



African Conference for Linear Infrastructure and Ecology

10-15 March 2019

Skukuza Camp

Kruger National Park

South Africa



STRATEGIC PARTNERSHIP

SCHEDULE AT-A-GLANCE

Sunday, March 10, 2019		
13:00–17:00	Registration	Nombulo Mdluli Conference Centre
17:00–19:00	ACLIE Welcome Function (Painted Wolf Wines)	
Monday, March 11, 2019		
7:30	Registration	Nombulo Mdluli Conference Centre
8:30–9:45	Welcome Announcement and Keynote	Ndlopfu
9:45–10:30	Road Development and their Status in Africa	
11:00–12:45	Linear Infrastructure – Global Perspectives	
14:15–15:30	Planning and Development of Linear Infrastructure and Biodiversity	
16:00–17:15	Lessons Learned and Good Practise	
18:00–20:00	Energy Meeting (by invitation)	Cattle Baron Boma
18:00	“Sundowners” – meet for a drink	Cattle Baron
Tuesday, March 12, 2019		
8:00	Registration	Nombulo Mdluli Conference Centre
8:30–9:30	Announcements and Keynote	Ndlopfu
9:30–10:30	Power Lines and Ecology	
11:00–12:30	Global Mitigation Practices for Linear Infrastructure	Ndlopfu
11:00–12:30	Workshop – Mainstreaming Linear Infrastructure and Biodiversity	Ndau
14:00–15:15	Rail Ecology – are we on the Right Track?	Ndlopfu
14:00–15:15	Stories from the Line: Power Line Case Studies	Ndau
15:45–16:50	Lightning Talks (5 minutes each)	Ndlopfu
15:50–16:50	Workshop	Ndau
17:00–18:00	Poster Session	Ndlopfu
18:30–20:00	IUCN CCSG Transport Working Group (by invitation)	Cattle Baron Boma
18:30	“Sundowners” – meet for a drink	Cattle Baron
Wednesday, March 13, 2019		
	Field Trips	Nombulo Mdluli Conference Centre
Thursday, March 14, 2019		
8:00	Registration	Nombulo Mdluli Conference Centre
8:30–9:30	Announcements and Keynote.	Ndlopfu
9:30–10:15	Resilient Transportation as a Global Demand	
10:45–12:15	Mitigation Case Studies 1	
14:00–15:30	Mitigation Case Studies 2	
16:00–21:00	Depart for Bush Braai	Nombulo Mdluli Conference Centre
Friday, March 15, 2019		
7:30–13:00	Check-out and Departure	Nombulo Mdluli Conference Centre

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CONFERENCE CO-HOSTS



**ENDANGERED
WILDLIFE TRUST**
Protecting forever, together.

The Endangered Wildlife Trust

www.ewt.org.za

The EWT is a leading high-profile player in the arena of conservation. We identify the key factors threatening biodiversity and develop innovative methodologies and best practise guidelines to reduce these and promote harmonious co-existence and sustainable living for both people and wildlife. We achieve our goals through specialist programmes, and our skilled field staff are deployed regionally and throughout southern Africa.

Eskom

www.eskom.co.za



Eskom is responsible for generating sufficient electricity supply to meet the increasing power demands of South Africa. Interactions between the resulting infrastructure and wildlife often lead to negative impacts to ecosystems and/or specific species. In view of the complexity, scope and persistence of the problem of interactions between wildlife and Eskom infrastructure, Eskom and the Endangered Wildlife Trust (EWT) formalised their long-standing relationship by entering into a partnership in 1996. The Eskom/EWT Strategic Partnership was established to address the potential problems in a systematic manner from a national perspective, and to establish an integrated management system to minimise these negative interactions.

SPONSORS

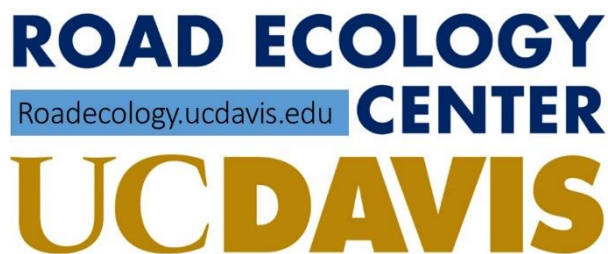
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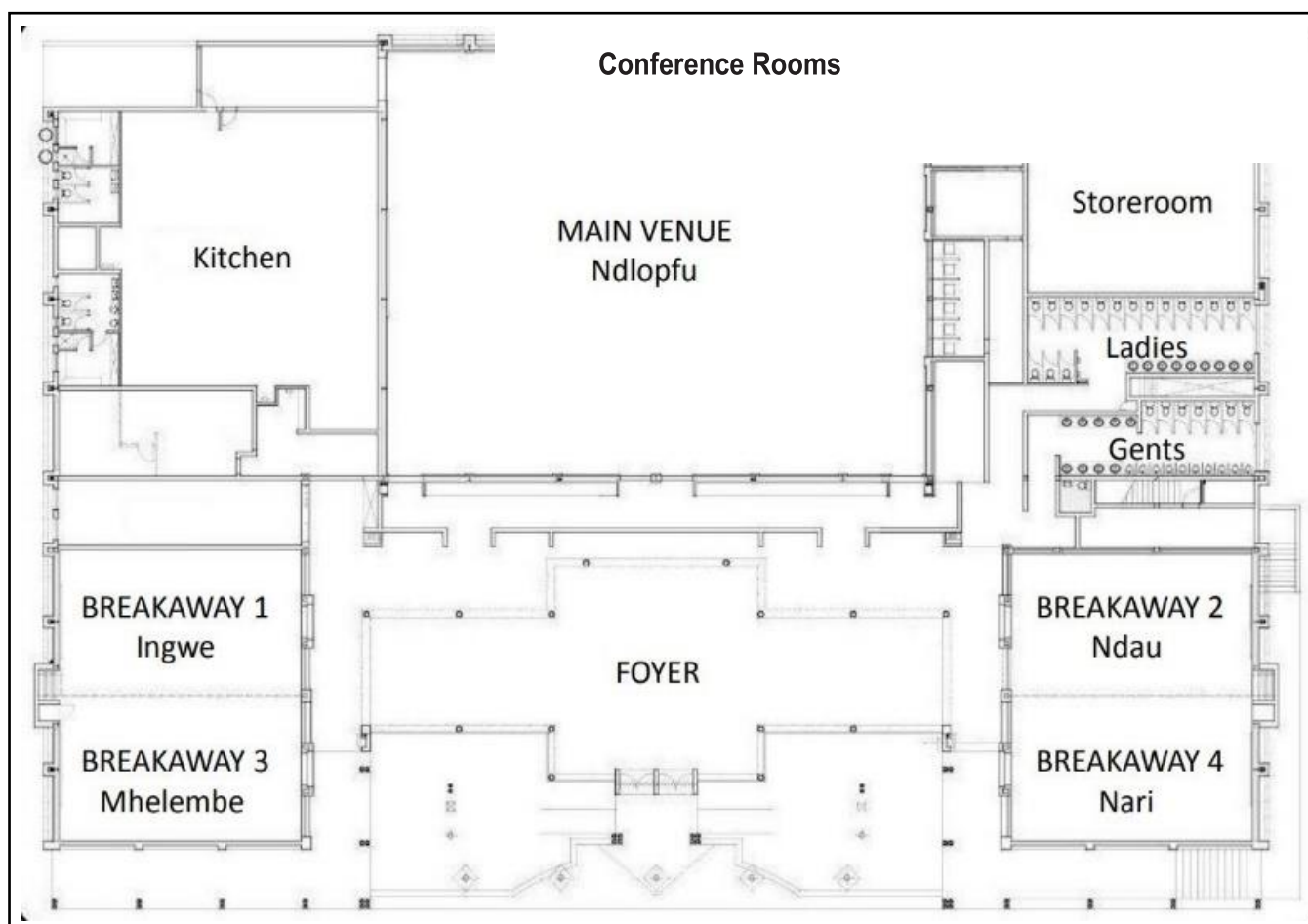


GENERAL INFORMATION

Please wear your name tag at all times, as it serves as your admission ticket to all events covered by your registration fee.

In the event of an emergency, please contact one of the conference team, or the SANParks (Skukuza) front desk on the numbers below:

- SANParks: 013 735 4000
- Magda Baille (africaMASSIVE): 083 577 0123
- Angus Morton (africaMASSIVE): 082 770 3855
- Constant Hoogstad (EWT): 082 334 4176
- Wendy Collinson (EWT): 073 596 1673



Wi-Fi is available at the conference centre. However, there is no Wi-Fi in the sleeping rooms or chalets.

SSID: ACLIE 2019
Password: Password

Registration

Registration for the African Conference for Linear Infrastructure and Ecology 2019 includes your welcome packet and admission to all keynotes, sessions and workshops. It also covers the following:

- Sunday evening Welcome Function
- Tea/coffee breaks twice each day and lunches on Monday, Tuesday and Thursday.
- Poster Session on Tuesday evening.
- Conference-related charges by the Skukuza Rest Camp (daily park fees; meeting rooms, breakout rooms, audio-visual equipment and sound).

Dinner is on your own, but we suggest meeting after the daily sessions at the Cattle Baron for a 'Sundowner'. This is a traditional way in Africa to enjoy the end of the day, watching the sun go down with a drink in hand. You will be able to meet other delegates and arrange dinner together, if you so choose.

The registration and information desk will be situated in the foyer of the Nombolo Mdluli Conference Centre for the duration of the conference. The desk will be open on:

- Sunday, 13:00-19:00
- Monday-Thursday, 07:30-18:00
- Friday, 07:30-13:00

Delegates who are registered with SACNASP and require a certificate of attendance, can contact the conference organisers or visit the SACNASP website (validation number: 2019-0528-000637).

Thursday Night Bush Braai Banquet

- I. Depart for game drive at 16:00
- II. Welcome at 19:00 – Wendy Collinson
- III. Awards Presentation* – Kishaylin Chetty
 - Best poster presentation
 - Best student presentation
 - Best overall presentation
- IV. Conference host recognition – Constant Hoogstad
- V. African Marimba Band and Traditional Dancers

The prizes for the awards have kindly been donated by Rodney van der Ree, Kari Gunson and Eskom



As a conservation NGO, the Endangered Wildlife Trust, believe very strongly in 'walking the talk', therefore to be environmentally friendly, we have limited the amount of printed materials at our conference. You will find a copy of this programme booklet on your memory stick in your welcome pack, as well as on our website. Please see provided brochure for an overview of the conference.

CONFERENCE FIELD TRIPS

Wednesday 13 March – Field Trips

#	Meet 30 minutes prior to departure at Nombulo Mdluli Conference Centre at Skukuza Rest Camp. Please note that lunch will be at another rest camp in the park at your own cost. Drinks and snacks will be available on the vehicle.	
1	Power line mitigation and game drive in Kruger National Park. Lourens Leeuwner.	Full day Depart 6:00 Return 18:00
2	Roadkill Mitigation Project and game drive in Kruger National Park. Wendy Collinson.	Full day Depart 6:00 Return 18:00
3	Specialised birding trip. Lawson's Birding Tours.	Half day Depart 9:00 Return 15:00
4	Power line mitigation and Roadkill Mitigation Project in Kruger National Park. Constant Hoogstad.	Full day Depart 6:00 Return 18:00
5	Behind the scenes with SANParks. TBC	Half day Depart 9:00 Return 15:00

Birding & Wildlife Safaris



www.lawsons-africa.co.za

Pre-conference

Escarpment and Kruger National Park

Western Cape

KZN, Swaziland & Kruger National Park



ACKNOWLEDGMENTS

Many people came together to create the African Conference for Linear Infrastructure and Ecology (ACLIE) in Kruger National Park, South Africa. The first conversations in planning the conference stem back to 2016, when it became apparent that in order to accelerate learning in the field of linear infrastructure ecology in Africa, we need to marry the global network of experts with African continent experts. The ideal solution would be for many of our local experts to regularly attend the existing international conferences so that they can engage with other national programs and gain an understanding into what is being done elsewhere. Unfortunately, many of our stakeholder NGOs, ministries and other agencies have limited funds to attend many of these international events. So, *“If the mountain won’t come to Muhammad then Muhammad must go to the mountain”* and we decided to facilitate an African linear infrastructure conference in 2019 in South Africa. Needless to say, there have been many conversations and many, many people involved since its auspicious beginning. Many thanks to those who contributed their time and talents, including session moderators and committee members as identified below. Marion Burger designed the iconic conference logo. Your conference brochure was designed by Wendy Collinson, Khanya Peacock, and Emily Taylor. With almost 130 delegates from 15 countries, the 2019 conference would not be possible without the services of africaMASSIVE, a for-profit, South Africa-based conference planning service. In consultation with the Endangered Wildlife Trust and Eskom, africaMASSIVE created and managed the conference website, handled online registration, and communication with conference delegates. We are very grateful to have had the professional help of africaMASSIVE’s Magda Baille and Angus Morton.



africaMASSIVE
IMAGINE • SHARE • LIVE

Special thanks to:

Conference Steering Committee

The ACLIE steering committee (SC) leads the network and develops the overall strategy for the conference. Members were invited to support ACLIE based on their expertise in their respective countries. The members of the ACLIE SC 2018-2019 are:

Wendy Collinson, Chair
Andre Botha
Kishaylin Chetty
Lazaros Georgiadis
Sandra Jacobson
Elke Hahn
Ali Halajian
Constant Hoogstad
Bibi Linden
Aliza le Roux
Lourens Leeuwner
Daniel Parker
Fraser Shilling
Rodney van der Ree

Scientific Programme

Wendy Collinson
Lazaros Georgiadis
Ali Halajian
Constant Hoogstad
Bibi Linden
Aliza le Roux
Daniel Parker
Samantha Page-Nicholson
Claire Patterson-Abrolat
Fraser Shilling
Emily Taylor.
Rodney van der Ree

Photo credits

Andre Botha
Wendy Collinson
Constant Hoogstad
Lourens Leeuwner
Bibi Linden
Anton van Niekerk

Moderators

Manisha Bhardwaj
Kishaylin Chetty
Wendy Collinson
Patricia Cramer
Lazaros Georgiadis
Kari Gunson
Lourens Leeuwner
Claire Patterson-Abrolat
Mattheuns Pretorius
Fraser Shilling
Tanya Smith
Rodney van der Ree

Logistical assistance

Harriet Davies-Mostert
Belinda Glenn
Oscar Mohale
Megan Murison
Khanya Peacock
Emily Taylor
Megan Murison
Innocent Buthelezi

VENDORS

Thanks to all of our vendors for their participation! Vendor booths are located in the presentation room area throughout the conference. Make sure to stop by and visit the vendor booths.



The Endangered Wildlife Trust

<https://www.ewtshop.co.za/>

You can become a member of the EWT (<https://www.ewt.org.za/donate.html>) or show your support of our work through purchasing conservation goodies either from our online store or at the conference.



South African National Parks Honorary Rangers

www.sanparksvolunteers.org

SANParks Honorary Rangers is a group of passionate and unpaid volunteers who give freely of their time and skills to support conservation in South Africa's national parks. They provide the people and the business community of South Africa with an opportunity to support and become involved in conservation efforts in our national parks.



Power Line Sentry

www.powerlinesentry.com

Power Line Sentry and their extensive line of wildlife mitigation products, provide effective wildlife and avian protection products for the distribution of electricity around the world. There are over 400,000 Raptor Guard units in service in North and South America, Caribbean, Mongolia, and Africa, providing a safe interaction between wildlife and our electrical infrastructure.

SKUKUZA REST CAMP



Skukuza Rest Camp in the Kruger National Park is a popular camp situated in the heart of Big Five territory and is easily accessed by road and air travel. Skukuza features a variety of accommodation options including camp sites, 21 furnished safari tents, semi luxury bungalows, cottages and 4 guesthouses. The myriad of birds and wild game in the area are easily spotted by going on bush walks and game drives. Wildlife documentaries are shown in an outdoor amphitheater. In March, the temperature on average dips to 18°C / 64°F at night and peaks at 30°C / 86°F during the day.

Skukuza is the largest rest camp in the Kruger National Park and serves as its headquarters and main hub for nature conservation. Here you will find museums, cottages, huts, restaurants, shops, facilities for day visitors, camping and caravan sites, a petrol station, vehicle emergency service, car hire, an airport, a post office, a bank, a doctor and a laundromat.

When you drive through the imposing gates into Skukuza, you find yourself in an administration centre abuzz with scientists, rangers, and conservationists. A wealth of knowledge can be gained in the information center, while adults and children can attend lectures in the nearby environmental education centre. A museum has been constructed at the railway siding, which was used on the Selati line in the 1920's. You can have a meal in a restaurant housed in two old railway carriages from the same period.

The camp is located in the southern region of the Kruger National Park. Also worth a visit is the Campbell 1929 Hut Museum. This national monument was one of the first tourist huts to be established in Skukuza and houses interesting relics from the period.



Skukuza has over 200 huts, making it the Kruger National Park's largest camp.

Skukuza Rest Camp Facilities

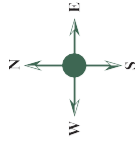
- | | | |
|--|--|---|
| <ul style="list-style-type: none">• Information at reception• Library• Medical practitioner• Public telephone• Post box• Bank• Car hire• Car wash• Two restaurants• Auditorium and conference facilities• Internet café• Delicatessen• Two swimming pools in camp (for | <ul style="list-style-type: none">overnight residents only)• Cafeteria• Shop• Laundromat• Filling station• Communal kitchens• Cutlery and plates hampers (from Reception)• Basic first aid assistance• TVs (limited DSTV) available in family bungalows only• DSTV (limited channels) available in luxury | <ul style="list-style-type: none">units only• Day visitor picnic spot (located 4km outside the camp) with own swimming pool• Cellphone reception• Skukuza Indigenous Nursery (located approximately 5km outside camp)• Magnificent 9-hole (18-tee), par 72 golf course• Communal ablutions |
|--|--|---|



South African
NATIONAL PARKS

SKUKUZA CAMP

Enjoy your stay with us



SPECIAL FEATURES:

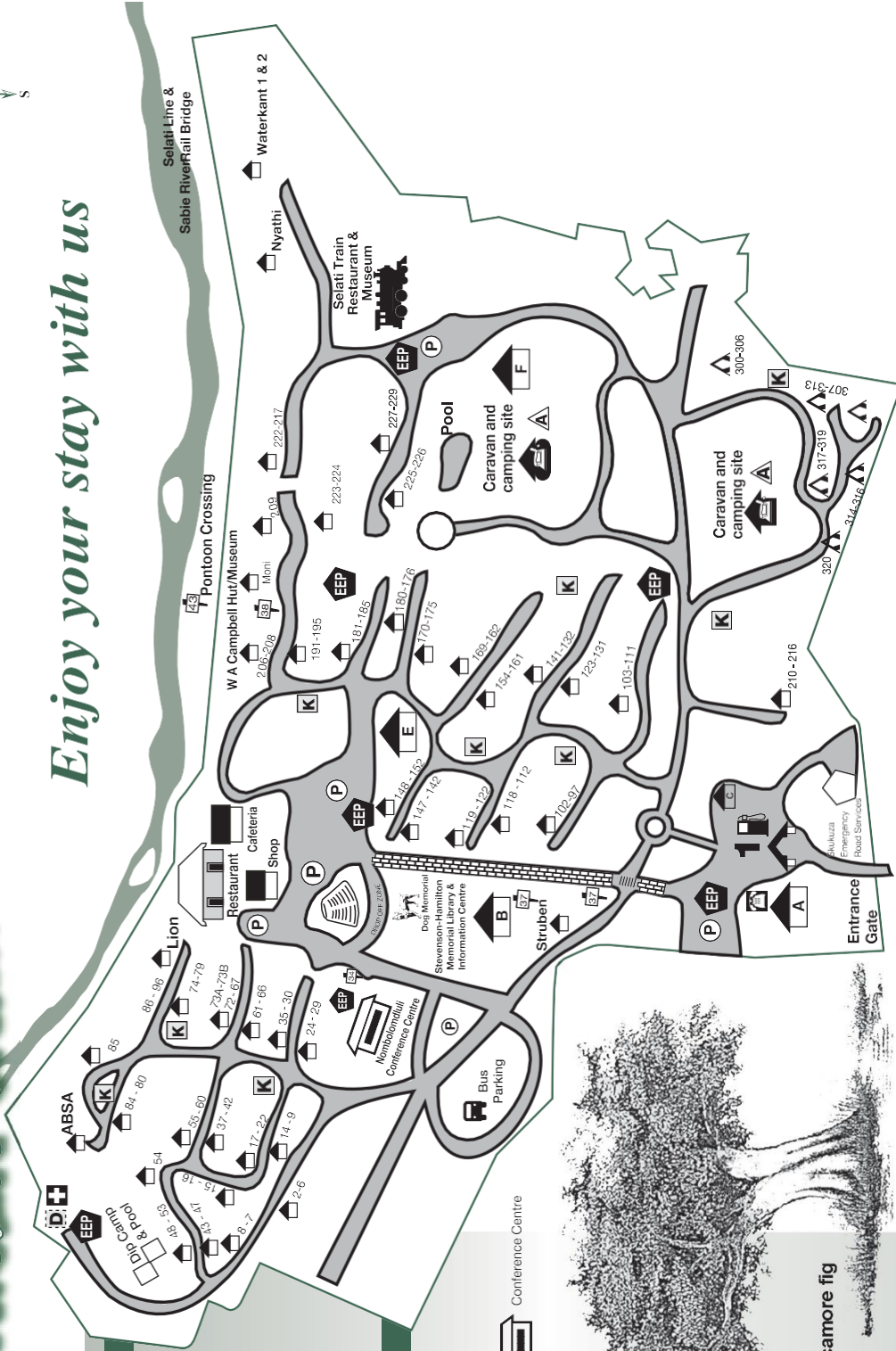
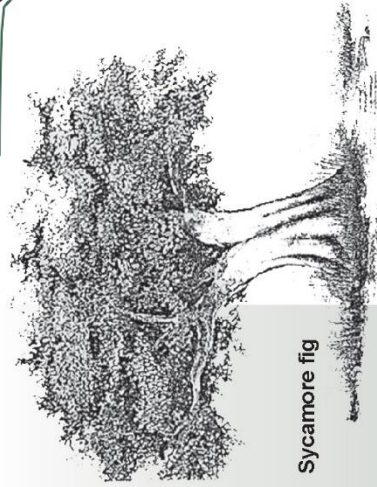
Special Features

- Skukuza Emergency Road Services
- Airport
- Museums
- Day/Night Drives
- Nursery of Indigenous Plants
- School Journey Services
- Police Station
- First National bank
- Conference Facilities
- Accommodation for Disabled
- Day Visitors Area with Pool

KEY

- Reception/Toilets/Post Office/FNB Bank Library/Auditorium/Information centre
- Restaurant/Toilets/Shop/Cafeteria
- Car Wash
- Housekeeping
- School journey services
- Administration block
- Entrance gate
- Laundromat and irons
- Car parking Bus parking
- Petrol & diesel
- Public telephone
- First Aid / Doctor
- Accommodation
- Ablution block
- Communal kitchens
- Film shows
- Caravan and camp sites
- Historical sites
- Skukuza Emergency Road Services
- Doctor
- Permanent tents
- Emergency Evacuation Points

Sycamore fig



PLEASE DEPOSIT KEYS IN KEY BOX AT GATE BEFORE DEPARTURE

DUTY MANAGER CELL NO. 082 802 1204

SANPARKS REGULATIONS

The function of SANParks is to protect, conserve and control the national parks and other protected areas assigned to it and that you are subject to the conditions set in terms of Section 86 of the National Environmental Management Act (107 of 1998) and the National Environmental Act: Protected Areas Act (Act 57 of 2003) for the duration of your stay in the National Park. Your attention is specifically drawn to section 64(1)(a), (b) & (c) which refers to penalties in terms of the Act.

