG), Germany); Oliver Tackenberg*

We developed a methodology to estimate the invasion risk of 123 invasive alien species (IAS) to the German railway system based on ecological traits, railway-specific traits, and occurrence data. Combining the methodology with performing a comprehensive literature survey, we created datasheets and risk assessments for all IAS. For IAS with a very high invasion risk, additional information on potential health risks, possible

damage to the railway system, and management measures were gathered. The results are essential for defining management priorities and identifying prospective measures for preventing and mitigating the introduction and spread of IAS via the transportation system.

**Thursday / 11:30 – 13:00**  
**Room: Saturn**

## Mitigation performance 3: Effectiveness of measures in reducing roadkill and barrier effect

**Moderator: Marcel Huijser, WTI, USA**

## An evidence-based approach to road mitigation for small vertebrate species

*Silviu Petrovan (Conservation Science Group, Department of Zoology, University of Cambridge, UK)*

This is a large review of multiple projects undertaken in the UK and Europe since 2013 in relation to the strategic planning and monitoring of effectiveness for road mitigation structures for small fauna species of conservation concern.

## Effectiveness of road mitigation for common toads (*Bufo bufo*) in the Netherlands

*Fabrice G.W.A. Ottburg, Edgar A. van der Grift (Wageningen Environmental Research, Wageningen University and Research, Netherlands)*

The impact of roads and traffic on amphibian populations is the result of amphibian road mortality. Measures have been developed to prevent road mortality. Although such measures are frequently applied across the world, only a few studies have evaluated their effectiveness in reducing road kill and facilitate safe movements across roads. This study focus on the effectiveness of mitigation measures taken for a common toad population on a local road in the central part of the Netherlands.

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## Standardized methods for amphibians at roads: Identifying critical road sections and evaluating mitigation measures

Jan Olof Helldin (Calluna AB / Swedish Biodiversity Center, SLU, Sweden); Ulrika Lundin, Anders Sjölund (Swedish Transport Administration, Sweden)

We present standardized national method protocols to identify road sections where current impacts on amphibians are critical and need to be mitigated, and to evaluate the effectiveness of amphibian mitigation measures. The method standards are intended to secure that results from different projects are comparable on national (Swedish) scale, and that they reach required quality.

## The suitability and use of green bridges by herpetofauna within the Veluwe district, The Netherlands

Richard P.J.H. Struijk (RAVON Foundation, Netherlands); David C. Broek

We investigated the suitability of green bridges for seven species of herpetofauna on five Dutch green bridges in the Veluwe district by comparing reptile densities on green bridges with surrounding suitable habitat. No significant differences in densities were found. Walls of tree stumps often being present on green bridges showed to be of strong significant interest to reptiles in comparison to open less-structured areas. Capture-mark-recapture techniques revealed individual movements of *Lacerta agilis*, *Anguis fragilis*, *Natrix helvetica*, *Coronella austriaca* and *Epidalea calamita* on a green bridge(s) itself, though full crossings have only been found once in *N. helvetica* and *E. calamita*.

## Amphibian and reptile highway crossings worldwide: A state of the practice review and gap analysis

Tom Langton (Herpetofauna C I Ltd., United Kingdom); Antony P. Clevenger (Western

Transportation Institute, Montana State University, USA); Robert Fisher, Cheryl Brehme (United States Geological Survey, Western Ecological Research Center, USA)

A programme is underway in California, USA, for the State Road Authority CALTRANS, to develop Best Management Practice Guidelines for road crossings for amphibians and reptiles by 2020. We examined a) passage construction and use, b) passage environmental variables and c) barrier construction and use for 52 English language studies, concerning 125 individual taxa from mainly Europe, North America, South America and Australasia. Of the 75 reptile and 50 amphibian species or sub-species involved, snakes, lizards and frogs each represented about 20-25% of total taxa with 13 salamander & newt taxa, eight toad, five turtle and two tortoise.