To ensure a safe and joyful trip through our parks, kindly adhere to the rules and regulations under the Protected Areas Act. Transgression of the rules and regulations as summarized below may result in prosecution and or penalties.



1. **INDEMNITY:** Guests entering national parks will be required to sign a document indemnifying SANParks against any claim, action, judgment, costs and/or expenses which may be made against SANParks.
2. **IDENTIFICATION:** Please ensure that acceptable means of identification are taken along when visiting parks. This does not only apply to the drivers of vehicles but could be requested of all adults that enter or visit parks.
3. **CONSERVATION FEES:** Daily conservation fees are payable for every day/ night stayed in national parks. The acquisition of a Wild Card is available as an alternative to paying daily conservation fees.
4. **COMMUNITY FUND:** SANParks have implemented a 1% Community Levy on all reservations (overnight and activity products) arriving on or after 1 June 2012. This is used to fund projects that support surrounding communities in bettering their livelihoods. For more information please view our website on www.sanparks.org
5. **STAY IN YOUR VEHICLE** – In most of the national parks there is a possible threat from dangerous animals. In such parks guests may only alight from vehicles in designated areas. No part of your body may protrude from a window or sunroof and doors should remain closed at all times;
6. **THE MAXIMUM SPEED LIMIT** – Please take careful note of the speed limits applicable in the various areas of the parks. Note that not all roads are accessible to caravans and/ or vehicles exceeding a certain mass, type or size.
7. **ALCOHOL:** The consumption of alcohol in public areas is prohibited. Day visitors are prohibited from entering Kruger National park with any alcohol in their vehicles.
8. **DRIVE SAFELY** – General rules of the road apply within the parks. It is an offence to drive on South African roads without a recognized driver's license or under the influence of alcohol. Driving or operating any vehicle in a reckless or negligent manner or in a deliberate disregard for the safety of a person, animal or property is a serious offence and can result in a summons being issued. Driving a vehicle in a manner that constitutes a nuisance, disturbance, inconvenience or danger to any other person may also be subject to a summons being issued.
9. **ADHERE TO GATE TIMES** – Gate times must be strictly adhered to. Please take note of the different times that apply at gates and also camps and lodges within the parks. Guests must plan their travelling thoroughly and make adequate provision for contingencies. After hours driving is not allowed and could result in a summons being issued.
10. **OVERNIGHT VISITORS** – Guests are only allowed to stay at a booked and recognized overnight facilities and must report to the relevant reception before occupying accommodation or camping;
11. **CAMP SITES** – Camping base rates include one motorized vehicle per campsite. Additional motorized vehicles per campsite are charged at a rate equivalent to the campsite base rate per night.
12. **AGE RESTRICTIONS:** For safety reasons some activities conducted in parks have age restrictions. Please take cognizance of these in order to prevent disappointments.

13. DEPARTURE TIMES – All accommodation and camping sites may be occupied from 14:00 on day of arrival and must be vacated by 10:00 on the day of departure;
14. DRIVING AREAS – Vehicles must remain on the designated roads at all times and off-road driving or driving on closed or no- entry roads is a serious offence. In many areas, overnight facilities are to be accessed only by booked overnight guests;
15. FEEDING OF WILDLIFE IS PROHIBITED – The feeding or intentional disturbance of wildlife is a serious offence. By feeding any wildlife you are potentially SIGNING THEIR DEATH WARRANT, AS THEY MAY BECOME DEPENDENT AND OFTEN BECOME AGGRESSIVE AND DANGEROUS, AND THUS HAVE TO BE EXTERMINATED;
16. FLORA & FAUNA – No plant, animal, wildlife or any natural or cultural items may be removed from the park without permission. To cut, damage, destroy or be in possession of any plant or part thereof, including dry wood or firewood is a serious offence. Importing of any specimen of an alien or listed invasive species into a national park is prohibited;
17. VEHICLE RESTRICTION – There are restrictions to the type of vehicle that may enter national parks. Please take careful note of vehicle restrictions applicable to the different roads and areas of the parks.;
18. PETS – No pets (dogs, cats, birds or any other) may be brought into a Park. Transgressors will be dealt with firmly, issued with a summons and the pets will be destroyed. Guide dogs for visually impaired guests are one exception, but only in consultation with park management and if the owner has the necessary inoculations and permits as ordained by the state veterinary department;
19. LITTER-FREE ZONE – Littering is prohibited. Deposit or leaving of any litter except in receptacles for that purpose will result in a fine;
20. DECLARE FIREARMS AT GATE – All firearms/dangerous weapons of any sort, any explosive, trap or poison must be declared upon entry, and firearms will be sealed;
21. NO KILLING OF ANIMALS – Poaching and killing or injuring of animals is strictly prohibited;
22. FIRE HAZARD – Starting or causing of any fire, whether it be intentional or unintentional other than in a fireplace or container purposely made available is strictly prohibited and will result in a summons being issued
23. SMOKING – Please take note of the smoking regulations applicable in the parks
24. BEHAVIOUR – Behaving in an offensive, improper, indecent or disorderly manner including the playing of any radio, compact disc player, music system, musical system or instrument, or in any way cause of any noise in any manner likely to disturb any species or specimen or other person is strictly prohibited and will be fined if not adhered to. The hindering, intimidating or obstructing of an authorized official in the execution of his/her duties or the performance of his/her functions will not be tolerated and is subject to a penalty. Violation, refusal or failure to obey or comply with any prohibition, request or instruction imposed by these regulations or by the management authority or authorized official will result in prosecution;
25. BICYCLES: Please enlighten yourself with the rules and regulations applicable to the use of roller skates, skateboards, bicycles and motorbikes for the park/s that you will be visiting as there are restrictions in some of the parks;
26. DRONES: The use of drones inside (and over) national parks is strictly prohibited.
27. BEWARE MALARIA – Kruger National Parks fall within a malaria zone. A 24 hour malaria hotline is available on 0822341800 and where relevant, please consult your medical practitioner.
28. PARK SPECIFIC INFORMATION – Kindly familiarize yourself with the general conditions prevalent in the park you are going to visit by visiting the website at www.sanparks.org and link onto Parks A-Z as there may be vital information contained therein to assist with your visit.



WELCOME LETTER FROM THE EWT



Sanibonani, Namukelekile e-Africa! Welcome to South Africa, we trust that you will enjoy the warm hospitality of our people, witness the natural beauty of our country, and marvel at the rich biodiversity to be found. The Kruger National Park is indeed an appropriate venue for the inaugural African Conference for Linear Infrastructure and Ecology 2019, and it gives me great pleasure to welcome you to one of Africa's prime wildlife areas.

The last 18 months have been quite an interesting and busy time since our decision to host the conference, and I was initially concerned that the cost and time required to travel to South Africa may result in only a small number of people being able to make the journey to attend this year's conference. At the time of writing this note of welcome, I am glad to say that these fears were unfounded and that this year's conference will host nearly 130 delegates from 15 countries. The lure of the African bush with its diversity of wildlife certainly must have contributed to this excellent turn-out, and we look forward to hosting you this week and sharing some of the magic of this part of Africa with you.

A conference such as this would not have been possible without the input of a range of organisations and individuals. I would like to thank Magda Baille and Angus Morton from africaMASSIVE who have carried the bulk of the burden in making the conference possible, by means of their excellent website and behind-the-scenes engagement with various stakeholders, including you, the delegate. Thank you to South African National Parks for their assistance with a range of matters, especially those in which many of you will participate. I also owe a debt of gratitude to our colleagues at Eskom, as well as the staff at the Endangered Wildlife Trust who have been involved in numerous meetings, and assisted with arrangements to ensure that the conference will be a success.

We trust that you will have a productive and enjoyable week, and establish lasting friendships and working partnerships to the benefit of ecology, and linear infrastructure development, globally.

Yours sincerely,

Wendy Collinson

Chair: African Conference for Linear Infrastructure and Ecology 2019

Manager: Wildlife and Transport Programme, The Endangered Wildlife Trust.



WELCOME LETTER FROM ESKOM



It gives me great pleasure to welcome you to the 2019 African Conference for Linear Infrastructure and Ecology in the Kruger National Park. As South Africa's power utility, Eskom plays an important role in 'keeping the lights on', whilst ensuring that activities to generate, transmit and distribute electricity are done in an environmentally responsible manner. The Kruger National Park is a stronghold of many threatened species and as a result, significant focus has been placed by Eskom towards decreasing the impact of energy infrastructure on wildlife, whilst reducing electrical outages.

The Eskom/Endangered Wildlife Trust (EWT) Strategic Partnership, a world first, was formalised in 1996 to establish an integrated management system to minimise negative interactions between wildlife and energy infrastructure, which are a global problem.

Eskom's collaboration with the EWT has achieved a number of significant milestones over the last 23 years. New pole structure designs, collision and electrocution risk maps, proactive mitigation strategies, research projects focused on priority bird species, and a world first nocturnal bird flight diverter are only a few examples of the many innovative outputs achieved. In another first for Africa, the partnership is developing a mechanism to use drones to attach bird flappers to power lines. This innovative technology will replace the conventional method of using helicopters, thereby reducing costs and eliminating the associated safety risks. As drones are faster and cheaper to dispatch, more power lines across the country can be marked in a safe and cost effective way, further reducing the threat that linear energy infrastructure pose to wildlife.

Looking to the future, the Eskom/EWT partnership is striving to consistently reduce the number of negative wildlife interactions with energy infrastructure. The Eskom/EWT Strategic Partnership demonstrates well how industries and NGOs can work together for the benefit of the environment, whilst ensuring legal environmental compliance for Eskom, continuity of electricity supply to customers, and reduced overall business expenditure.

We look forward to hosting you and wish you an enjoyable conference.

Yours sincerely,

A handwritten signature in black ink, appearing to read 'Kishaylin Chetty'.

Kishaylin Chetty
Senior Environmental Advisor
Eskom Biodiversity Centre of Excellence
Eskom/EWT Project Manager





STRATEGIC PARTNERSHIP

Eskom EWT Strategic Partnership

Eskom and the Endangered Wildlife Trust (EWT) formalised their long-standing relationship by entering into a partnership in 1996. The Eskom/EWT Strategic Partnership was established to address the potential problems in a systematic manner from a national perspective, and to establish an integrated management system to minimise these negative interactions.

The Objectives of the partnership are:

- Assist with the mainstreaming of biodiversity into the Eskom business, through specialist advice on latest trends, biodiversity management practices, biodiversity networking and through input into the Eskom Biodiversity Strategy.
- Maintain, implement and regularly review the existing national central incident register for all wildlife interactions.
- Investigate reported wildlife interactions with Eskom infrastructure (including those on Eskom-owned properties).
- Support with research on, and the design of, mitigation measures to reduce negative wildlife interactions with all electrical infrastructure, including renewable energy and impacts related to business risks.
- Raise awareness through effective communication amongst Eskom employees and the general public on the issue of wildlife interactions.

Provide support through investigation and monitoring of Eskom



The Eskom/EWT Strategic Partnership continues to be of benefit to, and valued by, both partners. Since its inception, the partnership has built this specialised field worldwide, and remains a highly respected and esteemed collaboration internationally, achieving its objectives through a range of activities.

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STRATEGIC PARTNERSHIP

WORKSHOPS

Room: Ndau | Time: Tuesday 12 March 2019 from 11:00-12:30

The mainstreaming of biodiversity provisions in linear infrastructure by the transportation, energy, and mining sectors in Africa. Challenges and perspectives for an international strategy for engaging different stakeholders

Lazaros Georgiadis¹, Rob Ament², Anders Sjolund³, Elke Hahn⁴, Marita Boccher⁵, Rodney van der Ree⁶, Kate Newman⁷, Wendy Collinson⁸ & Fraser Shilling⁹

¹IENE – Infra Eco Network Europe, Biologist – Environmentalist, Greece.

²IUCN – International Union for Conservation of Nature, Connectivity Conservation Specialist Group. Transport Working Group/ Centre for Large Landscape Conservation, USA.

³IENE, Swedish Transport Administration, Sweden.

⁴IENE, Federal Ministry for Transport, Innovation and Technology, Austria.

⁵IENE, Federal Agency for Nature Conservation, Germany.

⁶ANET - Australasian Network for Ecology and Transportation / Ecology and Infrastructure International Pty Ltd, Australia.

⁷WWF-World Wildlife Fund US, USA.

⁸The Endangered Wildlife Trust, South Africa.

⁹ICOET-International Conference on Ecology and Transportation, Road Ecology Center, University of California Davis, USA.

Presenter: Lazaros Georgiadis, Ammochori, Florina, 53100, Greece. +306972640062. lazgeo36@gmail.com

Roads, railways, power lines, pipelines and other linear infrastructure are essential for human societies. However, they have deleterious impacts on species, communities, and ecosystems, including human and wildlife injury and mortality, and the loss, fragmentation and degradation of habitat. Habitat loss is inevitable and direct impacts can extend for kilometres on either side of the structures and continue to develop for years, thereby affecting ecosystems and their services across the landscape.

In collaboration with a growing number of colleagues from all over the world, and for the first time joining forces of four continental conferences including the African Conference for Linear Infrastructure and Ecology (ACLIE) and international organisations, we have been working together to develop the International Guidance for Ecologically Friendly Linear Infrastructure (IGELI) to ensure that the infrastructure we build today is as ecologically sensitive as possible. At the same time, mainstreaming of biodiversity in sectors such as energy, mining and infrastructure, has been raised in the framework of the Convention on Biological Diversity (CBD) and the achievement of Aichi Global targets.

In this workshop, we will summarise the feedback we received at the 14th COP in Egypt (Nov 2018) and seek an African perspective on challenges and opportunities to maximise ecological, economic and social outcomes of current and future linear infrastructure. We will also discuss whether it is possible to develop linear infrastructure and maintain biodiversity and other ecosystem benefits. Your contribution to this interactive workshop is essential to ensure the guidelines represent global best-practise and are cognisant of the needs and expectations of the African community.

Strategic environmental assessment for the identification of energy corridors

Dee Fischer¹, Annick Walsdorff², Rohaida Abed², Fahiema Daniels³, Tsamaelo Malibu³

¹*Department of Environmental Affairs, South Africa.*

²*Council for Scientific and Industrial Research, South Africa.*

³*South African National Biodiversity Institute, South Africa.*

Presenting authors: Dee Fischer, Annick Walsdorff, Rohaida Abed, Fahiema Daniels, Tsamaelo Malibu

Infrastructure investment is a key priority in the National Development Plan, and it is instrumental in the growth and job creation in South Africa. As such, 18 large-scale State Infrastructure Projects (SIPs) have been initiated to unlock strategic development potential and to be proactive rather than reactive in planning for infrastructure. SIP 10: *'Electricity Transmission and Distribution for all'*, aims to provide guidance for the efficient and sustainable expansion of strategic electricity grid infrastructure (EGI) in South Africa. Equivalently, Operation Phakisa was launched in 2014 to realise the potential of our coastline. The development of a phased gas pipeline network is therefore seen as an enabler for the offshore exploration and has the potential to unlock further possibilities for the growth of the gas industry in South Africa, contributing to the transition to a low carbon economy. The latest Integrated Resource Plan (2018) has also identified the need to accelerate the planning for gas to power.

Inefficient processes and poor integration between government departments responsible for infrastructure related authorisations has resulted in significant backlogs to development in South Africa. To ensure that environmental authorisations are not a cause for delaying the roll-out of infrastructure projects, the Department of Environmental Affairs (DEA) has embarked on a programme of Strategic Environmental Assessments (SEAs) for these critical infrastructure activities.

The aim of the EGI and Gas pipeline network SEA is to identify the optimal location for strategic corridors where transmission infrastructure development or expansion is needed to enable the regionalised balancing of future energy demand and supply requirements, whilst minimising negative impacts to the environment.

Use of biodiversity information to inform the identification of energy corridors

Dee Fischer¹, Annick Walsdorff², Rohaida Abed², Fahiema Daniels³, Tsamaelo Malibu³

¹*Department of Environmental Affairs, South Africa*

²*Council for Scientific and Industrial Research, South Africa*

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Presenting authors: Dee Fischer, Annick Walsdorff, Rohaida Abed, Fahiema Daniels, Tsamaelo Malibu

The aim of the Electricity Grid Infrastructure and phased Gas pipeline network Strategic Environmental Assessment (SEA) is to identify the optimal location for strategic corridors where transmission infrastructure development or expansion is needed to enable the regionalised balancing of future energy demand and supply requirements, whilst minimising negative impacts to the environment. The power corridors will represent the transmission backbone of South Africa. Based on the scoping level pre-assessment undertaken as part of these SEAs, proposed transmission level infrastructure developments triggering either a Basic Assessment (BA) or Environmental Impact Assessment (EIA) process will benefit from improved environmental regulatory treatment inside of the Power Corridors.

The SEA employs a multi-criteria analysis, focusing on constraints and opportunities mapping. An environmental sensitivity assessment is undertaken to determine areas within the corridors, which are most and least sensitive to gas pipeline development. The engineering constructability of the land will also be assessed to determine areas within the corridor to be avoided from an engineering perspective. The outputs of the SEA in the form of maps and development protocols and/or standards, Environmental Management Programmes (EMPr) will be put forward for adoption and released for public comments through publication in the Government Gazette.

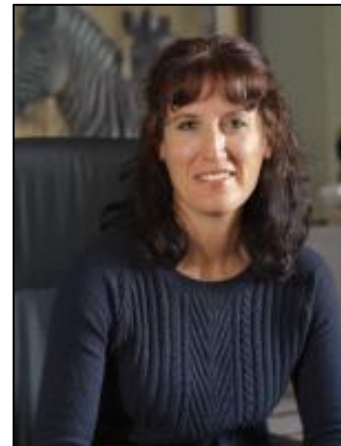
KEYNOTE SPEAKERS

Conservation and Development in Africa

Yolan Friedmann, CEO, The Endangered Wildlife Trust, Private Bag X11, Modderfontein, 1645, Gauteng, South Africa. +27 87 0210 398. yolanf@ewt.org.za

Yolan Friedmann is currently the CEO of the Endangered Wildlife Trust (EWT www.ewt.org.za), one of the largest conservation NGOs in southern Africa. She was the first female recipient of the *SAB Nick Steele Environmentalist of the Year* award in 2011; was the winner of the *CEO Most Influential Woman in Business and Environment* award in 2012 (Environmental category); received the 2012 *Green Globe* award and was awarded a WESSA Lifetime Achiever Award in for Conservation in 2016. Yolan was the first South African to serve as a Regional Councillor on the IUCN Council and co-chaired the IUCN's Constituency Committee for four years. She is also a Certified Director by the Institute of Directors South Africa and serves on their Sustainability Forum, Audit and Risk Committee, and Social and Ethics Committee. She also sits on the Advisory Board of the Ford Wildlife Foundation and is currently a regular judge of the Ecologic Awards, African Responsible Tourism Awards, and SA Federation of Steel and Engineering Industries Awards. Yolan has participated in programmes such as the Gordon Institute for Business Science Nexus Development Programme (2006), the Leadership for Conservation in Africa council, the African Leadership Seminar, Crans Montana Forum, and is a Fellow of the Archbishop Tutu Leadership Fellowship (2007). She was selected as a GreenMatter Senior Fellow in 2014.

Yolan has co-authored chapters in books such as *Bending the Curve* and *Biodiversity Monitoring & Conservation: Bridging the gap between global commitment and local action*. Yolan was featured in the book *The Best Advice I Ever Got* by Siya Mapoko and appeared in *Woman and Home* magazine as one of a group of "Powerful and Inspiring" women for 2012. She was also featured in the Financial Mail's "Rain Makers and Pot Stirrers – 100 of South Africa's most influential players in the mining sector" in 2013.



A powerful partnership

Deirdre Herbst, Environmental Manager, Eskom, South Africa.

Deirdre Herbst is currently the Environmental Manager for Eskom. In this capacity she has been responsible for amongst others providing strategic direction for environmental management to one of the largest utilities in the world. This role includes the integration of environmental management into the business with a specific focus on integration of environmental considerations into energy planning, business and biodiversity, air quality management, water management practices and waste management including ash utilisation.

Eskom is responsible for generating sufficient electricity supply to meet the increasing power demands of South Africa. Interactions between the resulting infrastructure and wildlife often lead to negative impacts to ecosystems and/or specific species. In view of the complexity, scope and persistence of the problem of interactions between wildlife and Eskom infrastructure, Eskom and the Endangered Wildlife Trust (EWT) formalised their long-standing relationship by entering into a partnership in 1996. The Eskom/EWT Strategic Partnership was established to address the potential problems in a systematic manner from a national perspective, and to establish an integrated management system to minimise these negative interactions.

The Eskom/EWT Strategic Partnership provides strategic and operational guidance that enables Eskom to effectively understand, identify and deliver plans to minimise the impact of Eskom's activities on ecosystems and where possible, enhance biodiversity through responsible management practices. Based on this, the objectives of the partnership are:

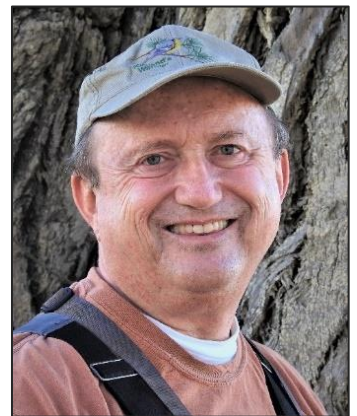
1. Assist with the mainstreaming of biodiversity into the Eskom business, through specialist advice on latest trends, biodiversity management practices, biodiversity networking and through input into the Eskom Biodiversity Strategy.
2. Maintain, implement and regularly review the existing national central incident register for all wildlife interactions.
3. Investigate reported wildlife interactions with Eskom infrastructure (including those on Eskom-owned properties).
4. Support with research on, and the design of, mitigation measures to reduce negative wildlife interactions with all electrical infrastructure, including renewable energy and impacts related to business risks.
5. Raise awareness through effective communication amongst Eskom employees and the general public on the issue of wildlife interactions.
6. Provide support through investigation and monitoring of Eskom renewable energy projects.

The Eskom/EWT Strategic Partnership is a great model for how industries and NGOs can work together for the benefit of the environment. As the Eskom/EWT Strategic Partnership has developed, so has the ability of Eskom changed from simply talking about biodiversity towards mainstreaming biodiversity activities into the core Eskom business.

Making Linear Infrastructure Biodiversity-friendly: Lessons from World Bank Experience

George C. Ledec, Ph.D., Lead Ecologist, Africa Region, The World Bank, Washington, DC 20433, USA. +1 (202) 473-9267. gledec@worldbank.org

Dr George Ledec is Lead Ecologist in the Africa Region of the World Bank, with more than 30 years of international experience in making large development projects more biodiversity-friendly. His work focuses on the environmental mitigation of dams, canals, power lines, and other infrastructure; protected area establishment and management; and other ways to address biodiversity conservation in development planning. Dr Ledec had a key role in preparing the Bank's new Biodiversity Conservation Standard, as well as the Natural Habitats and Wildlands policies that preceded it. His publications include "Biodiversity Offsets: A User Guide"; "Good Dams and Bad Dams"; "Biodiversity Conservation in Road Projects"; "Greening the Wind"; and "Towards Africa's Green Future: World Bank Support in Biodiversity Conservation". Dr Ledec was born in what is now the Czech Republic and is a naturalized United States citizen.



The world's growing demand for infrastructure should be met in ways that do not add to global biodiversity loss. This challenge is especially evident in Africa, where much of the infrastructure stock is not yet built--there thus exists a tremendous opportunity to do it better. Over the years, the World Bank has accumulated extensive experience with making development projects more biodiversity-friendly, including roads, canals, power lines, pipelines, and other linear infrastructure. The Bank's new Environmental and Social Standard ESS6, "Biodiversity Conservation and Sustainable Management of Living Natural Resources", imposes strict requirements for projects affecting Modified, Natural, or Critical Habitats as well as Protected or Internationally Recognised Areas.

Making infrastructure biodiversity-friendly requires translating good intentions into good results on the ground. Planning for biodiversity-friendly linear projects involves careful site selection and optimized alignment, effective use of strategic as well as project-specific environmental assessments, and adopting ecological compensation measures including (where appropriate) biodiversity offsets. Biodiversity-friendly construction needs clear requirements in civil works bidding documents and contracts—including the technical specifications and code of conduct—followed by diligent field supervision. Project operation typically requires biodiversity monitoring, linear landscape management, and adherence to biodiversity-friendly operating rules.

A key challenge is to ensure that biodiversity conservation is adequately considered during all phases of infrastructure planning, construction, and operation. This includes disseminating information on cost-effective biodiversity-friendly practices to facilitate their increased adoption.



CONFERENCE SCHEDULE

SUNDAY 10 MARCH

Venue: Nombulo Mdluli Conference Centre

13:00–19:00	Registration
17:00–19:00	ACLIE Welcome Function – Painted Wolf Wines

MONDAY 11 MARCH

Venue: Nombulo Mdluli Conference Centre - Ndlopfu

7:30	Registration
8:30	Welcome and address by <i>Glenn Phillips</i> , Managing Executive: Kruger National Park, South African National Parks (SANParks).
8:45	Conference introduction and announcements by <i>Constant Hoogstad</i> , Senior Manager for Industry Partnerships, The Endangered Wildlife Trust.
9:00	Keynote address by <i>Yolan Friedmann</i> , CEO of The Endangered Wildlife Trust. Conservation and Development in Africa.

Road Development and their Status in Africa (chair: Wendy Collinson)

9:45	Status of road ecology research in Africa: what more do we need to know? <i>Harriet Davies-Mostert</i> .
10:00	A review of the global impact of current and future road development on top predators. <i>Jeffrey Dunnick</i> .
10:15	Understanding the impacts of roads on sub-Saharan African ecosystems. <i>Lavinia Perumal</i> .
10:30–11:00	Break

Linear Infrastructure - Global Perspectives (chair: Rodney van der Ree)

11:00	Improving Linear Transportation Infrastructure within Areas of Connectivity Conservation. <i>Robert Ament</i> .
11:15	From biodiversity offsets to target-based compensation. <i>Martine Maron</i> .
11:30	Development Corridors in Kenya –The Standard Gauge Railway. <i>Lucy Waruingi</i> .
11:45	Environmental stewardship within the Belt and Road Initiative. <i>Fernando Ascensão</i> .
12:00	Approaching Biodiversity Issues in Transmission Line Route Studies and Impact Assessments. <i>Hélène Chouinard</i> .
12:15	The Unintended Consequences of Good Intentions. <i>Gwen Gosney</i>
12:30	Making Irrigation Infrastructure Biodiversity-friendly: Malawi's Shire Valley Transformation Project. <i>George Ledec</i> .
12:45–14:15	Lunch

Planning and Development of Linear Infrastructure and Biodiversity (chair: Lazaros Georgiadis)

14:15	The use of ecological standards in planning, design, construction and maintenance of roads and railways in Sweden. <i>Anders Sjolund</i> .
14:30	It's a long way from the first idea to the operation of a motorway in Austria. <i>Elke Hahn</i> .
14:45	The SLOSS dilemma of road ecology – Single Large Or Several Small fauna passages? <i>Jan-Olof Helldin</i>
15:00	Adapting the infrastructure to the surrounding landscape. <i>Lars Nilsson</i> .
15:15	The challenge of achieving no net loss / net gain for linear projects – lessons learnt from a European perspective. <i>Corin Simmonds</i> .
15:30–16:00	<i>Break</i>
Lessons Learned and Good Practise (chair: Manisha Bhardwaj)	
16:00	Cultivating Connectivity: An American Tale. <i>Alexander Levy</i> .
16:15	How to start defragmentation processes? <i>Hans Bekker</i> .
16:30	Superhighway development threatens tropical forest conservation and SDGs in Equatorial Africa. <i>Mahmoud I. Mahmoud</i> .
16:45	Seeking coordination in the complexity: lessons from efforts to mitigate environmental impacts of LAPSSET in northern Kenya. <i>Sarah Chiles & Toby Otieno</i> .
17:00	A sociological and biological study of human-wildlife interactions within the urban edge of Johannesburg. <i>Emily Taylor</i> .
17:15	Reporting and Analysing Wildlife-Vehicle Conflict at Large-Scales. <i>Fraser Shilling</i> .
17:30	End of day announcements
18:00	Sundowners at the Cattle Baron (Meet for a drink with your co-delegates, enjoy a beautiful African sunset overlooking the river.)
18:00–20:00	Energy Meeting – Cattle Baron Boma (by invitation).



TUESDAY 12 MARCH

Venue:	Ndlopfu	Ndau
8:00	Registration	
8:30	Conference introduction and announcements by <i>Constant Hoogstad</i> , Senior Manager for Industry Partnerships, The Endangered Wildlife Trust.	
8:45	Keynote talk by <i>Deidre Herbst</i> , the Environmental Manager for Eskom. A powerful partnership.	
Power Lines and Ecology (chair: Lourens Leeuwner)		
9:30	Eskom/The Endangered Wildlife Trust partnership 1996 – 2019; 22 years of partnering together to reduce impacts on business and on biodiversity. <i>Kishaylin Chetty</i> .	
9:45	Sensitivity, suitability or risk? A power line collision sensitivity model for Lesser Flamingos in South Africa. <i>Mattheuns Pretorius</i> .	
10:00	Monitoring bird mortality on power lines in the Czech Republic and proposed solutions for protection of birds. <i>Václav Hlaváč</i> .	
10:15	Can the forestry industry provide a conservation opportunity for Southern Banded Snake Eagles (<i>Circaetus fasciolatus</i>) in northern KwaZulu-Natal? <i>Melissa Whitecross</i>	
10:30–11:00	<i>Break</i>	
	Global Mitigation Practices for Linear Infrastructure (chair: Claire Patterson-Abrolat)	Workshop - Mainstreaming Linear Infrastructure and Biodiversity. (chair: Lazaros Georgiadis)
11:00	Build It and They Will Cross - Canada's 20 Year Highway Wildlife Mitigation Experience. <i>Terry M McGuire</i> .	The mainstreaming of biodiversity provisions in linear infrastructure by the transportation, energy, and mining sectors in Africa. Challenges and perspectives for an international strategy for engaging different stakeholders.
11:15	Current state of practice of road mitigation for small animals. <i>Kari Gunson</i> .	
11:30	Updates from the science of wildlife and roads in the in the western United States. <i>Patricia Cramer</i> .	

11:45	Road ecology research suffers from weak inference and biased conclusions. <i>Fernanda Zimmermann Teixeira.</i>Continued
12:00	Applying the Mitigation Hierarchy for Linear Infrastructure. <i>Jan-Willem van Bochove.</i>	
12:15	Ungulate use of non-fauna underpasses. <i>Mattias Olsson.</i>	
12:30–14:00	<i>Lunch</i>	
	Rail Ecology - are we on the Right Track? (chair: Fraser Shilling)	Stories from the Line: Power Line Case Studies (chair: Mattheuns Pretorius)
14:00	Railway Ecology: impacts and solutions within an African perspective. <i>Rafael Barrientos.</i>	An analysis of vulture mortalities on power lines in South Africa from 1996 – 2018. <i>Rudi Kruger.</i>
14:15	Observed and estimated mammal mortality on a Brazilian railway. <i>Fernanda Zimmermann Teixeira.</i>	The value of knowledge transfer to reduce raptor mortality due to power lines in North Africa. Jose <i>Rafael Garrido.</i>
14:30	On-board cameras reveal wildlife responses to approaching trains. <i>Manisha Bhardwaj.</i>	Development of road and power infrastructure in Zambia: implications for habitat connectivity and animal movements. <i>Mwape Sichilongo.</i>
14:45	Brazil’s roadless and railroad-less (RLRL) areas as conservation opportunities. <i>Fernanda Zimmermann Teixeira.</i>	Population dynamics, status and ecology of Martial Eagles breeding on power lines in the central and western Karoo, South Africa. <i>Gareth Tate.</i>
15:00	Quantifying the barrier effect of roads and railways on terrestrial animals in Sweden. <i>Manisha Bhardwaj.</i>	The darkness under the power lines: Energy justice and the linear infrastructure of the Grand Inga Dam. <i>Ruth Kruger.</i>
15:15–15:45	<i>Break</i>	
	Lightning Talks - A Linear Infrastructure Mix (Chair: Patricia Cramer)	Workshop. (chair: Fahiemah Daniels)
15:45	The European wildlife and traffic handbook: a tool helping to avoid and reduce habitat fragmentation in 21st century. <i>Lazaros Georgiadis.</i>	Use of biodiversity information to inform the identification of energy corridors.
15:50	THE ROAD AHEAD: Guidelines to mitigation methods to address wildlife road conflict in South Africa. <i>Wendy Collinson.</i>	

15:55	Road Ecology on the European Journal of Wildlife Research: a new Topical Collection calling for African studies. <i>Marcello D'Amico</i> .	Strategic environmental assessment for the identification of energy corridors.
16:00	The need for standardised wildlife crossing measurements. <i>Georgina Álvarez</i> .	
16:05	Exploring habitat restoration techniques for linear energy projects. <i>Corin Simmonds</i> .	
16:10	Wrong place at the wrong time? Influence of animal behaviour and species traits in roadkill risk assessment. <i>Bilal Habib</i> .	
16:15	Off-road ecology: Combining wildlife roadkill and behaviour to understand impacts of roads on wildlife. <i>Akanksha Saxena</i> .	
16:20	Reducing impacts on wildlife and improving motorist safety on three major toll routes in South Africa. <i>Claire Patterson-Abrolat</i> .	
16:25	Working on Sustainable Transportation in the Carpathians: The Carpathian Convention as pilot bio-region case to study. <i>Lazaros Georgiadis</i> .	
16:30	Mapping and modelling of wildlife and livestock roadkills along Kajiado, Makueni and Machakos counties in Kenya. <i>Peter Kibobi</i> .	
16:35	Species traits as predictors of road-avoidance responses in African ungulates. <i>Margarita Mulero-Pázmány</i> .	
16:40	Web-Based Management of Wildlife Camera Systems. <i>Fraser Shilling</i> .	
16:45	Understanding fatal collisions with trains in Balule Nature Reserve, South Africa. <i>Paul Allin</i>	
16:50	End of day announcements	
17:00–18:00	Poster Session (cash bar)	Cattle Baron
18:15–19:15	IUCN CCSG Transport Working Group Meeting (by invitation).	
18:30	<i>Sundowners at the Cattle Baron (Meet for a drink with your co-delegates, enjoy a beautiful African sunset overlooking the river)</i>	

WEDNESDAY 13 MARCH

Field Trips

Meet 30 minutes prior to departure at Nombulo Mdluli Conference Centre at Skukuza Rest Camp (See page 4 of programme).

THURSDAY 14 MARCH

Venue: Ndlopfu

8:00	Registration
8:30	Conference introduction and announcements by <i>Constant Hoogstad</i> , Senior Manager for Industry Partnerships, The Endangered Wildlife Trust.
8:45	Keynote talk by <i>George Ledec</i> , the Lead Ecologist in the Africa Region of the World Bank. Making Linear Infrastructure Biodiversity-friendly: Lessons from World Bank Experience.
Resilient Transportation as a Global Demand (chair: Kishaylin Chetty)	
9:30	The challenge to design safe and resilient transportation in Europe. <i>Anders Sjölund</i> .
9:45	Linear Developments, Protected Areas and the Art of War. <i>Irene Hatton</i> .
10:00	Where to now: A review of the progression of biodiversity related mitigatory measures for power lines within KwaZulu-Natal, South Africa. <i>Dinesree Thambu-Moodley</i> .
10:15–10:45	<i>Break</i>
Mitigation Case Studies 1 (chair: Kari Gunson)	
10:45	Samango monkey road kill mitigation in the Soutpansberg, South Africa. <i>Birthe Linden</i> .
11:00	Carnivore roadkill in Limpopo Province, South Africa. <i>Ali Halajian</i> .
11:15	Protecting the protected through assessing driver behaviour in protected areas, South Africa. <i>Wendy Collinson</i> .
11:30	Cranes and power lines in South Africa: reversing the declines and securing their future. <i>Tanya Smith</i> .
11:45	Effectiveness of road mitigation for Common Toads (<i>Bufo bufo</i>) in the Netherlands. <i>Fabrice Ottburg</i> .
12:00	Human settlement, roads and rivers rather than climate determine distribution of the Apple of Sodom (<i>Calotropis procera</i>) in northern Limpopo Province, South Africa. <i>Sipho Mbambala</i> .
12:15–14:00	<i>Lunch</i>
Mitigation Case Studies 2 (chair: Tanya Smith)	
14:00	Roads and their users as a threat to wildlife conservation: an approach to model amphibian roadkill in Vhembe Biosphere Reserve (Soutpansberg Conservancy), South Africa. <i>Thabo Hlatshwayo</i> .
14:15	Animal movement analysis predicts higher risk road crossing zones: an assessment for mesocarnivores. <i>Filipe Carvalho</i> .

14:30	Road proximity may compromise antiparasitic response and fat storage in a generalist lizard: A translocation field experiment. <i>Rafael Barrientos</i> .
14:45	Promoting Ecologically Sustainable Linear Infrastructure - case for Grey Crowned Cranes in south-western Uganda. <i>Jimmy Muheebwa</i> .
15:00	Using road patrol data to identify factors associated with carnivore roadkill counts. <i>Claire Patterson-Abrolat</i> .
15:15	Mitigating the ecological impacts of transportation infrastructure – A compilation of global case studies. <i>Rodney van der Ree</i>
15:30	End of day announcements
16:00	Depart for bush braai



SESSION ABSTRACTS

MONDAY 11 MARCH

Road Development and their Status in Africa

Status of road ecology research in Africa: what more do we need to know?

Wendy Collinson¹, Harriet Davies-Mostert^{1,2}, Lizanne Roxburgh¹ & Rodney van der Ree³

¹The Endangered Wildlife Trust, South Africa.

²Mammal Research Institute, University of Pretoria, Pretoria, South Africa

³Ecology and Infrastructure International, Australia.

Presenter: Harriet Davies-Mostert, The Endangered Wildlife Trust, Private Bag X11, Modderfontein, 1609 Johannesburg, South Africa. +27 (0)11 372 3600. harrietd@ewt.org.za

Roads are a critical element of human economic development and society, and global rates of road construction will likely rise for the foreseeable future. Roads and road users have numerous, diverse, and mostly negative consequences for biodiversity by, among other things, destroying and degrading habitats, fragmenting wildlife populations and their dynamics, direct impacts through collisions, and secondary impacts through increased access to previously unattainable natural resources. The science of road ecology (our understanding of such impacts and how these can be minimised) is fairly well developed in North America, Europe and Australia, but is only in its infancy in regions such as Africa, which is likely to experience rapid infrastructure development in the upcoming decades. In this study, we provide a review of the state of road ecology in Africa, to investigate the scale, scope and geographic extent of current knowledge, and identify gaps and priorities for future research. We used Web of Science to undertake a systematic literature search, generating a database of 210 peer-reviewed papers related to aspects of road ecology across 38 African countries between 1954 and 2016. Most studies were undertaken in the past decade ($n = 169$), and ~65% originated from just seven countries, with South Africa producing the highest output ($n = 66$). We categorised studies by geographic location, focal biodiversity components, study purpose, and whether they examined specific interventions aimed at mitigating impacts. We discuss our findings in light of future recommendations for road ecology research.

A review of the global impact of current and future road development on top predators

Jeffrey A. Dunnink¹, Maria Ariza², Edgar F. Cifuentes³, Itxaso Quintana⁴, Felipe, M. Fantacini⁴, Bibek, R. Shrestha⁵ & Freddie-Jean Richard⁴

¹African Wildlife Foundation,, Kenya.

²Natural History Museum, University of Oslo, Oslo, Norway.

³Laboratorio de Ecología de Bosques Tropicales y Primatología, Universidad de los Andes, Bogota, Colombia.

⁴Université de Poitiers, Lab Ecologie et Biologie des Interactions, Poitiers, France.

⁵School of Environmental Science, University of East Anglia, Norwich, U.K.

Presenter: Jeffrey A. Dunnink, African Wildlife Foundation, Ngong Road Nairobi Kenya 00502. +254742988886 / +27721866683. jdunnink@awf.org

The rapid global expansion of road networks has a severe impact on biodiversity functioning and ecosystem integrity. This impact is through both direct effects such as roadkill or habitat loss and fragmentation, or indirect effects such as disruptions to species distribution or altering gene flow between populations. The impact of road development is interwoven between both the ecosystem and species level. At the species level, the guild of top predators is critical to maintain healthy and efficient ecosystems. The disruption of this guild by the presence of roads has negative impacts on the functioning of the ecosystem and associated organisms. Given the substantial body of literature on both the impact of roads on conservation and the importance of top predators to ecosystem functioning, a review of these topics is required.