Friday / 9:30 – 11:00  
Room: Philips Hall

**CEDR Roads and Wildlife Manual:  
A new handbook for practitioners**

**Moderator: Kylie Soanes, The University of Melbourne, Australia**

## Integrating wildlife into Europe's national road network

Vincent O'Malley (Transport Infrastructure Ireland, Ireland); Ander Sjölund (Trafikverket/The Swedish Transport Administration, Sweden)

Investment in road infrastructure involves extensive discussions between various stakeholders which may result in the implementation of expensive mitigating actions. Therefore, it is crucial that such actions are cost-efficient. The Conference of the European Directors of Roads (CEDR) transnational research call focused on ensuring the latest best practice related to wildlife was adopted during the development of road infrastructure. This presentation covers the output of the research projects as well as the development of the new wildlife handbook for NRAs.

## Procurement – The relevance of the CEDR Roads and Wildlife Manual for road engineering

Eugene J O'Brien (School of Civil Engineering, University College Dublin (UCD) / Roughan & O'Donovan Innovative Solutions (ROD-IS), Ireland); Ciaran Carey, Seamus MacGearailt, Barry Corrigan (Roughan & O'Donovan Innovative Solutions (ROD-IS), Ireland)

The Conference of European Directors of Road identified the need for insight in how procurement practices consider ecological mitigation measures and how outcome-based procurement might influence the results for nature. This presentation will describe the content of Chapter 4 of the CEDR Roads and Wildlife Manual, 'Procurement and Performance Indicators'. Beginning with a review of the relevant Harmony and SAFEROAD results, which formed the basis of the Manual chapter, the presentation will then outline procurement approaches of road mitigation. Methods to achieve effective measurable outcomes that facilitate wildlife crossings are then discussed.

## Road mitigation for bats

Morten Elmeros (Department of Bioscience, Aarhus University, Denmark)

Roads may have a detrimental impact on bat populations by increasing mortality rates, fragmentation and habitat degradation and destruction. A range of measures has been constructed on roads to reduce their impact on bats. However, many uncertainties still exist regarding the bats' use of the measures and their effectiveness. The effectiveness varies between bat species and sites. However, potentially suitable mitigating interventions are available if the mitigation measures are carefully chosen and designed. The CEDR Manual provides recommendations and outlines key points to consider when to mitigate road impact on bat populations.

### Road maintenance guidelines to improve wildlife conservation and traffic safety

*Carme Rosell (Minuartia wildlife consultancy / Department of Evolution Biology, Ecology and Environmental Science, University of Barcelona, Spain); Heinrich Reck (Institute for Natural Resource Conservation (INR), Germany); Jan Olof Helldin (Calluna AB / Swedish Biodiversity Center, Sweden); Andreas Seiler (Swedish University of Agricultural Sciences, Grimsö Wildlife Research Station, Sweden); Eugene O'Brien (Roughan & O'Donovan Innovative Solutions, Ireland); Marina Torrellas, Albert Cama (Minuartia wildlife consultancy, Spain); Edgar A. van der Grift (Wageningen Environmental Research, Netherlands)*

Road maintenance practices are a fundamental factor to guarantee long-term effectiveness of measures constructed to reduce habitat fragmentation and hazards to road users and wildlife, enhance biodiversity, and reinforce European Green Infrastructure. Based on interviews with road maintenance professionals from 11 European countries, a literature review, and a workshop, a set of guidelines for the maintenance of roads and their surroundings from an ecological perspective have been produced and included in the CEDR Roads and Wildlife Manual. Road managers are recommended to adopt a flexible strategy and a lifecycle approach to identify the most appropriate BMPs.

### CEDR Roads and Wildlife Manual: Road mitigation strategies and monitoring

*Edgar A. van der Grift (Wageningen Environmental Research, Wageningen University and Research, Netherlands)*

Road agencies and conservation organisations are currently investing large amounts of money in developing and implementing numerous mitigation strategies and techniques. However, what is the most effective mitigation strategy? Should we focus on reducing wildlife

mortality due to vehicle-wildlife collisions? Is increasing road permeability for wildlife the better option, or should we consider doing both? Are the measures we take effective in reducing road impacts? What is the best way to evaluate mitigation performance? All these questions are addressed in the 'Roads and Wildlife Manual', recently published by the Conference of European Directors of Roads (CEDR).