Our review focuses on the fragmentation and isolation of selected top predator populations by road development; including impacts on other wildlife due to the increase of associated human pressure (e.g. poaching, bush meat hunting). We evaluated the potential consequences of proposed road developments in different parts of the world (namely, Africa, Latin America and Asia), focusing on areas where top predator populations already face significant declines. The threats to these top predator populations will ultimately disrupt ecosystem functioning and landscape structure, that are valuable for the livelihoods of local people. Moreover, losing charismatic top predators threatens vital economic gains from tourism. We propose mitigation strategies to highlight best practices to alleviate the negative impact of roads globally.

Understanding the impacts of roads on sub-Saharan African ecosystems

Lavinia Perumal¹, Mark G. New², Matthias Jonas³ & Wei Liu³

¹*Department of Environmental and Geographical Sciences, University of Cape Town, South Africa.*

²*African Climate and Development Initiative, University of Cape Town, South Africa.*

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Emerging road infrastructure across Africa is expected to have major implications for future development and conservation at local to continental scales. The impacts of roads on ecosystems remain unclear for Africa as a whole. We conducted a systematic review using the RepOrting standards for Systematic Evidence Syntheses (ROSES) methodology. The main aim is to conduct an integrated assessment and synthesis on the current state of knowledge on the impact of roads on sub-Saharan African (SSA) ecosystems. This review is the first to assess the environmental impact of roads in SSA.

Preliminary findings indicate that, in general, roads have varied impacts across African ecosystems. Despite roads not being the primary focus of most reviewed articles, approximately 100 published scientific papers have tested a specific impact of a road on an ecosystem. Most studies were conducted in South Africa and The Congo Basin in Savanna and forest ecosystems, respectively. Additionally, short-term studies usually focus on species richness and abundance impact, whereas long-term work (>7 years) focus on land cover/land use change impact. The road effect zone across African ecosystems varied with impact type. For instance, roads appear to negatively influence species richness and abundance within 15 km of a road, while promoting agricultural expansion within 50 km from a road.

To address the Social Development Goals (SDGs) in Africa, while minimising environmental costs, we require effective and informed infrastructure planning. This requires a comprehensive empirical understanding of the extent of available knowledge on the impacts of roads on ecosystems unique to Africa.



Linear Infrastructure – Global Perspectives

Improving Linear Transportation Infrastructure within Areas of Connectivity Conservation

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Conserving ecological connectivity is widely recognised as a key component of effective protected area ecological network management. At a range of scales, maintaining and restoring landscape linkages, facilitating species movement, and sustaining ecosystem functions among and between protected and other conservation areas is essential.

The IUCN World Commission on Protected Areas launched the Connectivity Conservation Specialist Group (CCSG) in 2016 to respond to the demand for more collaboration, guidance, and capacity to sustain and restore natural connectivity. CCSG is now a coalition of over 800 volunteer members working to advance concepts, consistent approaches, and implementation of connectivity conservation that reinforce protected and other conserved areas within ecological networks, while accelerating achievement of place-based and species-specific conservation.

At a time when connectivity is crucial to the survival of species and the maintenance of ecological processes, the accelerating construction of roads, railways, and canals is increasing habitat fragmentation and degradation. Thus, the CCSG's Transport Working Group (TWG) was formed to deliver best practices for linear infrastructure that avoids, minimises, and/or mitigates impacts to wildlife movement and mortality. By guiding connectivity-sensitive linear infrastructure development, TWG seeks to reduce the risk that protected and other conservation areas become isolated islands void of ecological integrity. This presentation will discuss the importance of connectivity conservation, the work of the CCSG, and provide insight from TWG into advances promoting linear infrastructure policies and practices that help mitigate impacts to ecosystem function, wildlife movement, wildlife injury and mortality.

From biodiversity offsets to target-based compensation

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Essential infrastructure development can have negative impacts on biodiversity. The mitigation hierarchy—via which such impacts are avoided and minimised, and any residual impacts then offset—aims to achieve at least ‘no net loss’ of biodiversity, while still allowing for unavoidable impacts. This approach is an increasingly important mechanism for reconciling conflicts between development and biodiversity conservation. Nevertheless, the biodiversity outcome from offsets is often unclear, as ‘no net loss’ of biodiversity can be interpreted in many different ways.

There has also been relatively little focus on how to align offsets, or other forms of ecological compensation associated with development projects, with the achievement of broader (e.g. jurisdiction-level) targets for biodiversity conservation. However, examples from South Africa and Brazil provide examples of how such target-based compensation could be achieved.

We will present an approach for better aligning compensatory actions at the project level with jurisdiction-level biodiversity conservation goals or targets. Being explicit about the desired outcome for biodiversity at the jurisdictional level can help to clarify the type of compensatory approach that would be most appropriate at the project level, in response to residual biodiversity losses. The framework helps clarify the role that different types of ecological compensation can play in contributing to jurisdictional-level targets, and helps resolve ambiguity around the concept of ‘no net loss’. Linking project-level ecological compensation to jurisdiction-level targets represents an opportunity to ensure such actions contribute to, rather than detract from, the achievement of broader biodiversity conservation goals.

Development Corridors in Kenya –The Standard Gauge Railway

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Although not a new phenomenon and variously labelled, the number of ‘development’ or ‘economic’ corridors have been escalating across Africa and the rest of the world. Often these have been driven generally by globalisation and specifically China’s quest for natural resources – with perhaps the most dramatic example being China’s ‘Belt and Road’ initiative. However, concerns have been expressed that these developments have often been taking place with inadequate attention to their potential negative environmental and social impacts. Further, in some cases, doubts have been expressed about some of them ever actually attaining their full development potential for which they are intended. In 2018, a consortium of universities and research institutes from the UK, China, Kenya and Tanzania embarked on a 4-year programme to help develop the capacity to better plan and manage corridors - The Development Corridors Partnership. This programme is bringing together high calibre research scientists to review and evaluate experiences in corridor planning and management in East Africa. Through this work, it is also intended to develop guidelines to improve the way corridors are planned and managed globally. This paper will introduce the Development Corridor Partnership and will discuss the practical experiences to date in the development of the China-funded transport corridor - the ‘Standard Gauge Railway’ (SGR). This links Mombasa and Nairobi and eventually will continue further towards Uganda. The routing of this new railway, albeit following the previous route of the colonial “Lunatic Express” for much of its early stages, controversially traverses both the Tsavo and the Nairobi National Parks. Various mitigation measures have been taken to lessen the impact on wildlife movements during the construction of the railway, but questions are raised about their efficacy and whether or not better planning and wider stakeholder engagement during an Environmental Impact Assessment process could have avoided these iconic high value conservation areas in the first place.

Environmental stewardship within the Belt and Road Initiative

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The China's Belt and Road Initiative (BRI) will greatly influence the future of global trade, particularly in Asia, Africa and Europe, involving a massive development of trade routes between and within these regions. This includes a large-scale expansion of land transportation infrastructure, coupled with the development of new ports in the Pacific and Indian Oceans. Such infrastructures are expected to facilitate regional and intercontinental trade flow, and increase oil and gas supply. However, the BRI may also promote permanent environmental degradation, particularly with the expansion and upgrading of transportation infrastructure in environmentally sensitive areas, and the large amounts of raw material needed to support that expansion. We claim that, if not properly addressed, the negative environmental impacts of the BRI will put at risk the biodiversity and the wellbeing of the people it aims to help. We call for strategic environmental and social assessments (SESA) of the BRI and along each major economic corridor, providing a systematic evaluation of the environmental consequences of proposed policies, plans and programs, ensuring that they are appropriately addressed at the earliest stage of decision making, concurrent with the economic and social consequences. China and the nations involved in the BRI should act as environmental stewards, planning and building infrastructures in ways that are responsive to the different natural and socioeconomic contexts, at both local and regional scales. In this way, the BRI can become an opportunity of setting higher standards for best practices that link the design and implementation of infrastructure to environmental protection.

Approaching Biodiversity Issues in Transmission Line Route Studies and Impact Assessments

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Biodiversity is a growing issue for transmission-line projects. A flexible approach to avoid and reduce project impacts on biodiversity is essential. Multiple methodologies can be applied to achieve this goal, which vary in time and efforts required. This presentation will provide examples of methodologies recently used by Williams Sale Partnership (WSP) on high voltage transmission projects in Africa. WSP uses high-level GIS data processing as a powerful tool when biodiversity is considered early in line-route definition of very large projects with short timelines such as the North Core Interconnection (Burkina Faso, Niger, Benin and Nigeria). Multiple routing alternatives were identified based on environmental, social and technical criteria. Meeting with stakeholders, analysis of existing land-uses, and primary data have allowed us to identify the line route

with least impacts on sensitive biodiversity components of the receiving environment. Other approaches were applied on smaller-scale projects at later stages of their development (Kigoma-Butare-Ngozi-Gitega (Rwanda) and Gulu-Agago (Uganda)). These approaches included habitat characterization, as well as identification of threatened bird species and key habitats based on field works. Biodiversity data acquisition and integration in decision-making is crucial in all cases. Building partnerships with conservation NGOs and stakeholder consultations can reduce field efforts by leveraging existing national and scientific knowledge. Integration of biodiversity factors in transmission line design during ESIA preparation can be adapted according to consultant scope of work, project scale, design stage, budget and timeline. Careful consideration of these factors is crucial when selecting design approaches to maximise project impact avoidance.

The Unintended Consequences of Good Intentions.

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The construction of bulk raw water transfer pipelines is a disturbance intensive process that disrupts the use of impacted landowner's properties. Effective project implementation and rehabilitation of the construction scar can significantly reduce the risk of post construction impacts on all stakeholders' interests. Environmental requirements typically included in Environmental Authorisation, approved Environmental Management Programmes (EMPr) and contracting requirements are intended to ensure good practice and limit negative environmental and social impacts of the infrastructure development.

In practice, compliance to a number of the well-intentioned requirements has been found to be ineffective and can increase project risks. Risks include increased potential for environmental degradation, intensified scope and duration of rehabilitation work and the hindering of projects ability to accommodate the needs of directly impacted stakeholders. The unintended consequences of commonly prescribed environmental protection measures are demonstrated. These 'Good practice' provisions that have gone wrong include: reduction of the construction footprint, stripping and stockpiling topsoil, diverting rivers, indigenous seeding, and the use of drainage berms and gabions to control erosion. Alternatives are presented as a means of promoting improved environmental protection on linear development footprints. The presentation highlights the role of interdisciplinary collaboration and stakeholder engagement in the achievement of accurate risk assessments and effective application of the mitigation hierarchy towards the protection of all stakeholder's needs and interests.

Making Irrigation Infrastructure Biodiversity-friendly: Malawi's Shire Valley Transformation Project

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Malawi's Shire Valley Transformation Program (SVTP) seeks to make a large new irrigation canal and associated agricultural development as biodiversity-friendly as feasible. The irrigation intake location was selected to minimise adverse impacts upon the Majete Wildlife Reserve. The Main Canal design includes a drop structure (with 3+ mwater freefall) to prevent invasive fish species from entering the Shire River above Kapichira Falls, thereby protecting Lake Malawi's exceptional aquatic biodiversity. Within the Majete Reserve, the canal's entire above-ground length will be walled or fenced on both sides to protect wildlife. Siphons and generously dimensioned culverts will facilitate wildlife crossings under the canal. Compensatory tree plantings and new wildlife watering ponds will further mitigate the canal's impact. All ancillary facilities (including construction camps, borrow pits, waste disposal sites, and equipment staging areas) will be located outside the Majete Reserve. The bidding documents specify strict rules for contractors and workers, including enclosed work sites, time-of-day restrictions, and wildlife safety training. An innovative feature is the requirement for the main civil works contractor to compensate African Parks (which manages Majete) for any lost tourism revenues during the canal construction period (in comparison to an agreed baseline). Besides the canal works, other biodiversity-friendly features of project design

include (i) designating non-irrigated set-aside lands within the command area and (ii) minimising pesticide use through integrated pest management. The SVTP also includes a US\$5.6 million Natural Resources Management Component, which will strengthen the management of five large protected areas that surround the irrigation scheme.

Planning and Development of Linear Infrastructure and Biodiversity

The use of ecological standards in planning, design, construction and maintenance of roads and railways in Sweden

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The Swedish Transport Administration (STA) decided upon ecological standards (ES) for roads and railways in May 2016; a result of a very extensive and demanding collaboration between scientists and practitioners and administrations. These standards comprise the Why (many wildlife accidents) - What (fauna passage) - How (design) chain. The “how” introduces a set of rules and regulations comprising demands and advices regarding the design and construction of roads. A corresponding set of rules and regulations for railways are planned to be developed in 2019. The ES address four selected impacts of infrastructure on biodiversity: 1) mortality and permeability, 2) disturbance, 3) connectivity and 4) invasive alien species. For each impact, a number of indicators are defined and specific methods for inventories and/or analyses appointed. These methods must be used to identify potentially mitigation when new infrastructure is planned as well as to identify mitigation requirements along existing infrastructures. The results of the performed inventories and analyses are compiled and stored in a web-based database accessible to all employees at the STA. This database constitutes the hub of a management system that includes all fields of activities within the STA, This includes long-term and action planning, for the design and construction of roads and railways, as well as maintenance and monitoring activities.

In this presentation, I discuss the pros and cons of this approach to ecological impact management, for instance, the most important impacts on biodiversity is certainly addressed and mitigated, but at the expense of that, not all possible environmental aspects are addressed. Likewise, a procurer / investor can easily procure the planning, designing and construction of a road with predetermined quality regarding ecological impact and easily check the result, if good knowledge is available about roads’ impact on biodiversity.

It’s a long way from the first idea to the operation of a motorway in Austria

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The planning process of linear transportation infrastructure in Austria takes many years, sometimes even decades. It is determined by European directives and national laws, as well as strictly regulated by many technical and environmental directives and guidelines. Environmental impacts on humans and nature have to be taken seriously into account in every stage, right from the first idea until operation. The first and most crucial step has to be straightforward multidisciplinary strategic planning, which is inevitable for fulfilling human transportation needs without significantly harming other human activities like living areas, or destroying nature and ecosystem connectivity. Within the Strategic Environmental Assessment – if done properly – the economic, social and environmental development of an area can be effectively and successfully guided, whilst severe and unrecoverable negative impacts can be avoided. On project level, the Environmental Impact Assessment has to evaluate economic, social and environmental impacts and measures to mitigate and compensate negative impacts have to be defined. The effectiveness of these measures has to be proved – and if necessary improved – through ecological supervision during the construction phase, and by monitoring during operation. The Ministry for Transport authorises construction and operation of motorways in Austria. Our experience with the challenges during the whole planning process from the first idea to operation will be presented and the lessons we learnt can serve as important recommendations for the future.

The SLOSS dilemma of road ecology – Single Large Or Several Small fauna passages?

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Road ecologists are often asked by planners “How wide does a fauna passage have to be?”, and however appealing, “The larger the better” is only rarely the wisest answer. The width tends to be one of the most cost driving factors for fauna passages at linear infrastructures, and in the planning reality, cost—efficiency have to be considered.

In this presentation, I address *the SLOSS dilemma of road ecology*, i.e., the discussion whether a Single Large Or Several Small fauna passages would produce the most benefit for wildlife. I point out risks (ecological as well as practical) with investing in one large passage, and list a number of situations where it may be more beneficial to distribute the conservation efforts in the landscape by constructing several smaller passages; for example when the ecological knowledge is insufficient, when animal interactions are expected to be significant, when the landscape changes over time or future human development cannot be controlled.

I argue that such situations are in fact what infrastructure planning normally faces, and that the default strategy therefore should be to distribute rather than to concentrate passage opportunities along major transport infrastructures. With this strategy follows an increased focus on how to make also narrower passages functional, e.g., by adapting vegetation and limiting human disturbance in and around passages. Single large fauna passages should be selected in sites where it is likely that they can serve a large proportion of target animals (species and individuals), and where their long-term functionality can be guaranteed. Using partly migratory Scandinavian deer as examples, I show how this planning principle can lead to different output in different regions.

Adapting the infrastructure to the surrounding landscape

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During the 1980's, systems for environmental impact assessments were developed and introduced into road planning in Sweden. However, this worked on the individual road project and did not allow for setting national goals or for monitoring the outcome on a national level.

In 1998, the Swedish road administration developed a system for targets and indicators for ecological and cultural heritage. We were involved in this work, which identified the qualities of an ecologically “good” road. The idea was to report, on a national level, the proportion of new roads or the proportion of all roads that meet these standards. The development work was later stopped due to declining interest in goal directed management among the authorities. However, the understanding of the central qualities from an ecological point of view continued to increase due to both national and international research programs.

The Swedish Transport Administration has recently responded to a new political interest in road ecology by completing the work started in 1998, with a set of standards. These consider infrastructure that can be adapted to the surrounding landscape. For the issue of ecological adaptation, these standards set tangible target levels for:

- safe passages for animals;
- traffic noise pollution in ecologically important habitats;

- loss of crucial habitats;
- management and creation of species-rich infrastructure habitats; and,
- control of invasive species.

We believe that the use of standards for landscape adaptation is a crucial element in issues related to road and rail ecology strategic planning.



The challenge of achieving no net loss / net gain for linear projects – lessons learnt from a European perspective

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Exploring transferable techniques and innovations from developed countries that can be applied in an African context is key to achieving net gains for terrestrial biodiversity. Specific difficulties encountered with delivering net gains for linear projects such as; how to ensure biodiversity benefits in perpetuity alongside pressures on land for development, overcoming issues of land ownership and complexities of accurate habitat mapping will be explored. I will discuss the various drivers and guidance for net gain in the UK, Europe and worldwide and how biodiversity offsetting as a concept is developing, including an exploration of the European Bank for Reconstruction and Development's (EBRD) guidance in comparison with the equivalent guidance from the International Finance Corporation (IFC) and developing UK guidance. A case study using the Crossrail development is presented where a biodiversity action plan was developed in 2016 to identify biodiversity losses and gains along the route and link areas of important habitat along an urban route using the transport corridor. UK transport corridors often double up as wildlife corridors and can be utilised to deliver environmental gain through effective and appropriate habitat creation and restoration linked to the existing protected area networks. The opportunities and limitations of facilitating movement of species across linear projects through embedded designs such as green bridges, as well as construction techniques including dead hedge bales and operational phase amphibian tunnels are captured.



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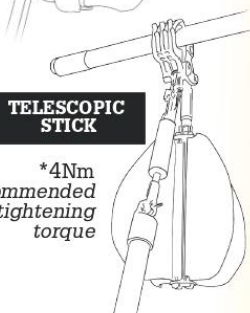


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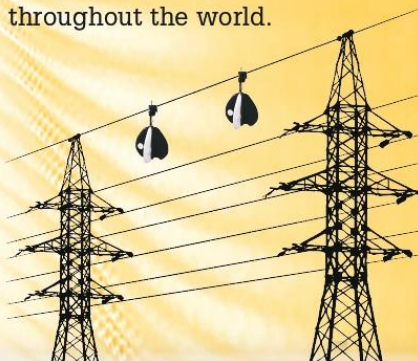


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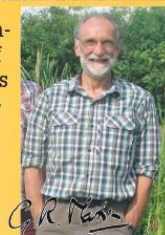
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Lessons Learned and Good Practise

Cultivating Connectivity: An American Tale

Alexander F. Levy¹

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Facilitating the adaptation of entire ecosystems and wildlife populations to a changing world, the quest for landscape level habitat defragmentation is emerging as one of the most critical, yet achievable challenges in the 21st century. From the subtropical swamps of its southeast to the alpine climes of its northwest, and from the iconic deserts of its arid west, to the temperate forests of its northeast comes a story of persistence and persuasiveness for conservation in the United States of America. From a nation associated with enormous resources, a diverse culture, and economic prowess, this presentation looks at how initiative in one corner of the United States has grown across the North American continent in just two decades.

Along this journey, dismissive attitudes are steadily eroded by science, advocacy, and a conviction to jointly improve human safety, ecosystem functions, and connected landscapes. Research and education professionals, government officials, conservationists, planners, engineers, and even a handful of politicians are using grassroots resolve to advance meaningful research and are steadily achieving sustainable policies and practices.

The history and relationship of advocacy through thematic and allied forums will be included in this overview of one nation's journey to achieve landscape connectivity at multiple scales through an evolving and enduring community-of-practice. Thriving at the roots of the American movement are stalwart conservation advocates, just like those gathered at ACLIE, who are rallying to the cause of improving the environmental quality of linear infrastructure and the mobility of both two and four-legged stakeholders.

How to start defragmentation processes?

Hans Bekker¹

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Fragmentation of nature by linear infrastructure is a worldwide, increasing phenomenon. In many countries, minimising measures have proven effective but are often difficult to implement. To implement any new measures to build roads requires a robust Environmental Impact Assessment (EIA) to be undertaken. Often, past linear infrastructure development has neglected the environmental process. Specifically the fragmentation of natural areas is often a forgotten issue. We discuss how to initiate actions in this kind of situation?