**Friday / 9:30 – 11:00**

**Room: Foyer**

**Roads and bats: Impacts, mitigation and monitoring**

**Moderator: Lazaros Georgiados, Biologist and Environmental consultant, Greece**

### What drives the spatial distribution and temporal persistence of bat road kill hotspots?

*Denis Medinas, João Tiago Marques, António Mira (CIBIO-UE – Research Centre in Biodiversity and Genetic Resources. Pole of Évora / InBIO – Research Network in Biodiversity and Evolutionary Biology / UBC – Conservation Biology Lab, Department of Biology, University of Évora, Portugal)*

Many hotspots change locations annually, while others tend to persist. There is little about the factors of these variations. We evaluate the spatiotemporal persistence of bat road kill aggregation during three years in a Mediterranean landscape. Our results showed that persistent hotspots are usually located on road segments crossing areas of higher vegetation productivity where bat activity tends to be higher. We show that vegetation productivity can be used to predict bat road kill locations. Therefore, this broadly available remote sensing information can be used to minimise the impact of roads.

### Predicting bat diversity, abundance and movements in road projects – Evaluation of a habitat suitability model

*Johnny de Jong, Gesa von Hirschheydt (Swedish Biodiversity Centre, SLU, Sweden); Oskar Kindvall (Calluna AB, Sweden)*

Road planning requires a good knowledge of potential conflicts with conservation values. In this presentation, a habitat network model for bats is demonstrated. The model is based on publicly available geographical data and takes several important aspects of bat population ecology into account. It can be used to make predictions on bat abundance, distribution and movements. The model was evaluated in the field by bat surveys during summer 2017, and the result and future development of the model will be discussed.

### Ecological effectiveness and implementation of hop-overs for bats: a case study on the N356

*Margriet Krijn, Yde van der Heide, Mark Koopmans, Eddy Wymenga (Altenburg & Wymenga ecological consultants, Netherlands)*

The N356 road crosses the small-scaled bocage landscape of the northern part of Friesland which is an important area for bats. Therefore, mitigation measures such as hop-overs were needed. To design effective ecological constructions being feasible concerning planning and construction, a system engineering approach was used. Ecologists were involved at an early stage of the process and monitoring continued throughout the process. Monitoring showed that bats frequently use the constructed hop-overs. Additionally, agreements on operation and maintenance were made. This approach helps to communicate effectively and additionally facilitates to test hop-overs on ecological functionality.

## **A road-effect zone for insectivorous bats not caused by lack of insects**

*Manisha Bhardwaj (University of Melbourne, Australia / SLU, Sweden); Kylie Soanes, Jose Lahoz-Monfort (University of Melbourne, Australia); Lindy Lumsden (Department of Environment, Land, Water and Planning, Australia); Rodney van der Ree (Ecology and Infrastructure International Pty Ltd, Australia)*

We evaluated the road-effect zone (REZ) for insectivorous bats and nocturnal flying insects to understand the influence prey availability has on the impacts of roads on predators. We surveyed bat activity and insect biomass along eighteen transects that were perpendicular to three freeways in southeast Australia. Although bat activity decreases with proximity to the freeway, insect biomass does not change. This suggests that prey availability isn't the primary factor behind the REZ for bats, and the influence of other factors (e.g., traffic disturbance, a gap in the canopy) should be evaluated to mitigate the impact of roads on bats.