Often fragmentation of habitat is firstly, triggered by animal-car collisions, with records of place and species, followed by the question, how, where and to whom is this information addressed? Next, is the search for solutions, key stakeholder engagement and awareness, permission and finance. The crucial steps to initiate the defragmentation process commences from lessons learned in countries where it has been applied and translated to the way of working in different countries. 'Buy-in' from road administration agencies is essential, and whilst legislation and decision-making may differ per country, many ecological and civil engineering axioms are the same, worldwide. Involving all stakeholders in the process is key – from the road users (members of the public) to the agencies themselves. We discuss the processes employed in the Netherlands and other countries and relate this to the African situation.

Superhighway development threatens tropical forest conservation and SDGs in Equatorial Africa

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This African case study shows how re-routing poorly planned highways can reduce negative environmental impacts. The proposed 260 km superhighway in Cross River State (CRS), south-eastern Nigeria illustrates how linear infrastructure threatens biodiversity and wildlife conservation in equatorial Africa. The CRS Government in Nigeria proposed an ~115 km intersection of the highway through intact tropical rainforest or protected areas, costing ~ US\$2.5 billion. Two alternative routes were proposed and evaluated as causing less damage to the Cross River National Park, unprotected forests, and biodiversity habitats. Although, slightly longer (~290 and ~353 km), the alternative routes cost less to construct (~ US\$0.9 billion), with the first proposed alternative avoiding intact forest as well as providing benefits to farmers and settlers. In the context of achieving Sustainable Development Goals (SDG), smart infrastructure provisioning and sustainable land-use management suggestions from research outcomes should be incorporated as strategic tools for developing an informed conservation economy policy and decision-making in Africa. If optimised, conservation-reduced environmental impacts and maximal socioeconomic benefits can be achieved. Africa-wide, lessons, trade-offs and synergies from the illustrated African case study on road planning and forest landscape management should be promoted and integrated in the spatial infrastructure and land-use planning process towards attaining local-scale SDGs.

Seeking coordination in the complexity: lessons from efforts to mitigate environmental impacts of LAPSSET in northern Kenya

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The Lamu Port-South Sudan-Ethiopia Transport (LAPSSET) Corridor comprises a complex suite of infrastructure projects intended to unlock the economic potential of oil and trade in the East Africa region. As part of its plans under LAPSSET, the Government of Kenya is facilitating unprecedented and rapid investment in linear infrastructure in the arid and semi-arid lands of northern Kenya. The projects, in various stages of development, include highways, a standard gauge railway, a crude oil pipeline and a transmission line. These are being routed through the biodiversity-rich Ewaso Nyiro North Basin, a landscape renowned for its protected areas, community conservancies and endemic species. The Basin cuts across multiple county boundaries and is therefore under varied governance regimes.

Efforts to mitigate the environmental impacts of LAPSSET have highlighted the critical importance of building on existing county, project and stakeholder relationships to generate new forms of coordination for managing the Corridor's complexity. We analyse the success of mitigation efforts for selected LAPSSET projects, and draw out lessons for coordination at three levels: county government, project management, and stakeholder forums. We show that new types of capacity, knowledge management, and communication are needed to secure meaningful environmental governance of LAPSSET at a landscape scale.

A sociological and biological study of human-wildlife interactions within the urban edge of Johannesburg

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To improve the nature of interactions between wildlife and people in the City of Johannesburg Municipality (COJ) in South Africa, and mitigate threats posed to wildlife by human presence or activity in the city, it is important to understand where wildlife occurs, and what kinds of conflict incidents it is involved in and where. To identify common types of human-wildlife conflict and common species involved, and to determine whether location and nature of incidents were influenced by factors such as roads and other linear infrastructure, land-cover class, proximity to green spaces, or human population density, I analysed incident reports from FreeMe and Friends of Free Wildlife (FFW). I also used roadkill reports from the Endangered Wildlife Trust's (EWT) Wildlife and Roads Project (WRP), and conflict reports from the EWT's Urban Conservation Programme (UCP).

Spatial analysis suggested that both wildlife presence and conflict incidents were more commonly reported in regions in which certain land-cover classes are prevalent, and within 1 km of green spaces. The nature of the most common reasons for admittance or recording of wildlife conflict incidents indicated that conflicts recorded were not always necessarily as a result of human intent, but of human presence or activity (52% of cases). These reasons included animals being hit by cars, or colliding with fences or power lines. Species heavily impacted by linear infrastructure in the COJ include the Giant Bullfrog (*Pyxicephalus adspersus*), Barn Owl (*Tyto alba*), Large Spotted Genet (*Genetta tigrina*) and the Southern African Hedgehog (*Atelerix frontalis*).

Reporting and Analysing Wildlife-Vehicle Conflict at Large-Scales

Fraser Shilling¹

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Wildlife-vehicle conflict (WVC) can result in aversion, injury or death of the animal involved. Many regions and countries have systems to report roadkilled animals. A few also record other animal and driver fates, including the driver crashing when trying to avoid colliding with the animal and the animal being injured by the collision. Collectively, collecting reports of these events can help decide where and how to mitigate impacts from WVC. We have developed and maintained WVC reporting systems for two US states (Maine and California) that collect information about live, injured and dead animals and impacts to drivers and vehicles. In California, we have two linked web-systems, one that collects reports from the state police (California Highway Patrol) regarding animal-related incidents and another that collects roadkill carcass observations from >1,000 volunteers (<https://wildlifecrossing.net/california>). Together they provide a comprehensive sampling of WVC events in CA, including ~15,000 reports/year and currently totalling >80,000 reports.

In Maine, we worked with Maine Audubon to develop a system for volunteers to report live and dead animals on or near roadways (<https://wildlifecrossing.net/maine>). So far, 350 people have contributed 6,500 observations and these data are often combined with state carcass data for analyses. In both states, annual hotspots analysis have been conducted to identify places where mitigation of WVC would be appropriate; in CA by the Road Ecology Center and in Maine by Maine Audubon and the Department of Transportation.

Recently, we developed a tool that any US state can use to identify WVC hotspots on state highways (<https://roadecology.ucdavis.edu/hotspots/>). Registered users can upload WVC datasets and within minutes (depending

on number of WVC data) receive an analysis of incident density and statistically significant clustering. In addition, we developed a real-time map of incidents in CA, overlying a map of WVC hotspots (<https://roadecology.ucdavis.edu/hotspots/map>). These incident points are generated from live state police reports using a text-query for deer and are >95% accurate. Large-scale reporting of WVC by government staff or volunteers provides an unprecedented opportunity to not only understand WVC, but also to estimate wildlife population trends, to monitor animal invasions, and to track disease.



TUESDAY 12 MARCH

Power Lines and Ecology

Eskom/The Endangered Wildlife Trust partnership 1996 – 2019, 22 years of partnering together to reduce impacts on business and on biodiversity

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Eskom is responsible for providing electricity to meet the ever-increasing needs of its end users. As a result, Eskom's linear electrical infrastructure is continuously being expanded upon to support annual load growth. Negative interactions between wildlife and electrical infrastructure take on many forms including the electrocution of birds (and mammals), birds colliding with power lines and birds and/or animals causing short circuits in the electricity supply through various activities on electricity structures. These interruptions to the power supply have dire consequences for large industries and residential areas. The challenge for Eskom is to find the balance between the electricity demands of the nation, the interests of industry, the residential electrification programme, and the effective use and conservation of natural, social and economic resources.

In view of the complexity, scope and persistence of the problem of interactions between wildlife and power lines, Eskom and the Endangered Wildlife Trust (EWT) formalised their long-standing relationship by entering into a partnership in 1996 to address the problem in a systematic manner on a national basis and to establish an integrated management system to minimise these negative interactions. Twenty-three years later (1996-2019), the partnership is still going strong. The Eskom/EWT strategic partnership evolved over the years to include other facets of the business including the power generation element. Eskom identified the need for the EWT to assist them in the management of biodiversity in and around power stations across South Africa. Activities include the assistance with the design of biodiversity action plans for all power stations, and guidance on game management, wind farm biodiversity monitoring and biodiversity mainstreaming activities. Additionally, EWT assist Eskom with the management of wildlife interactions across all Eskom infrastructure and through advising on all biodiversity related issues.

A power line collision model for Lesser Flamingos in South Africa

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Models that identify the probability of some threat impacting on a species are broadly termed 'risk' models. In the context of interactions between wildlife and linear infrastructures, risk usually relates to the potential threat posed to a species by different sections of a power line, railway or road. Because the risk is relative, it can only be scaled appropriately if the degree of interaction is known. Using the example of the Lesser Flamingo (*Phoeniconaias minor*), we illustrate the complexity of developing models describing the risk of collision with power lines in South Africa. Our initial prediction was that flamingo collision risk was highest in bottlenecks along well-established migration routes, however this was dismissed when examining altitude readings from GPS-GSM-tagged individuals, as the birds recorded flight heights far above collision risk height. We thus limited our analysis to power line sections within a certain distance from waterbodies, given their size and voltage. Habitat suitability was determined by means of logistic regression models predicting flamingo presence at

waterbodies, and collision risk was assigned to adjacent power line sections accordingly. Variables in models with the best fit, based on Akaike weight, included chlorophyll-a content and changes in water occurrence. Field validation showed that the model was accurate in predicting flamingo power line collisions (overall accuracy = 93%). We discuss the implications of our results for flamingo power line collision mitigation and suggest caution against the term 'risk' in a spatial context only.

Monitoring bird mortality on power lines in the Czech Republic and proposed solutions for protection of birds

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Protection of birds on power lines has been given attention in the Czech Republic since the 1980s. Despite this, thousands of birds die due to electrocution or collision with the wires every year. For this reason, an extensive study on bird mortality has been carried out in the Czech Republic in recent years.

During 2015 - 2016, approximately 76,000 power poles and 6,400 km of power lines (~10% of the country's total) were inspected. The aim of the study was to identify types of poles that are dangerous for birds as well as the number of birds dying on individual types of poles. From data collected, estimates calculated that almost 117,000 bird mortalities on power lines occur each year in the Czech Republic. Raptors were the most impacted group, with 35,000 mortalities attributed to the Common Buzzard (*Buteo buteo*) each year. Other raptors were the Golden Eagle (*Aquila chrysaetos*), White-tailed Eagle (*Haliaeetus albicilla*) and Osprey (*Pandion haliaetus*).

Based on this study a cooperative partnership with energy companies has been established. A safety assessment system for new constructions has been introduced. According to law, only bird-safe structures can be used for building new and reconstructing existing power lines in the Czech Republic since 1992. However, there are still thousands of old structures that are fatally dangerous for birds throughout the landscape and reaching a complete solution to the problem in the Czech Republic may take another 10 - 20 years.

Can the forestry industry provide a conservation opportunity for Southern Banded Snake Eagles (*Circaetus fasciolatus*) in northern KwaZulu-Natal?

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The KwaZulu-Natal north coast is home to many birds of prey, a large proportion of which have experienced shifts in their distributions in response to the large scales of habitat transformation linked to anthropogenic activities across the region. One of the most affected species is the Southern Banded Snake Eagle (*Circaetus fasciolatus*), a coastal forest specialist, which is listed regionally as Critically Endangered in South Africa with an estimated population of less than 50 individuals. BirdLife South Africa (BLSA) is working to understand how land cover transformation has impacted the distribution of these cryptic forest raptors and whether the species has adapted to the conversion of their natural coastal forests into a matrix of plantations, mines and human settlements with only pockets of natural forest remaining outside of the formally protected areas. Within the protected area network, an electrocution risk assessment has been conducted to determine the potential

exposure of Southern Banded Snake Eagles to electrical transformers, which they may perch on when hunting. BLSA has conducted surveys of the plantation matrices and protected areas to collect information in conjunction with citizen science records for the development of habitat suitability models and patch connectivity measurements between suitable sites for Southern Banded Snake Eagles. This work will inform the development of land management guidelines in conjunction with Forestry South Africa and provincial nature conservation authorities, which promote the survival of Southern Banded Snake Eagles and other forest dwelling raptors.

Global Mitigation Practices for Linear Infrastructure

Build it and They Will Cross - Canada's 20 Year Highway Wildlife Mitigation Experience

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Year 2017 marked the 20th anniversary of the introduction of the first wildlife overpass in Canada built on the Trans-Canada Highway in Banff National Park, Alberta, Canada. Since then, another six wildlife overpasses and 42 underpasses of varying dimensions and geometry have been constructed in conjunction with four-laning this 88 km stretch of highway. Their subsequent recorded use by wildlife makes it a worldwide conservation success story for what is the world's largest mitigation complex. In addition, crossing structures have also been constructed in the provinces of Ontario and British Columbia, Canada. Not all of these structures were built at the same time and so this is a story of adaption and adoption by not only wildlife but those charged with constructing the fencing and crossing structures. The presentation identifies engineering considerations that went into site selection and design; their respective costs; and important lessons learned along the way in achieving this conservation success story. With a focus on the Banff mitigation complex and apart from the sheer number of crossing structures and associated right-of-way fencing, what makes this highway mitigation complex truly unique is the seventeen plus years of continuous monitoring of these crossing structures. The presentation highlights the result of this continuous monitoring of the effectiveness and efficacy of these structures in ensuring the survival of several species and achieving greener transport infrastructure that may have transferability to others.

Current state of practice of road mitigation for small animals

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Road wildlife mitigation (e.g. crossing structures and exclusion fencing, for small animals) has only been implemented since 1991, where the first known mitigation was installed for amphibians in Switzerland. Since then, the U.S. and Canada followed suit and implemented mitigation for reptiles and amphibians in the late 1990s. Since then we have made leaps and bounds with installing these measures and research has progressively increased. For example, the first ever amphibian overpass was built for amphibians in the Netherlands in the 2005.

This presentation will provide a current review of the state of practice of exclusion fencing types, and dedicated, and non-dedicated crossing structures, focusing separately and together for amphibians, reptiles and small mammals. The review

will include 'design' materials, implementation techniques, and monitoring effectiveness for over 100 studies reviewed worldwide. We will draw from several monitoring projects we are currently involved with that includes five phases of mitigation for Canada's Endangered reptiles on Highway 69.

Our aim is to provide a repository of information that includes drawings, photos and documentation of successful measures but also to build on lessons learned to improve on the 'state of practice'. The initial hump to establish the need for installation has begun, however techniques and information sharing are still evolving. At this point, we need to continue encouraging transportation officials to implement mitigation, for many of these declining species, but a commitment for on-going monitoring and maintenance is sorely needed to maintain our investments.

Updates from the science of wildlife and roads in the western United States

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The results of research in the western U.S. states are reported for wildlife crossing structure preferences of wild ungulates and carnivores, along with tested escape ramp and deterrent designs. The latest trend to include wildlife considerations into transportation planning will also be discussed. Results from our research on wildlife crossing structures in the U.S. states of Utah, Montana, Idaho, Colorado, Oregon, and Washington demonstrate the important dimensions of wildlife crossing structures for prey and predator species. We found that the length of crossing structures, meaning the distance animals move beneath the road, is the most important structural dimension for mule deer (*Odocoileus hemionus*), followed by width, and lastly by height. Elk (*Cervus canadensis*) are one of the more difficult animals to convince to use structures, along with Bighorn sheep (*Ovis canadensis*) and pronghorn (*Antilocapra americana*). We report successful designs for these species. White tailed deer (*Odocoileus virginia*) are more adaptable to structures than other ungulate species less tolerant of humans and readily use large bridges structures as short as 1.5 m high. Our research on escape ramps, deterrents, and new technologies have helped find the most cost-effective solutions for helping animals move beneath and above roads. The more recent trend to include wildlife needs to move into transportation planning will be presented. The planning approaches various states use will also be presented.

Road ecology research suffers from weak inference and biased conclusions

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Impacts of roads and traffic on wildlife populations are well documented. The mechanisms that may cause these negative effects on populations fall into three categories: reduced connectivity, increased mortality (roadkill), and reduced habitat quality. Researchers commonly recommend road mitigation measures based on the mechanism they deem responsible, and the effectiveness of a measure depends on an accurate assessment of the underlying causes of road and traffic effects.

We reviewed the international literature from 2012 to 2016 to evaluate the relative importance of these three mechanisms. We found 327 negative responses of wildlife to roads, from 307 studies. While most (84%) responses were consistent with

multiple mechanisms, 61% of authors invoked only a single mechanism. This indicates that the literature suffers from weak inference and does not allow estimation of the relative importance of the three mechanisms. In addition, we found strong biases in authors' conclusions. When all three mechanisms were actually consistent with study results, authors were 2.4 and 2.9 times as likely to infer reduced habitat quality compared to reduced connectivity or increased mortality, respectively. When both reduced connectivity and increased mortality were actually consistent with study results, authors were 5.2 times as likely to infer reduced connectivity compared to increased mortality. Given these biases, road ecologists are likely over-recommending mitigation measures for habitat quality and connectivity, and under-recommending measures to reduce roadkill. Our synthesis suggests that we do not know which mechanism is the dominant one, and therefore we recommend that mitigation target all possible mechanisms.

Applying the Mitigation Hierarchy for Linear Infrastructure

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The mitigation hierarchy is a widely adopted tool to help limit the impacts of development projects on biodiversity. Applying the mitigation hierarchy to linear infrastructure poses some practical challenges. These include defining a suitable geographical study area that encompasses both potential direct and indirect impacts, but is not unfeasibly large; and mitigating impacts for a wide range of biodiversity features across multiple ecological zones. We outline practical approaches for effective application of the mitigation hierarchy to linear infrastructure projects, focusing on the early, preventative steps in the hierarchy (avoidance and minimisation), which are generally the most effective. These include good practice standards for defining a geographical study area to evaluate biodiversity risks; screening of risks during early planning stages to avoid impacts to sensitive features (e.g. by re-routing) and identify cost-effective mitigation options; and methods to minimise impacts (e.g. placement and design of over- and under-passes to maintain habitat connectivity). These approaches will be illustrated by examples drawn from The Biodiversity Consultancy's experience working to meet best practice biodiversity standards in an African context.

Ungulate use of non-fauna underpasses

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In order to mitigate barrier effects of highways and exclusion fences on wildlife, road administrations around the world are investing millions of euros in strategically placed fauna crossing structures. While such structures may be significant to species conservation or management at local scale, they may not necessarily suffice to maintain landscape connectivity on a broad scale. Conventional, non-fauna road bridges, however, are usually abundant along the major infrastructure corridors and may also serve as corridors for wildlife. Given the large number and density of such passages, their cumulative effect may well be underestimated. In this study, we use sand-bed track inventories to study the approach and use of conventional road tunnels in south-central Sweden by common wildlife species such as roe deer (*Capreolus capreolus*) and moose (*Alces alces*). We studied the influence of passage dimensions, design, human disturbance and landscape factors and derived recommendations on limits in size and human co-use based on generalized linear mixed models (binomial-distribution models to determine difference between structures that were used and not, and gamma-distribution models to determine factors that influenced passage approach and passage use). We found that moose and roe deer use conventional, non-fauna underpasses, if they are wide, if there is less human co-use, and if the average daily traffic above the structures is low. We

conclude that roe deer and moose use conventional structures in Sweden, and that designs to reduce the appearance of traffic (e.g. screens) may improve their use.

Rail Ecology – are we on the Right Track?

Railway Ecology: impacts and solutions within an African perspective

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The global railway network is developing rapidly, with a worldwide footprint of approximately 1 million km and forecasted to increase by 45% by 2050. Existing studies of the negative impacts of railways on wildlife have identified mortalities as a result of a collision (particularly among large mammals, such as ungulates and carnivores), creating barrier effects, isolating populations or limiting the access to resources. Additionally, railway corridors can serve as routes for the expansion of invasive species.

The consequences of habitat loss, fragmentation and pollution from railways are largely unknown to date, particularly in developing countries, such as Africa. To address these negative impacts, we have produced an open access book entitled *Railway Ecology* that addresses all these issues and is a point of support for future studies. In this presentation, we discuss some of the measures addressed in the book such as; how molecular tools can be used to determine population substructure (due to the barrier effects of rail), how to evaluate the restoration of functional connectivity after the application of mitigation measures, and how capture-recapture methods can generate valuable data on the habitat use in relation to the railway corridor and, combined with computer simulations, estimate the impact of mortality on populations' viability.

Observed and estimated mammal mortality on a Brazilian railway

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The low number of studies concerning the impacts of rail on wildlife (specifically collision mortality) may give the impression that railways have little impact on biodiversity. Furthermore, the correction of observational errors (such as searcher efficiency and carcass persistence) in mortality estimates has not yet been applied in railway ecology, as is already the practice in road and wind farm studies. By not considering these errors, mortality is underestimated and the comparison among studies is hampered.

We estimated mammal mortality magnitude on a 750 km stretch of railway in the Brazilian Savanna (Cerrado), considering searcher efficiency and carcass persistence. We used a dataset collected by Rumo Logística during the environmental licensing. Over a two-year period (2015-2016), 2,405 mammal carcasses were recorded. Searcher efficiency and carcass persistence were estimated based on field experiments. Due to sample size limitations, we calculated mammal carcass persistence for the studied railway (n=100) and a less conservative scenario for the railway network (n=226). The probability of a carcass persisting on the railway for three days was ~98% for both scenarios, but the mean persistence time varied: 298 for the former and 73 for the later. Searcher efficiency for mammals on this railway was 19%. Considering both scenarios, we estimated that 7,387 and 17,174 mammals died on this railway in two years. Our results suggest that mortality can be substantial for mammals on railways. Surprisingly, mammal carcass persistence was much higher than reported for other infrastructures. Improving data collection and correcting mortality estimates are fundamental for a better comprehension of wildlife mortality on railways.

On-Board cameras reveal wildlife responses to approaching trains in Sweden

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Collisions between wildlife, especially ungulates, and trains are of increasing concern to railway traffic in Sweden. In order to develop efficient mitigation measures, we studied the behaviour of animals towards approaching trains, using on-board video recordings made by train drivers during April 2015– June 2018. Train drivers were instructed to capture all incidences they detected wildlife within or near the railway corridor. The video recordings were then analysed with respect to the animals' flight responses in relation to the distance to, and the speed of, approaching trains. A total of 454 recordings was included in the analysis (279 cases with roe deer, 99 moose and few with wild boar, and red and fallow deer). In most cases, animals escaped the train in time; only 16 collisions were documented. On average, animals were recorded at a distance of about 150 m. In 50% of all observations, the animals were already in flight mode when they were detected. In most other cases, animals initiated flight when the train had approached to less than 90 m. Flight distances were slightly longer when animals were on the track than outside the rail corridor. Most animals that collided with trains were not aware of the danger or initiated their flight response too late. Our results suggest that animals may, to some degree, habituate to train traffic and respond rather late. We conclude that measures that would help to increase train detectability by animals could be effective in reducing collision risks.



Brazil's roadless and railroad-less (RLRL) areas as conservation opportunities

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Brazil's transportation infrastructure is significantly underdeveloped in comparison to the size of the country, and its growing economy and arguably needs significant upgrades. New and expanded roads and railroads, a key component of Brazil's development policies, are being planned and constructed as a means of improving the country's economy. However, federal policy related to transportation infrastructure often disregards conservation planning and practices in the pursuit of desired economic development. Historically, Brazil's transportation infrastructure has been planned according to the demands of the agricultural and minerals sectors. This paradigm continues to impact Brazil's megadiverse ecosystems and is the principal driver of deforestation and land use change in the Amazon and Cerrado.

Brazil's Roadless and Railroad-less (RLRL) areas were computed using buffer distances at 1 and 5 km away from all existing roads and railroads according to official federal transportation authority and Open Street Map data. The modelled 1 km and 5 km RLRLs account for approximately 71.3% and 39.2% of Brazil's continental territory respectively. At the national level, using 1 km RLRL areas, 25.5% of the Brazilian Ministry of Environment's (MMA) Priority Conservation Areas (PCAs) overlap with 1 km RLRLs and these overlapping areas account for 18.2% of Brazil's continental territory. Using 5 km RLRL areas, 19.3% of MMA's PCAs overlap with 5km RLRLs and the overlapping areas account for 7.5% of Brazil's continental territory. The vast majority of these identified overlapping areas are currently unprotected. Our RLRL areas represent conservation opportunities that can be used to avoid impacts that roads and railroads could cause to the country's megadiverse ecosystems.

Quantifying the barrier effect of roads and railways on terrestrial animals in Sweden

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Roads and railroads can comprise movement barriers to many terrestrial wildlife species. The barrier effect can be attributed to several factors among which fencing and traffic volume are presumably the dominant ones for larger species. However, systematic studies to reveal the barrier effect are rare and only few have attempted to quantify the dose-response relationship between traffic and barrier effect in large wildlife. In this study, we used snow tracking along selected unfenced road and railroad sections to determine the barrier effect of roads and railways on moose (*Alces alces*), roe deer (*Capreolus capreolus*), wild boar (*Sus scrofa*), red deer (*Cervus elaphus*), fallow deer (*Dama dama*), red fox (*Vulpes vulpes*) and hares (*Lepus timidus* and *Lepus europeus*). We quantified the difference between the number of tracks along a control transect (200 m from the road/railway), edge transect (adjacent to the road/railway) and the number of tracks crossing the road/railway, at each site, in relation to the type of habitat of each transect, and the traffic volume, speed and width of the transportation corridor. We found significantly more tracks of moose and roe deer along control transects compared to the edge, or crossing the transportation corridor, indicating that transport corridors repelled many of these animals. Hare and red fox tracks were less differentiated suggesting a lower response to traffic. Findings from this study will help narrow down the cause of the barrier effect from transportation corridors on terrestrial wildlife, and will aid in developing strategies to mitigate these impacts.

Stories from the Line: Power Line Case Studies

An analysis of Vulture mortalities on power lines in South Africa from 1996–2018

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Vulture mortalities recorded by the Eskom/Endangered Wildlife Trust (Eskom/EWT) Strategic Partnership since its inception during 1996 – 2018 are presented here. Data were analysed to determine species most affected, the type of power line structures responsible for the mortalities, and the key factors that contributed to the mortalities. The number of sites mitigated, as well as the average response time of mitigation measures were examined. Eskom's policy and standards for re-active mitigation as well as the recently adopted Pro-Active Bird Mitigation Strategy are explained. Challenges such as limited funding and the lack of technical solutions to reduce vulture mortalities on power lines in South Africa are discussed.

The value of knowledge transfer to reduce raptor mortality due to power lines in North Africa

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Avian electrocutions on power lines are well-documented worldwide, although records from North African countries are sparse. For the first time in 2016, a 'black spot' of raptor mortality due to electrocution was identified in South-Western Morocco. Since then, the IUCN Centre for Mediterranean Cooperation (IUCN-Med), in collaboration with the Regional Government of Andalusia (Spain), the High Commissioner for Waters and Forests and the Fight against Desertification of Morocco, the Directorate General for Forests – Tunisia and other partners in the region, are developing knowledge-transfer activities to identify and minimise the impacts of power lines on raptors. Among other activities, IUCN-Med organised an international meeting aimed to engage North African and Spanish stakeholders on trans-boundary conservation of threatened raptors (2015), a regional workshop on identification of the impact of electric infrastructures on birds (Spain, 2016) and two national capacity building workshops on the same issue in Tunisia (2017) and in Morocco (2018). Currently, a *Manual for the identification of dangerous power lines for birds in North Africa*, a mobile application to monitor dangerous power lines and a Data Base on bird electrocution events in Morocco are being developed, as well as a mapping exercise on areas of electrocution risk for birds in Morocco, all tools to improve spatial planning and retrofitting actions on power lines to advance in raptor conservation. Finally, a first monitoring programme of raptor populations is being launched in Morocco in order to assess the real extent of this problem and to determine priority areas for mitigation actions.

Development of road and power infrastructure in Zambia: implications for habitat connectivity and animal movements

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The 7th National Development Plan (2017-2022) for Zambia seeks to increase and diversify power production, which is currently over-dependent on large-scale hydropower plants, to include mini-and micro- hydro, wind and solar power. It also plans to increase current access to electricity from the current 5% (rural areas) and 65% (urban areas) or a national general average of 34% to 50% connected to the national grid. Given this reality however, the Sustainable Energy For All (SE4ALL), Action Agenda and Investment Prospectus has raised this target to 75%. Under the 'Scaling Up Renewable Energy Project', 20 mini- or micro-hydro project sites have been identified which include mainly waterfalls on rivers across the country; the other two projects being solar and wind. These major infrastructure projects for power will be accompanied by additional distribution infrastructure with the upgrade of roads, including feeder roads.

Plans to expand the road network under the LinkZambia Project of 2012, aims to upgrade 37 roads from gravel to bituminous standards in 10 provinces covering a total of 8,201 km over the next five to eight years. This implies that power and road infrastructure will criss-cross the country, much of which includes protected areas. Protected areas, corridors connecting habitats and local and major migration flyways are home to important species such as the Wattled Crane (*Grus carunculata*) and vultures – both of which will be negatively impacted by these developments.

We recommend a partnership involving the power and road development authorities, environmental regulators and environmental civil society organisations to enhance the Environmental Impact Assessment process, to quantify the status of power lines and roadkill and develop capacity for mitigation measures. Mitigation measures should include identification of 'no-go' areas for infrastructure development because of their high ecological value.

Population dynamics, status and ecology of Martial Eagles breeding on pylon-structures in the central and western Karoo, South Africa

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The Martial Eagle, *Polemaetus bellicosus* is Africa's heaviest eagle species, occurring over a wide range of habitats at naturally low population densities. Throughout Africa, *P. bellicosus* populations are exhibiting concerning declines. South Africa is no exception; here recent research has revealed uniform reductions of up to 60% in populations over the past 20

years, including stronghold populations within protected areas such as the Kruger National Park. The locally Endangered South African population of *P. bellicosus* is currently estimated at fewer than 800 adult birds, with the bulk of the known population believed to be residing in larger protected areas. *P. bellicosus*, however, also builds nests and breeds on pylons that support high voltage transmission lines running through the largely treeless, semiarid landscapes of the Karoo. It is estimated that over a third of the national breeding population, nests on pylon-structures in this region. This finding, which is at odds with the generally held belief that *P. bellicosus* is increasingly confined to large protected areas, can have significant implications for our thinking around the conservation management of this globally threatened species. The long-term status and sustainability of the pylon-nesting population are currently unknown. While it certainly represents an important population, its relative size could well contribute to sustaining populations in other regions that would otherwise be declining. Alternatively, it may represent a sink population, which can counter the decline in the overall South African population. This project examines the status and population dynamics of *P. bellicosus* nesting on transmission structures in the central Karoo. Breeding is monitored by using ground surveys and remote nest cameras, as well as the spatial ecology, dispersal, and survival of marked samples of adult and nestling eagles using color-ringing and GPS-tracked individuals. Here we present our initial findings of research launched in July 2018.

The darkness under the power lines: Energy justice and the linear infrastructure of the Grand Inga Dam

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The Grand Inga Dam in the Democratic Republic of Congo (DRC) has exported electricity to South Africa in the past, through long power lines stretched across Zambia and Zimbabwe. Today, these power lines have fallen into disuse, but will be upgraded so that South Africa may buy 2500 MW of the total 4500 MW that will be generated by the next phase of the project (Inga 3). This is despite the very low-levels of energy access in the DRC, around 13.5%. The agreement is necessary, however, as the DRC will be unable to repay their loans for development without a steady buyer. Linear infrastructure therefore represents economic opportunity to local people, but also frustrations and injustice. To evaluate this dynamic, a study was conducted in 2017 using the theory of energy justice. Fieldwork was done along the Congo River, in Kinshasa, Boma, Inga and Muanda, and ultimately Inga 3 was found to be lacking in terms of energy justice. The complaint most often raised by study participants across the study sites was that power lines deliver electricity to urban centres and industry, but do not electrify the villages located beneath them. Further, many study participants felt that South Africa should not receive electricity at the expense of local people. In general, this study shows the great opportunities created through linear infrastructure, but also its significant pitfalls in terms of equitable development patterns. This suggests the relevance of justice theory to thinking about linear infrastructure, particularly where it traverses the gradient from poorer areas to richer.



Lightning Talks – A Linear Infrastructure Mix

The European wildlife and traffic handbook: a tool helping to avoid and reduce habitat fragmentation in 21st century

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Habitat fragmentation is recognised globally as one of the biggest threats to the conservation of biological diversity and transport infrastructure networks are one of the major factors increasing this threat. A challenge for infrastructure designers and constructors as well as for ecologists is to apply effective, evidence based measures to avoid and reduce the habitat fragmentation caused by new and existing infrastructures. The Wildlife and Traffic Handbook (<https://handbookwildlifetraffic.info/>), published in 2003, is a solution-orientated product that was the main output of the COST 341 Action: a scientific and technological project involving ecologists and engineers from 19 European countries that was promoted by the Infra Eco Network Europe (IENE). Its chapters are drafted to be useful for practitioners and to encourage best evidence-based practice.

The Handbook is used globally, although to date, has only been available in printed format. IENE with the support of the Swedish Transport Administration has initiated a cooperative process to update and transform the Handbook so that it will be available for download on the internet. Our first step has been in creating a website; we provide a presentation on accessing the site and how to access and download chapters. Moreover, the website includes a portal to access the most relevant guidelines and handbooks on transport ecology from different countries. During the course of 2019, a global team representing different countries will commence the update of existing chapters as well as the creation of new chapters covering new topics.

THE ROAD AHEAD: Guidelines to mitigation methods to address wildlife road conflict in South Africa

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Although roads are integral to the financial development and prosperity of the national economy in South Africa, there is a potential conflict between the country's development and conservation goals. To improve the ecological sustainability of roads, best management practices need to be incorporated into the planning and design stages of roads as early on as possible.

In 2016, the Endangered Wildlife Trust developed *The Road Ahead: Guidelines to mitigation methods to address wildlife road conflict in South Africa* as a user-friendly guide to the practices that should be followed when designing or upgrading roads. As the first of its kind, this handbook seeks to fill knowledge gaps regarding road ecology in South Africa. Although based

on an extensive collection and synthesis of current literature, knowledge, and science-based data with regard to the practices already in use in countries around the world, it is recognised that few of these have been field-tested in South Africa, or adapted to local conditions.

The handbook is intended for use by a range of stakeholders including road development agencies, environmental assessment practitioners, decision makers such as the Department of Environmental Affairs and the Department of Transport, and research institutions. It is intended that this handbook informs decision-making, helps raise awareness of the impacts of roads and road users on wildlife, and assists in the identification of appropriate mitigation measures to reduce the impact of roads on wildlife. Ultimately, it is hoped that use of the handbook will lead to a reduction in the loss of wildlife.

Road Ecology on the European Journal of Wildlife Research: a new Topical Collection calling for African studies

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The European Journal of Wildlife Research introduces a new Topical Collection focused on Road Ecology that is open to submissions from any country in the world. All the articles submitted at different times to the Topical Collection will be publicly available upon their very first acceptance in different journal volumes. This Topical Collection aims to be a useful tool for the development of generalised principles and applications concerning wildlife-related aspects of Road Ecology, providing a forum for collaborative dialogue. This Topical Collection will consider for publication all the high-quality manuscripts concerning wildlife-related aspects of Road Ecology, including original papers (both empirical and theoretical investigations), reviews (both systematic reviews and perspectives), short communications and technical notes (describing novel techniques or methodological improvements). Submissions exploring costs and potential benefits for wildlife coexisting with road-networks, and those investigating lesser-studied regions for Road Ecology, such as Africa, are encouraged. Importantly, this Topical Collection will also consider for publication all research on wildlife and other linear infrastructures, such as railways or power lines, as they share similar negative and potentially positive effects on biodiversity. Furthermore, all manuscripts including data on road-related mortality or the use of wildlife crossing-structures will be invited to respectively co-author two data papers aiming to provide standardised and accessible global-scale information on these two topics.

The need for standardised wildlife crossing measurements

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Numerous studies conducted in different countries have published results of monitoring of the use or effectiveness of wildlife road and railway crossings. However, only a few mention how the crossing dimensions were measured. In 2015, the Ministry of Agriculture, Fisheries, Food and Environment carried out a sampling of 940 Universal Transverse Mercator (UTM) 1x1 km

quadrats across Spain. Within these grids, 1,358 potential crossing structures were identified and characterised. During characterisation, work errors were detected due to a disparity of criteria in classification and measurement of the structure typology by different teams of technicians in the field, for example, in viaduct heights, culvert and other structure widths, but particularly in multi-structures width, and the calculation of the openness index. This index, which expresses the visibility for an animal —through the infrastructure— of the land on the opposite side is considered to be one of the most important factors that define its suitability as a fauna crossing. In many cases, the width was found to be overestimated between two to 25 times, and the openness index from double to five times. It led to produce erroneous results of effectiveness of the structures with respect to their dimensions. In order to use the measurement data for meta-analyses, a review of the field measurements and photographs was required to correctly identify the dimensions and rectify any incorrect data. For example, changing the total width given for a structure of nine cells by the individual width of each. Standardised field records and classifications of fauna crossing types and measurements is essential to ensure the reliability of results on the use or effectiveness of wildlife crossings.

Exploring habitat restoration techniques for linear energy projects

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This brief presentation will explore novel approaches and techniques to restoring habitats to pre-construction conditions on linear energy projects. Effective habitat restoration is a key part of linear energy projects and involves multi-disciplinary working and collaboration with landowners and stakeholders as well as on-going monitoring and management. This talk will highlight some issues encountered during the habitat restoration phase and how these problems were overcome. I will provide examples from two case studies; one cable route from an offshore windfarm which passes through some important grassland habitat in England and a pipeline route in mainland Europe where a variety of approaches were used to ensure the conservation of rare plants. In order to demonstrate success, it is essential to produce and implement effective management and monitoring plans and ensure corrective action is taken where required. The examples focus on how these plans were executed and how unforeseen problems were effectively overcome, as well as sharing lessons that can be applied to linear energy projects in Africa.

Wrong place at the wrong time? Influence of animal behaviour and species traits in roadkill risk assessment

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Roadkill has emerged as a major impact of roads on wildlife, and several studies have attempted to understand the influence of the factors contributing to roadkill. However, the role of species, road and traffic characteristics have been relatively less studied and could affect mitigation effectiveness. To address this gap, we calculated probabilities of animal-vehicle collisions (AVCs) for different road, traffic and animal characteristics on the National Highway 7 near Pench Tiger Reserve, central India, during July-August 2018. To incorporate the influence of species response to road-related disturbance, we estimated hourly estimates of roadkill risk using animal activities as a proxy for probability of animal presence near road.

We found that the AVC probability was highest for large-sized, group-living and slow moving animals on high volume traffic comprising mostly of heavy vehicles. Activity patterns revealed avoidance of roadside habitat during high traffic hours in contrast to natural activity patterns for animals like gaur (*Bos gaurus*) and sambar (*Rusa unicolor*), resulting in low roadkill risk during high traffic hours. Animals whose activities near roadside habitat coincided with high traffic hours (chital, *Axis axis* and wild pig, *Sus scrofa*) had a greater roadkill risk during these times than at peak animal activity hours. Animal activities at roadside habitat determine AVC risk, and must be factored into roadkill predictions for evaluating the relative barrier effect of traffic. The present framework to predict relative vulnerabilities of animal species based on species, roads

and traffic characteristics could provide a basis for identifying priority mitigation sites across landscapes with identified animal movement corridors

Off-road ecology: Combining wildlife roadkill and behaviour to understand impacts of roads on wildlife

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Wildlife roadkill data is critical for informing mitigation measures. However, on roads with high-traffic volumes, roadkill data may be biased in terms of missed detections and degraded/missing roadkill. We found 86 roadkill across three taxa on roadkill surveys conducted twice daily across summer, 2017 and monsoon, 2018 on NH-44 intersecting Pench Tiger Reserve, central India. Most roadkill (62.79%) were found on road sections near forests, followed by agriculture (25.58%). Roadkill-prone sections coincided with navigable terrain for animal crossing (raised 48.78% and flat roadside topography 34.15%) and high driver visibility (67.57%). A roadkill persistence experiment was conducted by assigning recognisability scores to carcasses every 12 hours. Within the first 20 hours of roadkill occurrence, 33.3% ($p < 0.001$) of reptile roadkill, and 71.1% ($p = 0.003$) roadkill located at the outermost edge of the road were lost to degradation. When we assessed detectability of roadkill decoys as a function of the position on the road and roadkill taxa, we found a high probability of missing reptile roadkill (0.97), and roadkill on the opposite lane of road (0.93). Moreover low roadkill rates of large mammals such as chital (*Axis axis*; $n=2$) and wild pig (*Sus scrofa*; $n=5$) could be explained by moderate activity near road, and no roadkill of gaur (*Bos gaurus*) and sambar (*Rusa unicolor*) because of low activity near roads. This activity was positively influenced by road proximity for chital and negatively for sambar. Our study suggests that drawbacks of roadkill data necessitates correction factors and deliberation of data in a behavioural framework for a bigger picture of the impacts of roads on wildlife.

Reducing impacts on wildlife and improving motorist safety on three major toll routes in South Africa

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In South Africa, the 3rd most biodiverse country in the world, roads are integral to the country's continued development and prosperity. However, these roads can pose a direct threat to the tourism sector, which contributes around 7% to the national Gross Domestic Product per annum, as many species are at risk from wildlife-vehicle-collisions (WVCs or 'roadkill'), often leading to an animal's death.

Efforts to reduce wildlife mortality around main roads are often hampered due to a lack of research, and a lack of funds, with other priorities usually dictated by the country's socio-economic situation. Road Ecology is an emerging science within the country and the Endangered Wildlife Trust (EWT) has been spearheading the collection of robust baseline data to support the implementation of mitigation measures.

Partnering with the EWT are three of the country's toll concessionaires namely, the N3 Toll Concession (N3TC), Bakwena N1N4 Toll Concession (Bakwena) and Trans African Concessions (TRAC) N4. All three toll routes are important because they pass through a diverse range of habitats ranging from urban landscapes, to communal land to agricultural areas. These areas are home to people, domestic animals, livestock and wildlife, all of which may come into contact with the vehicles using the road.

This paper will outline the data collection methods used to date, as well as the training programmes that have supported the reporting of data. Furthermore, we will briefly discuss some of the key results and recommendations that have emerged from data analysis.

Working on Sustainable Transportation in the Carpathians: The Carpathian Convention as pilot bioregion case to study

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The Carpathian Mountains are home to an extremely rich biodiversity, including numerous endemic species, and to many human communities across Central and Eastern Europe. Preserving the balance between wildlife and human activity in this rapidly developing region will represent one of the greatest challenges of the 21st century. Today, large-scale developments and infrastructure projects, in particular, exert significant environmental impact at an irreversible level. Linear transport infrastructure connects people, but disconnects wildlife, building upon the natural landscape an artificial 'grey wall' of fragmented areas.

To achieve sustainable development in the Carpathian Mountains, the Carpathian Convention, hosted by the United Nations - Vienna Environmental Office, has a crucial role in transforming the global outlook on nature conservation and in promoting collaboration at trans-national and cross-border levels. More precisely, the Sustainable Transportation Protocol of the Carpathian Convention provides a basis for a comprehensive strategy and a follow-up action plan, which shall translate global concerns to local actions and provide solutions to preserve the ecological connectivity of the area.