## **Recent innovations in threatened microbat mitigation on road projects in New South Wales, Australia**

*Josie Stokes (Roads and Maritime Services, Australia)*

Bridge and culvert replacement projects can result in local extinctions of threatened microbats through habitat loss. To mitigate this, we have conducted studies on roosting and breeding habitats to incorporate habitat design features into new and existing structures. This presentation provides details of the evolution of microbat mitigation in NSW, highlights recent innovations on road projects, and points out lessons learned during construction of permanent roosting and breeding habitat on new concrete bridges. We report on ecological monitoring that demonstrates successful uptake and breeding events in purpose-built permanent microbat habitat.

**Friday / 9:30 – 11:00 /  
Room: Neptune**

## **Canalized waterways: Restoring habitat and connectivity for aquatic species**

**Moderator: Fabrice Ottburg,  
Wageningen Environmental Research,  
Netherlands**

## **Restoration and optimising ecological connectivity in the North Sea Canal Region**

*Arjen Kikkert (Rijkswaterstaat, Netherlands)*

Since 2012, eight authorities around the North Sea Canal have joined in a partnership to improve fish migration. In this region, diadromous species used to be common. However, as a result of habitat fragmentation amongst others, a severe decline in stocks has been noted. After several joint projects, the partnership has now started a large-scale three-year monitoring program in which the focus is on species that used to be common in the local water systems. The program aims to contribute to more sustainable water management, an increase in species diversity and more stable ecosystems.

## **Ecological value of constructed shallow water zones along a navigable canal: A case study from the canal Ghent-Bruges**

*Andy Van Kerckvoorde (Research Institute for Nature and Forest, Belgium)*

A case study of constructed shallow water zones along the navigation canal Ghent-Bruges (located in the northern part of Belgium) is presented. The shallow water zones provide appropriate conditions for establishment of native herbaceous helophyte vegetation and willow shrubs but are of little importance for rooted aquatic plant species. Lower oxygen values were observed during summer and autumn in the shallow water zones compared to the fairway. Mitigation measures for navigation impacts can increase biodiversity and ecological processes in navigable canals and are useful for waterway managers,

policy-makers and technicians in future bank engineering projects.

## **Adjusted tidal sluice management, an easy way to improve the upstream migration of glass eels in Flemish waterways (Belgium)**

*Jeroen Van Wichelen, David Buysse, Claude Belpaire, Johan Coeck (Research Institute for Nature and Forest, Belgium); Kristof Vlietinck (The Agency for Nature and Forests, Belgium)*

Tidal sluices form a significant challenge for the growing phase (glass eels) of the critically endangered European eel during their upstream migration towards their freshwater growth areas. We present the effectiveness of adjusted tidal sluice management (slightly opening the floodgates at flood tide) as a mitigation measure. In this way, we were able to demonstrate that this cheap and easy applicable technique is a valuable tool for the management and restoration of this enigmatic species.

## **Pumping stations and the 'migration road' towards safer pumps for the critically endangered European eel**

*David Buysse, Jeroen Van Wichelen, Raf Baeyens, Ine Pauwels, Ans Mouton, Johan Coeck (INBO – Research Institute for Nature and Forest, Belgium)*

The impact of pumping stations on eel (*Anguilla anguilla* L.) populations is poorly understood. Eel mortality was studied after downstream passage through four different types of pumps and pump sizes on three lowland canals in Belgium. A propeller pump, Archimedes screw pumps, de Wit Archimedes screw pumps, and a fish-friendly screw pump. Based on the condition of the fish and injuries sustained, maximum mortality rates were calculated. To achieve escapement targets set in the eel management plan, we need fish-safer pump designs and effective PS bypass solutions.

**Friday / 9:30 – 11:00**

**Room: Jupiter**

**Crossing borders: New approaches towards green and sustainable transport infrastructure**

**Moderator: Anders Sjolund, Swedish Transport Administration, Sweden**

**Crossing borders between roads agencies and building companies, for a greener and sustainable transport infrastructure**

*Victor Loehr (Rijkswaterstaat, Netherlands); Jan Willem Burgmans, Bas Bakker (Heijmans, Netherlands)*

Ecological measures in Dutch highway constructions are largely identified and selected by government agencies. Two major highway expansions used a new approach where traditional borders between government agencies and building companies were crossed, and building companies were challenged during the tender to identify ecological measures. Tendering building companies conducted landscape-level analyses with highly-skilled personnel and submitted plans that added significant ecological value to the projects. The early timing of collaboration between ecologists and civil-engineers contributed to innovation and mutual understanding, benefiting all project phases. Two highway expansions have been constructed, and several future projects will follow the same approach.