European Union (EU-Interreg) projects as TransGreen and ConnectGreen, and initiatives such as the Infrastructure and Ecology Network Europe (IENE) and GreenWeb, an IENE working group in south-east Europe, already provide a framework for joining efforts to prevent and reverse habitat and landscape fragmentation in the Carpathian Mountains. This presentation will look at this framework sharing working experience in pilot areas in Carpathian bioregion and producing specialised deliverables on transportation and ecology as guidelines, state of the art reports and training materials.

Mapping and modelling of wildlife and livestock roadkills along Kajiado, Makueni and Machakos counties in Kenya

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Linear development in Kenya is rapidly fragmenting the landscape and negatively affecting both wildlife and livestock and their movements. Currently the challenge in Kenya is to build a more efficient transport system that facilitates economic growth and development. The Mombasa- Nairobi highway (A109), transects, Kajiado, Machakos and Makueni counties; these counties harbour crucial ecosystems that sustain both wildlife and man. Since 2007, Action for Cheetahs in Kenya (ACK) has documented wildlife and livestock movement between the growing towns of Kyumvi and Emali, and documented a number of animal road mortalities, particularly cheetah (*Acinonyx jubatus*).

The aim of this study is to determine the impacts of linear development on both wildlife and local livelihoods. A structured model based on binary regression will be used to determine the factors that influence road mortalities on wildlife and livestock thus mapping roadkill hotspots within the study area. The characteristics of animals killed will also be determined. Using a combination of interviews and questionnaires, local community members will be engaged to assist with guidance on mitigation measures. The study will therefore try and expose the effects that come along with the need for growth in terms of linear development especially on both wildlife and local livelihoods, where concerns and attitudes of the local communities on the impacts of linear development will be addressed.

Species traits as predictors of road-avoidance responses in African ungulates

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Road-networks have negative effects on biodiversity and ecosystems, even in protected areas. The combination of roadkills and animals' road avoidance can produce barrier effects, which may lead to population fragmentation and even local extinction. Previous studies postulate species-specific variations in animal abundance related to roads and traffic, but the potential for using trait-based models in Road Ecology remains largely unexplored. This study addresses this gap by evaluating the role of diverse species traits in explaining animal responses to roads and traffic. We collected data from ungulate species along touristic roads of three South African protected areas, recording the occurrence of flight responses and the local spatial distribution of the animals in relation to roads. Using generalised linear mixed effects models, controlling for phylogenetic relationships, we evaluated whether species traits (lifespan, morphology, reproductive speed, foraging behavior and social structure) predicted flight responses and animals' spatial distribution along roads, and how these relate to road surface and traffic. We recorded 513 sightings of 18 ungulate species along a total of 722 km. Our results showed that smaller and solitary ungulate species located closer to roads were more likely to flee than larger species. This aligns with the effects of traffic on local spatial distribution patterns, as we found ungulates were located further from busier roads. Browsers, smaller and short-lived species were detected closer to roads than grazers, larger and long-lived ungulate species. The results can be explained by ecological mechanisms or methodological biases, and further work would be required to disentangle this question.

Web-Based Management of Wildlife Camera Systems

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Safe passage of wildlife across roads is good for animals and drivers alike, but difficult to demonstrate. Camera traps are often employed for wildlife monitoring in remote and developed settings, and can be used at places where road crossings occur. Additionally, camera traps may confirm wildlife movement over or under roadways, including crossing structures built to accommodate wildlife passage. We will describe the state of camera trap practice in North America and Africa and provide an overview of the various uses of camera traps in wildlife research, including assessing safe passage of wildlife across roads. We will also describe opportunities and limitations for using this technique. We have found that although camera traps are often used to monitor wildlife presence at roads and passage structures, rarely are they used as part of research-grade studies. Often findings are expressed only as counts of number of individuals and species without relating these values to each other, potentially impacting factors, structure attributes, or habitat characteristics.

We have developed a web-system and techniques for managing camera trap projects and images (<https://wildlifeobserver.net>). These systems should decrease the work and complexity of managing images and increase time and opportunities for analysing the image data. The system allows bulk tagging of images and maintenance of records in a shareable relational database. Finally, we are developing two important tools to accompany the web-system – identification of false positive (no animal) images and identification of common wildlife species. We will provide recommendations for ways to employ current approaches in contemporary studies of wildlife passage across roads.

Understanding fatal collisions with trains in Balule Nature Reserve, South Africa

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Unnatural barriers created by anthropogenic linear infrastructure are a cause for ecological concern, as they promote population fragmentation, limit access to resources and degrade the natural environment. Furthermore, anthropogenic activity occurring along linear infrastructure can also result in localised population declines through fatal collisions.

43km of railway traverses the Balule Nature Reserve, servicing the Phalaborwa Mining Company and Foscor Mines. Trains travel day and night through the reserve and both wardens and Transnet have been recording animal mortalities since dropping of fences and subsequent creation of Balule Nature Reserve in 1996. The infrastructure and accompanying rail activity along the Phalaborwa/Hoedspruit railway in Limpopo, South Africa, may pose a significant threat to local wildlife populations.

Over 500 fatal collision data were recorded, including elephant, giraffe, buffalo, impala, lions, leopard, wild dog and cheetah. 147 collisions were spatially and temporally analysed, showing that ecological and landscape features can account for hotspots of collisions. Features such as topography, vegetation density, vegetation communities and water distribution on the landscape may be major contributors to collision mortalities.

Using camera-traps, we assessed animal behaviour in the collision hot-spots and control areas, and ground-truthing of the entire length of the railway showed that topography, visibility (bush density) and resources (water and vegetation) could be the primary contributors to the high collision mortalities. Our analysis of the data will assist managers to find cost-effective mitigations to reduce animal mortalities as well as costly infrastructural damage and reduce the environmental and financial impacts, in critical hot-spots along this railway.

THURSDAY 14 MARCH

Resilient Transportation as a Global Demand

The challenge to design safe and resilient transportation in Europe

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A safe, efficient and sustainable transportation system is key to the modern way of life. Yet traffic and infrastructure often entail significant habitat degradation and fragmentation, which represent a threat to biodiversity worldwide. The loss of biodiversity is a significant spillover from anthropogenic activity and the reversal of the trend is recognised as a major challenge for the 21st century.

The main negative impacts on wildlife populations caused by transport infrastructure are: the loss and transformation of habitats, disturbances (due to visual obstacles, noise, light and vibration), traffic mortality and barrier effects. Transport infrastructure cuts through habitats, imposes barriers and thereby interrupts the genetic interchange, leading to declining and degenerated populations. Furthermore, as animal-vehicle incident numbers increase, apart from human fatalities and injuries, the economic damage becomes evident. Overcoming these negative impacts is possible. The necessary tools for actions and the required knowledge is already available.

The Infrastructure and Ecology Network Europe (IENE) is a 420-member network of experts working on the impacts of transportation on the environment, with the aim to promote safe and ecologically sustainable pan-European transport infrastructure by applying recent research results and recommending planning procedures and mitigation measures to conserve biodiversity, counteract landscape fragmentation and reduce vehicular accidents and wildlife casualties. IENE is an international forum where experts, researchers and practitioners can exchange knowledge and good practices in the field of transportation and ecology thus contributing to large-scale coordinated action to promote and develop safe and resilient infrastructure.

Linear Developments, Protected Areas and the Art of War

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This is War! Make no mistake about it! This is a war in order to survive. Linear developments have always presented a significant threat to protected area integrity. The types of threats, responses and decision making for linear developments have changed markedly in KwaZulu Natal (South Africa) over the past 25 years with a greater reliance on EIAs and other tools to assist in sustainable decision-making.

Despite South Africa having some of the leading international environmental legislation, the twin pressures of job creation and service delivery are key drivers in the current environmental, economic and political climate and are often at the forefront of decision-making. Officials often tend towards short term or least resistance solutions, and thus linear development threats to the protected area estate are having a greater impact than ever before. Decision-making tools are often designed to try and adapt to this almost unbearable pressure in order to find an expedient solution when faced with potentially mutually exclusive demands on a protected area. This reactive, piecemeal defence slows down, but still assures the decline of the protected area estate.

A co-ordinated, untiring and proactive approach is required to secure our remaining protected areas from the impacts of linear developments and we may do well to heed the principles of the Art of War when considering our strategy.

Where to now: A review of the progression of biodiversity related mitigatory measures for power lines within KwaZulu-Natal, South Africa

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Ezemvelo KZN Wildlife (Ezemvelo), the conservation authority for the province of KwaZulu-Natal in South Africa, is mandated to comment on land-use change applications that may adversely impact on the province's biodiversity. Over the last 11 years, Ezemvelo has received and commented on 63 power line applications, of which 20 applications (31.7%) had significant concerns in terms of potential biodiversity impacts. Of these 20 applications, 50% had the potential to have negative impacts on Protected Areas. In response to this, Ezemvelo has consistently drawn on best practice mitigatory measures, new/innovative thinking (from various specialists), as well as modified generic mitigation to address specific negative impacts, in specific circumstances to ensure that proposed power line applications have acceptable impacts on biodiversity. However, there are still fundamental gaps in the Environmental Impact Assessment (EIA) process that have the potential to have detrimental impacts on critically important biodiversity, for example the EIA process approves extremely large corridors, as opposed to specific alignments; voltage of power lines are used to trigger EIAs, as opposed to the potential impacts of the power line.

This presentation will briefly illustrate the progression of power line mitigatory measures over the last few years and put forward new ideas for dealing with future power line EIAs, particularly in highly sensitive environments, so as not to foreclose on conservation planning initiatives and/or conservation goals and targets.

Mitigation Case Studies 1

Samango monkey road kill mitigation in the Soutpansberg, South Africa

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A threat assessment has shown that one major threat to samango monkeys (*Cercopithecus albogularis schwarzi*) in the Soutpansberg area are provincial roads, with 21 roadkilled samangos collected and more than a dozen road crossings observed since 2012. A solution to this problem could be the establishment of canopy bridges that allow for safe road crossing. Canopy bridges for arboreal animals have been trialed in Australia, Brazil, Kenya and Madagascar and have shown promising results for primates, porcupines and opossum species.

In order to establish a suitable bridge design we conducted experiments on habituated samangos at the Lajuma Research Centre. Parameters tested were 1) solid pole bridge versus flexible rope bridge and 2) different levels of canopy cover over the bridges. The effectiveness of the bridges was evaluated through direct behavioural observations. We found significant differences between the number of crossing events when comparing the two types of bridges with solid pole bridges being preferred. Principal Component Analysis suggests that crossing sites with open and partial tree canopy have higher frequencies of bridge crossing events. We further found that bridges under full canopy were related to high scores for walking, sitting and stopping behaviours and a reduced score of running behaviour suggesting that the monkeys perceive bridges with canopy cover as less risky. Camera trap observations on bridge crossings also showed that another seven mammal species as well as reptiles could benefit from canopy bridges. Results from the experiments are being used to design the most suitable and cost-effective bridge prototype for erection at the actual roadkill hotspots.

Carnivore roadkill in Limpopo Province, South Africa

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South Africa is ranked as the third most biodiverse country in the world, and has a rapidly developing economy with large investments in linear infrastructure. Linear infrastructure, specifically roads, is known to cause wildlife mortalities through animal-vehicle collisions, which can negatively affect biodiversity and animal populations. Several studies in the world have shown that a combination of factors can play a role in the occurrence of roadkill. However, roadkill can also be biased to certain animal taxa, sex and age classes which can have demographic consequences.

In this study, we document the diversity of roadkill collected in Limpopo Province, South Africa, over a seven-year period. Between July 2012 to January 2019, we gathered *ad hoc* roadkill data whilst driving random roads in the province. For each roadkill, the locality (including GPS coordinates) species, age, sex, and a photograph were recorded. We collected 618 roadkill belonging to 21 carnivore species from six families (Canidae, Felidae, Herpestidae, Hyaenidae, Mustelidae and Viverridae). The highest diversity collected were herpestidae (n=7 species). Domestic dogs (52%) and cats (29%) were the

most common carnivore roadkill collected whilst mongooses (6.6%) were the most common among native carnivores. More male (58%) than female (42%) roadkill were collected. During subsequent autopsies on fresh roadkill samples, we collected ecto- and endoparasites. While all species collected were classified as Least Concern (except for Brown Hyena, *Hyaena brunnea* [Near Threatened]), our results here could assist in further population viability assessments and parasite diversity.

Protecting the protected through assessing driver behaviour in protected areas, South Africa

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Social media discussions highlight public concern for wildlife-vehicle collisions (WVCs) inside protected areas. We investigated factors affecting the likelihood of WVCs within Pilanesberg National Park (North West Province), and assessed the comparative effectiveness of wildlife-warning signage (WWS) for altering driver behaviour. We laid a dummy snake on roads across four combinations of habitat and road shape and recorded 10 driver-related variables for 1454 vehicles that passed, or collided with the dummy snake. An interaction between speeding and driver occupation (staff/visitor) was the best indicator for WVC. When driving below the speed limit, visitors were almost three times more likely than staff to hit the dummy snake. Collision probabilities increased when speeding and became more similar between visitors and staff, although still significantly higher for visitors.

We investigated the effectiveness of signage in modifying driver behaviour by erecting four variations of WWS, depicting either a snake or a cheetah. We positioned the dummy snake either 100 m or 1 km after the signage and recorded our 10 variables (n = 6400 vehicles). Sixty-one percent of drivers who passed a WWS changed their behaviour when they saw the dummy snake, compared to 37% with no sign present. Further, this behaviour change significantly reduced collisions, with 98% of drivers positively altering their behaviour. Finally, a WWS depicting a snake, and placed 100 m before the dummy snake, was most effective at reducing collisions. Our results suggest that drivers adapt their behaviour to signage that portrays smaller animals and awareness retention is low.

Cranes and power lines in South Africa: reversing the declines and securing their future

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All three of South Africa's threatened cranes species, namely the Grey Crowned, Blue and Wattled Crane (*Balearica regulorum*, *Grus paradise*, *Bugeranus carunculatus*) suffered drastic declines over several decades until the late 1990's. Over the past two decades, we have witnessed increases in core regions in all three species. For example, results of the annual crane aerial survey spanning 25 years in KwaZulu-Natal, shows Grey Crowned and Wattled Cranes are increasing at an average annual rate of 3.5% and 4.8% respectively in the province – a stronghold for both species. In the Western Cape, where more than 50% of the global population of Blue Cranes occur, the Coordinated Avifaunal Road (CAR) counts have shown similar increasing trends. One of the main threats to cranes are collisions with overhead power lines, with an estimated 12% of the Western Cape Blue Crane population killed annually. The most widely used mitigation measure to reduce collisions is to improve the visibility of power lines by attaching markers to the conductor and earth wire cables. A research study completed by the Eskom/EWT Strategic Partnership showed that markers fitted to transmission lines in the Karoo reduced Blue Crane collisions by 92%, proving a suitable mitigation method for cranes. For the purpose of this presentation, we will highlight the role of power lines in the decline or growth of crane populations in South Africa, as well

as looking at the future viability of South Africa's national bird, the Blue Crane in the face of increasing renewable energy and associated power line infrastructure.

Effectiveness of road mitigation for Common Toads (*Bufo bufo*) in the Netherlands

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The impact of roads and traffic on amphibian populations is primarily the result of amphibian road mortality. This is particularly obvious in species, such as the Common Toad (*Bufo bufo*), that migrate between its wintering and breeding habitat and often crosses roads. A variety of measures have been developed to prevent road mortality.

This study focuses on the effectiveness of mitigation measures taken for a population of Common Toads on a local road in the central part of the Netherlands. In 2013, 2014 and 2015, we carried out a capture-mark-recapture study. We marked a total of 722 toads. Of the marked toads, 31% used the tunnels to cross the road, 68% failed to use the tunnels to cross the road, and 1% ended up on the road. Before mitigation, the migrating population was estimated at around 3,000 individuals. After mitigation, the migrating population size decreased to approximately 800 individuals. The main reason seems to be the low tunnel density, which means the distances are too great for most toads to travel. Furthermore, many toads fail to get through the tunnels and consequently take no part in breeding.

Our research emphasises that the following measures are vital for mitigating road impacts to adequately maintain viable toad populations. 1) Better baseline studies on where toads cross and what distances they move before mitigation, 2) Tunnel densities that are based on the mean movement distance of the most critical toads, and 3) drift fences that go well beyond the location where toads cross the road.

Human settlement, roads and rivers rather than climate determine distribution of the Apple of Sodom (*Calotropis procera*) in northern Limpopo Province, South Africa

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Alien plant invasion is one of the increasing threats to biodiversity and ecosystem services globally. Anthropogenic activities disturb ecosystems and cause a shift in community assemblages. In recent decades, climate change has become the driving force in the disruption of ecosystems and the loss of species diversity, and in promoting species extinction and the distribution of alien invasive plant species. In South Africa, 161 out of 8750 species cause problems to biodiversity and 117 alien invasive species are well-established and are widespread. Population counts of *Calotropis procera* were conducted for each km consecutively for 20 km and 10 km on paved and unpaved roads, respectively in the former Mutale Municipality of Vhembe District, Limpopo Province, South Africa. The use of the existing GBIF (Global Biodiversity Information Facility) dataset of *C. procera* historical collections from around the world were used to model the species distribution globally and in Southern Africa. Maxent 3.3.3k was used to model current distribution of *C. procera* using their distribution records after preparing and projecting to Albers equal area projection for the world. QGIS 2.18.20, was used to create distribution maps of South Africa and Vhembe Biosphere Reserve in relation to the position of roads, rivers and settlements. The statistical test from the drive transects showed a positive regression and significance between *C. procera* abundance and human disturbances in settlements. Distance explained 40% of variation in density estimates, $p < 0.001$, while Maxent results showed the significance of Annual Mean Temperature in the global distribution of the *C. procera*. The total transformed areas (settlements), as well as roads and rivers, show new records of *C. procera* fall in areas predicted to have low habitat

suitability. This study concludes that human settlements, urbanisation, rivers and road construction influences the current distribution of *C. procera*.

Mitigation Case Studies 2

Roads and their users as a threat to wildlife conservation: an approach to model amphibian roadkill in Vhembe Biosphere Reserve (Soutpansberg Conservancy), South Africa

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Increasing threats of transportation infrastructures to wildlife conservation makes it imperative to monitor road impacts on wildlife. Despite evidences proving that transportation networks are associated with a pool of threats that degrade the integrity of wildlife resources, very little has been done in Soutpansberg Conservancy in Vhembe Biosphere Reserve (VBR). With the proposed plans to upgrade regional roads around this region by an addition of lanes by 2050, threats to wildlife species are predicted to accelerate enormously. This will be worse for smaller vertebrates such as frogs and reptiles. Many population of amphibians suffer violent mortalities and are declining at a rapid rate; thus, resulting to a great conservation concern. However, it is with great pity that the ecological impacts that amphibians unpleasantly suffer from roads during seasonal migration are poorly discussed in many African studies. Mortalities of amphibians due to direct roadkill incidents is amongst other factors that contribute to the global amphibian decline crisis. Henceforth, folklores about frogs make people to disregard their value in the ecosystem, consequently contributing to their decline. This study aims to undertake an assessment of vertebrates' roadkill on a combined 113 km line transect along three regional road networks bisecting the Soutpansberg Conservancy. This project intends to monitor vertebrates' roadkill, with focus on amphibians, for the upcoming 2018/19 hot/dry and hot/wet ecological seasons. This will assist in developing a roadkill database of Soutpansberg Conservancy, and assist in identifying habitat characteristics that are associated with wildlife roadkill.

Animal movement analysis predicts higher risk road crossing zones: an assessment for mesocarnivores

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Roads have been recognised as the main human cause of deleterious effects on mobile species, such as large carnivores. However, little attention has been given to their impacts on mesocarnivores, which outnumber larger carnivores, and are

accepted as apex predators. Some studies have shown that mesocarnivores road casualties are clumped, to include different species, but few have tried to describe which factors shape their behaviour toward roads. We aim to understand what influences similar mesocarnivores to cross road-risk zones using the reliability of the genet (*Genetta genetta*) telemetry-based path analysis (Movement scenario-MOV) to predict those areas. We used conditional logistic regression to discriminate observed vs random locations along roads. We compare the best models for each species under two scenarios: road intersections with the path analysis (MOV) vs. real (roadkill/sightings) crossings (RC).

Our findings showed that mesocarnivores crossed roads mostly near to forests, riparian corridors and culverts (being the effects stronger in the MOV scenario). By contrast, mesocarnivores avoided agriculture and urban areas but selected areas near to sharp road curves for crossing roads (being the effects stronger in the RC scenario). Responses to agriculture areas were different in the RC scenario than in the MOV, probably due to a high proportion of sub-adult roadkill, who often disperse through suboptimal habitats. Overall, the MOV genet model outperformed the RC one and proves to be effective in predicting risk zones for all species. Our results support mitigation guidelines to hamper mesocarnivore depression by enhancing the restriction of mesocarnivore access to risk zones and by avoiding constructing sharp road curves.

Road proximity may compromise antiparasitic response and fat storage in a generalist lizard: A translocation field experiment

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Globally, road networks are expanding, with an expected increase of >60% by 2050. Forecasting the impacts of this increment on wildlife represents a major challenge for applied ecologists. Most research to date on the impacts of roads, comes from studies that focus on a selected group of species, (mainly large, charismatic mammals), or is individual-focused, local-scale studies, and obviating population-level implications.