**'Structure-Permeability-Index' to assess highway alignments**

*Marguerite Trocmé (Federal Road Office, Switzerland); Kim Krause (Kaden & Partner AG, Switzerland)*

Using data accumulated through the monitoring with infrared cameras of 96 crossing structures on two highway stretches, a structure-permeability index was developed. The index uses easily available data combining structure type and dimensions, Corinne land-use of surroundings, traffic noise mapping

and traffic levels during night-time on the structure. The index showed an excellent correlation to number of wildlife crossings on the structures and can be used in the future to rank structures suited for retrofit or upgrading for wildlife.

**A user-friendly computer platform to assess the impact of transport infrastructure on wildlife: a case study with the Eurasian lynx in France**

*Sarah Bauduin, Laetitia Blanc, Cyril Bernard, Arzhela Hemery, Olivier Gimenez (CEFE, France); Anaïs Charbonnel, Estelle Germain (CROC, France); Luc Chrétien, Alain Morand (CEREMA, France); Christophe Duchamp, Eric Marboutin (ONCFS, France); Stephanie Kramer-Schadt (IZW, Germany); Fridolin Zimmermann (KORA, Switzerland)*

The terrestrial transportation network is getting denser, which increases collision risks with wildlife. Focusing on lynx in France, we develop an operational tool that managers can use for decision making and land-use planning. Together with stakeholders, we built a spatially-explicit individual-based model to predict extinction risks and assess the impact of transport infrastructures. This model was implemented in a user-friendly computer platform. We adopted a participatory approach to ensure the smooth appropriation of this platform by stakeholders. Our contribution fills a gap between academic research, the stakes of land planning, lynx conservation and the needs of transport infrastructures stakeholders.

**On-Board cameras reveal wildlife responses to approaching trains**

*Andreas Seiler, Linda Höglund (Swedish University of Agricultural Sciences, Department of Ecology, Grimsö Wildlife Research Station, Sweden); Mattias Olsson (Enviro-Planning AB, Sweden); Pär Söderström, Anders Forsberg (SJ AB, Rolling Stock Division, Sweden); Anders Sjolund (Swedish Transport Administration, Sweden)*

Wildlife-train collisions are a growing concern. However, conventional measures to mitigate the problem are rare and very expensive. To better understand how wildlife responds to trains and how they could be warned to avoid collisions, we conducted onboard video recordings of animals within the rail corridor. Our results suggest that animals most often respond appropriately and in time, but that they need time to detect the train. We conclude that measures that would help to increase the detectability of the train by wildlife could be useful in reducing ungulate-train collisions.

**Changing driver behaviour in Protected Areas of South Africa**

*Wendy Collinson (Endangered Wildlife Trust, South Africa); Courtney Marneweck (School of Biology and Environmental Sciences, University of Mpumalanga, South Africa); Innocent Buthelezi (Tshwane University of Technology, South Africa); Harriet Davies-Mostert (Centre for Wildlife Management, University of Pretoria, South Africa)*

The Endangered Wildlife Trust has strived to raise public awareness of the impacts of roads on biodiversity through media campaigns, extensive social media platforms and by engaging with relevant stakeholders. Initially our attention was focused on road impacts on wildlife outside of protected areas, since traffic volume is higher and collisions are often more visible and more threatening to human life. However, reports from various social media platforms have indicated huge public concern for wildlife-vehicle collisions (WVC) inside protected areas. Consequently, in 2017 we initiated an assessment of driver behaviour within Pilanesberg National Park in South Africa.