An understudied topic in the discipline of road ecology is the potential for road infrastructure to act as agents of selection, whereby adapted individuals survive and/or /benefit from them. Selection occurs when heritable phenotypes have a higher fitness, meaning individuals expressing those phenotypes survive and reproduce more successfully. For example, species who have modified their behaviour to avoid roads are less likely to become roadkill.

Few studies have evaluated the evolutionary impact of road infrastructure on populations with low capability to migrate, such as lizards. In our study undertaken in central Spain during the spring of 2018, we carried out a capture-recapture translocation experiment with the lizard *Psammotromus algirus*, as a model species, to study the impact of road proximity on body condition, parasite load, and the maintenance of male sexual coloration. We found a negative effect of the translocation treatment on *P. algirus*, since they lost weight. However, those control individuals captured and recaptured far from the road significantly increased their body condition compared to the rest of the experimental groups. Interestingly, these same lizards were able to significantly reduce their hemoparasite loads. Our results suggest a selective impact of the road since none of these effects were detected before translocation.

Promoting Ecologically Sustainable Linear Infrastructure – Case for the Grey Crowned Crane Conservation in south-western Uganda

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Uganda forms an integral part of the Albertine Rift – one of the most biodiverse regions of the continent accounting for ~50% of the Africa's bird species, ~40% of African mammals and ~20% of its indigenous flora. The region is home to more endemic species than anywhere else in Africa and is recognised as a Biological Hotspot, a Global 200 Ecoregion and an Endemic Bird

Area. Uganda is evolving from very low electricity consumption rates per inhabitant to a target of 2.5 million new connections by 2022. Similarly, the country is undergoing major exploration in the oil sector, specifically the Uganda – Tanzania Crude Oil Pipeline (UTCOP) that will transport oil from the fields in western and south-western Uganda to the distant sea port of Tanga in Tanzania. Equally, Uganda has also embarked on a long-term plan for improving the road and rail transport network to traverse the country. Many of these developments pass through the Albertine Rift region and may pose a significant risk to the unique and high biodiverse region. An opportunity to guide the linear infrastructure developments in this region is possible as we draw from the experience of the EWT/Eskom Strategic Partnership and more than two decades of conservation and research of the Grey Crowned Crane – Uganda's National bird. Since 2008, incidents of Grey Crowned Crane collisions with power lines and vehicles have been catalogued. We discuss some of our findings relating to the severity of the impact of the linear infrastructure on Grey Crowned Cranes.

Using road patrol data to identify factors associated with carnivore roadkill counts

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As the global road network expands, roads pose an emerging threat to wildlife populations. One way in which roads can affect wildlife is wildlife-vehicle collisions, which can be a significant cause of mortality. In order to successfully mitigate these problems, it is vital to understand the factors that can explain the distribution of roadkill. Collecting the data required to enable this can be expensive and time consuming, but there is significant potential in partnering with organisations that conduct existing road patrols to obtain the necessary data. We assessed the feasibility of using roadkill data collected daily between 2014 and 2017 by road patrol staff from a private road agency on a 410 km length of the N3 road in South Africa. We modelled the relationship between a set of environmental and anthropogenic variables on the number of roadkill carcasses, using serval (*Leptailurus serval*) as a model species. We recorded 5.24 serval roadkill carcasses/100 km/year. The number of carcasses was related to season, the amount of wetland, and the number of owls killed on the roads, but was not related to any of the anthropogenic variables we included. This suggests that roadkill patterns may differ greatly depending on the ecology of species of interest, but targeting mitigation measures where roads pass through wetlands may help to reduce serval roadkill. Partnering with road agencies for data collection offers powerful opportunities to identify factors related to roadkill distribution and reduce the threats posed by roads to wildlife.

Mitigating the ecological impacts of transportation infrastructure – A compilation of global case studies

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One of the greatest challenges in adopting best practise when planning and designing roads and other linear infrastructure is that there is no single source containing mitigation knowledge and experience. Consequently, many engineers, planners and project managers are unaware of the accumulated knowledge and experience and continue to make the same mistakes or implement outdated mitigation. To address this, I am proposing an open access book or website with case studies of mitigation from around the world in an accessible style and format. Case studies will:

- Be co-authored by an ecologist and a designer/engineer who were involved in the project;
- Include successes and failures, as both are important;
- Be written for a wide audience;
- Be geographically and taxonomically diverse;
- Span the mitigation hierarchy; and,
- Include a rich diversity of supplementary material, such as videos, photos, project plans, reports.

The case studies will be published as an **open access E-book or website**, so that everyone, everywhere, can access it at any time, for free.

In this presentation, I will explain the proposal and invite contributions of content and funding support. All projects have a 'story to tell', and others can learn from both your successes and failures. Open access materials are free to access but quality publications cost money to produce. Ideally, publication costs for authors will be minimal if sufficient sponsorship (e.g. from road agencies, development banks, private companies, NGOs or philanthropic sources) can be obtained.

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POSTER ABSTRACTS



Protecting the protected through assessing driver behaviour in protected areas, South Africa

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Social media discussions highlight public concern for wildlife-vehicle collisions (WVCs) inside protected areas. We investigated factors affecting the likelihood of WVCs within Pilanesberg National Park (North West Province), and assessed the comparative effectiveness of wildlife-warning signage (WWS) for altering driver behaviour. We laid a dummy snake on roads across four combinations of habitat and road shape and recorded 10 driver-related variables for 1454 vehicles that passed, or collided with the dummy snake. An interaction between speeding and driver occupation (staff/visitor) was the best indicator for WVC. When driving below the speed limit, visitors were almost three times more likely than staff to hit the dummy snake. Collision probabilities increased when speeding and became more similar between visitors and staff, although still significantly higher for visitors.

We investigated the effectiveness of signage in modifying driver behaviour by erecting four variations of WWS, depicting either a snake or a cheetah. We positioned the dummy snake either 100 m or 1 km after the signage and recorded our 10 variables (n = 6400 vehicles). Sixty-one percent of drivers who passed a WWS changed their behaviour when they saw the dummy snake, compared to 37% with no sign present. Further, this behaviour change significantly reduced collisions, with 98% of drivers positively altering their behaviour. Finally, a WWS depicting a snake, and placed 100 m before the dummy snake, was most effective at reducing collisions. Our results suggest that drivers adapt their behaviour to signage that portrays smaller animals and awareness retention is low.

Enhancing management of Transfrontier Conservation Areas to 'Leave No one Behind'

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Transfrontier Conservation Areas (TFCAs) denote cross-border regions whose different component areas have diverse conservation status such as national parks, private game reserves, communal natural resource management areas and even hunting concession areas. These areas also come with various linear infrastructure types such as, fencing, roads, railway lines, power lines, all of which may impede animal movement, requiring co-management for long-term sustainable use of natural resources and biodiversity conservation. In South Africa, the intersection of the country's development needs and ecosystem conservation calls for an enhanced co-management to ensure the effective management of such key resources and sustainable development. The Intergovernment Panel on Climate Change Report (IPCC) in 2016, categorised several locales associated with TFCAs as climate hotspots and specified management strategies. This is necessary to enhance natural resources, dependent livelihoods and stem incidences of poaching and natural resources conflicts, resulting from linear infrastructure and development. This study situates TFCAs in the 'Leaving No one Behind' agenda as an instrument for safeguarding wildlife whilst improving human-environment relations.

Creating a model for the prediction of roadkill in Kruger National Park, South Africa

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Roads not only create barriers for animals by preventing the free movement of individuals between populations, but also cause mortalities through collisions with vehicles (i.e. roadkill). In South Africa, most of our understanding of roadkill events stems mainly from research on national and regional roads, with very little known about the impacts of roads in protected areas. Despite ad hoc roadkill reports in protected areas by members of the public on social media, there have been little systematic roadkill surveys undertaken in South African protected areas and, road signage aside, no effective mitigation measures have been applied except the traffic officials of whom they are unable to monitor all roads simultaneously. Our study will form part of a five-year project to undertake an assessment of roadkill in protected areas and assess mitigation measures to reduce it. The present two-year project will record temporal and spatial roadkill in one section of the Kruger National Park, on both paved and unpaved roads. Factors, such as surrounding habitat, proximity of a water source and traffic volumes and speeds will be recorded. Using these data we will identify the predictors of where roadkill is most likely to occur, which will then be used to develop a 'Roadkill Risk Map'. The procedure can then be tested in other protected areas, and used as a future, cost-and time effect model for roadkill predictions.

Multilateral Development Banks in Africa: Do they Have Wildlife Friendly Infrastructure Policies?

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It is projected that 25 million km of new roads and over 300,000 km of rail track will be built around the world by 2050; 90% of this construction is planned in developing countries. This is a multi-sectoral push to rapidly increase infrastructure development; much of it relying on funding from multilateral development banks. In Africa, this raises questions about which financial institutions are active, where investments are located, and what policies exist to protect ecological connectivity and other conservation values. With billions of dollars in investments poised to transform many of the landscapes of the continent, governments, transport planners, and NGOs have the opportunity to shape financial institution investment strategies that avoid ecosystem fragmentation, disruption of wildlife movement, and reduce human and wildlife mortality.

In Africa, over a dozen multilateral development banks are investing in linear transportation infrastructure. The resulting projects, while meeting social needs, might cause significant harm to landscapes and biodiversity. Therefore, it is critical to understand the scope of infrastructure development and employ best-practices to mitigate the impacts on humans and nature.

This poster presentation will summarise current levels of investment by multilateral development banks in infrastructure in sub-Saharan Africa. It will highlight the policies and guidelines in place to proactively manage potential adverse impacts of linear infrastructure development on biodiversity. We review the types of policies and the strength of policy enforcement as delineated in each bank's working documents, when available. Based

on this review, we highlight specific examples of best practices, like explicitly including habitat corridor and landscape connectivity measures as biodiversity conservation actions that mitigate the impact of infrastructure development on wildlife.

Efficient construction of wildlife crossings

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In Spain, several thousand of over- and underpasses have been built along linear infrastructure to allow fauna to cross highways and railway tracks enclosed by perimeter fences. It is important to know whether these structures have the appropriate design for small, medium and large-size vertebrates, and ultimately whether they really facilitate ecological connectivity across an area that has been fragmented by transport infrastructure.

During 2015, a sampling of 940 Universal Transverse Mercator (UTM) 1x1 km quadrats was carried out across Spain, in areas designated as priority defragmentation zones, by the Ministry of Agriculture, Fisheries, Food and Environment. Within these grids, 1,358 crossing structures were identified and characterised. The parameters chosen to characterise them included their dimensions, the floor material, whether or not they had dry lateral ledges to cope with underpass flooding, whether the perimeter fences were correctly installed and whether there were obstacles that could hinder passage to or from the entrance or exit of the structure, amongst others. Only 8.6% of the structures complied with the characteristics required for fauna crossings, all of them viaducts. The survey also noted the percentages of structures requiring low, medium or high adaptation effort to make them suitable for fauna crossings, grouped into types: ecoducts, wildlife overpasses, multi-use overpasses, viaducts, underpasses for medium and large vertebrates, multi-use underpasses, underpasses for small vertebrates and culverts.

Development of transportation and protection of fauna in the Carpathians

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Within Europe, the Carpathian Mountains region is still an area of unique natural values. Due to a low level of fragmentation, all three species of European large carnivores (brown bear, Eurasian lynx and wolf) still reside in the area. However, the rapid development of transport infrastructure and associated traffic has increased in the Carpathians over the past two decades and some parts of the region have already lost their original connectivity.

In response to this, the Carpathian Convention prepared a Protocol on Sustainable Transport and has initiated two international projects to conserve connectivity. Within these projects, a network of wildlife corridors across the Carpathians is currently being delineated and Guidelines for the Sustainable Development of Transport in the Carpathians are being drafted. These guidelines will provide recommendations to ensure permeability of transport infrastructure for fauna, as well as measures to reduce mortality within the Carpathian region. Standards for monitoring the impact of transportation on fauna and monitoring the effectiveness of implemented measures will also feature as an important part of the guidelines under preparation.

TRIEKOL – Swedish research on applied road and rail ecology

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TRIEKOL – Applied Road and Rail Ecology is a Swedish research program focusing on the impact of transport infrastructure on biodiversity conservation and landscape ecology. The aim of the research is to develop knowledge and methods that can help the transport sector to maintain and, where possible, improve the ecological functions and qualities of the landscape. The program encompasses two main themes: i) Animals – dealing with the impacts on vertebrate populations, such as wildlife accidents, movement barriers and noise disturbance, and ii) Infrastructure habitats – dealing with the biodiversity directly related to the vegetation in road and railway areas, such as plants, insects and other invertebrates, and pollen/nectar resources. Full scale construction, maintenance and retrofitting of roads and railways are used as “experiments” in a Before-After-Control-Impact (BACI) approach, and field methods include, i.e., wildlife tracking in bridges and passages, population density census, species inventory and vegetation characterisation. The research is funded by the Swedish Transport Administration (STA), and the results shall help the transport sector in prioritising and adopting cost-efficient conservation actions. The close cooperation with practitioners (officials, consultants, NGOs) secures that the research results are swiftly and correctly implemented, for example in guidelines, new investment projects and maintenance of existing roads and railways. TRIEKOL was started in 2009 and the current program period runs from 2017 through 2022.

TasNetworks collaborative approach to managing the impact of Tasmania’s electricity network on threatened raptors

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TasNetworks owns and operates the transmission and distribution networks for Tasmania, consisting of over 22,000 km of power lines supplying electricity to the Tasmanian community. The majority of these power lines cross agricultural and forested land, posing a particular electrocution risk to the Endangered Tasmanian Wedge-Tailed Eagle (WTE; *Aquila audax fleayi*); an iconic species to Tasmanians. Also impacted are the Endangered Grey Goshawks (*Accipiter novaehollandiae*) and Vulnerable White-bellied Sea-eagles (*Haliaeetus leucogaster*). The limited visibility of conductors and easy perching provided by the poles has resulted in TasNetworks recording 29 WTE electrocutions in 2017/18, from an estimated population of approximately 1000 individuals.

The impact of electricity infrastructure is not only TasNetworks’ most significant environmental impact, but also presents a significant reputational and brand risk to the business, threatening the business’s ‘social licence’. As co-existence between WTEs and the electricity network is an unavoidable, ongoing challenge, TasNetworks developed a Threatened Bird Strategy in 2016 with the aim to materially reduce their impact on threatened Tasmanian birds.

The strategy has a holistic design of three core components; building knowledge and awareness, mitigating infrastructure risk, and voluntarily offsetting residual impact. Implementation of the strategy using a collaborative approach, including engaging and partnering with key external stakeholders, undertaking community engagement, and ensuring strong cross-functional collaboration internally within TasNetworks, has yielded positive results. An increase in reporting of incidents and

near-misses, and a reduction in negative media coverage, has enabled the implementation of asset management solutions resulting in a reduction in repeat incident locations and the overall risk to raptors.

Guide for the prevention and mitigation of the electrocution of fauna by power lines in Costa Rica

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Costa Rica hosts 5% of the world biodiversity, but, as with most countries, linear infrastructure has major negative impacts on biodiversity, particularly transmission lines. As a country, we are working to measure and reduce the impact of electricity distribution activities on wild animals. Costa Rica's government, in association with electricity companies, has developed a guide to reduce mortalities caused by power lines. This official guide promotes and demands that companies in Costa Rica implement activities and devices to reduce injuries and death to wild animals from electrocution. Companies have to provide data about electrocuted wildlife incidents and the actions taken to reduce new episodes and finally, create plans to attend and rescue wild injured animals and check results from the monitoring devices, such as bridges and anti-scaling devices. This instrument is a national effort to reduce the impact detected in the forested and protected areas of the country, produced by the electric distribution lines. Species that appear most vulnerable to electrocution are monkeys, sloths, squirrels, kinkajous, coatis. The Costa Rican government published regulations to make the guide implementation mandatory to the electric Costa Rican companies. This year we are working to monitor this implementation and measure the real impact of electric lines in wild animals.

Wildlife road traffic accidents: a standardised protocol for counting flattened fauna

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Previous assessments of wildlife road mortality have not used directly comparable methods and, at present, there is no standardised protocol for the collection of such data. Consequently, there are no regionally comparative statistics documenting roadkill rates. In this study, we used a combination of experimental trials and road transects to design a standardised protocol to assess roadkill rates on both paved and unpaved roads. Simulated roadkill were positioned over a 1 km distance, and trials were conducted at eight different speeds (20-100 km.h⁻¹). The recommended protocol was then tested on a 100 km transect, driven daily over a 40-day period. This recorded a total of 413 vertebrate roadkill, comprising 106 species. We recommend the protocol be adopted for future road ecology studies to enable robust statistical comparisons between continental studies.

Using citizen science to survey roadkill at wide spatio-temporal scales: the example of South Africa

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The work of the Endangered Wildlife Trust (EWT) has improved our understanding of the impacts of road infrastructure on wildlife in South Africa. Repeated road surveys conducted by trained personnel are the ideal way to monitor the impacts of roadkill on wildlife populations but are impractical to conduct over large areas. However, the development of public participation for data collection (often dubbed 'citizen science') has facilitated monitoring at broad spatial and temporal scales, far beyond the limit of traditional field studies. In January 2014, we launched a national public awareness campaign to report roadkill sightings through various social media platforms and a smartphone app. To date, we have collected almost 20,000 roadkill data points, with the assistance of over 200 volunteers from across the country. From these data, we can identify problem species and sites, and develop and implement targeted measures to reduce roadkill.

Protecting the protected: reducing wildlife-vehicle collisions through changing driver behaviour in the Kruger National Park

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Reports from various social media platforms have indicated public concern for roadkill incidences inside many protected areas of South Africa, but specifically, Kruger National Park (KNP). In 2018, we initiated an assessment of driver behaviour within KNP to determine why roadkill still occurs despite low speed limits (50 km/h maximum), and it being a protected area. Preliminary work undertaken in 2018 showed that traffic volumes and excessive speeding are problematic in KNP.

During the financial year (2016 / 2017), a record number of 1,817,724 people visited KNP, exceeding recommendations from early ecological studies, which stated that not more than 250,000 visitors should be allowed access to the park per annum. This increase in visitors has the potential to apply pressure on the environment, through increased traffic volumes, and poor driver behaviour.

In an effort to improve driver behaviour, our project examines the effectiveness of various wildlife-warning signage (WWS) as a mitigation measure to reduce the rates of roadkill within KNP. Using a dummy snake (our response variable), and traffic monitoring devices, we will assess various scenarios on both paved and unpaved roads, with and without various WWS. Driver response to the dummy snake will be monitored, including a 'hit' or 'miss' of, and whether they stop, slow down, swerve, or ignore the dummy snake. Four WWS will be used based on signs created for previous research undertaken in other South African protected areas, as well as signs currently in use on our roads. The outcomes of our research are expected to assist KNP with their Traffic Management Plan.

Does body size affect the likelihood of a snake becoming roadkill?

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The transportation of resources and human travel forces road systems to increase, often resulting in the destruction of the natural environment. Roads affect animals through habitat destruction, movement restriction and causing mortalities due to collision with vehicles. This study was conducted in the northern border between Kwazulu-Natal and Mpumalanga, South Africa, and aims to investigate (i) whether the snake body size increases its probability of becoming roadkill and (ii) whether vehicle drivers deliberately run over the snakes. This was achieved by using black, rubber snakes of three different body size classes and placed either in direct vehicle pathway, or closer to the road verge. This was to assess whether drivers firstly observed the fake snake, and what their reaction was (e.g. hit, miss, swerve, slow down, stop, or deliberately kill). The fake snakes placed in the middle of the road were intentional killed more frequently than those placed on the verge. There was a statistically significant association between the driver reaction and the different body-sized snake classes ($X^2 = 17.43$, $d.f = 4$; $p < 0.05$) with the large-sized snake being hit most often. The outcomes of this study show that drivers are generally vigilant on regional roads, but some drivers will deliberate drive over wildlife on the road.

Linear infrastructure development and lion conservation in northern Kenya

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Kenya is home to about 2,000 lions (*Panthera leo*). Northern Kenya, including the Samburu-Isiolo ecosystem, is estimated to host about 200 lions. Lions face a plethora of threats including retaliatory killing due to livestock depredation, reduction in prey numbers due to land degradation, and encroachment into protected areas. A rising threat to lions in the 21st century is the loss of habitat through development and urbanisation. Linear infrastructure development in Kenya, as with much of Africa, is experiencing a boom, with large-scale projects planned during the next two decades. Recently, the Kenyan government embarked on a project to improve the country's economy and upscale livelihoods leading to the initiation of Lamu Port-South Sudan-Ethiopia-Transport (LAPSSET) corridor project - comprising a road, railway, pipeline, airport and a resort city - cutting through the biodiversity rich region of Samburu and Isiolo.

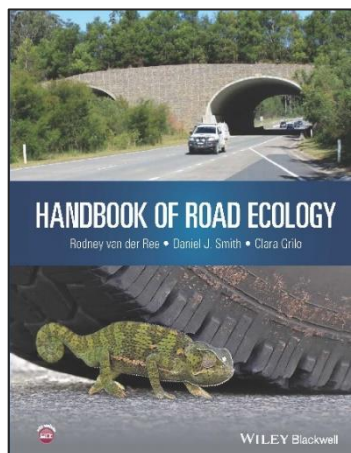
Northern Kenya is predominantly occupied by pastoralists whose lifestyle is generally more compatible with wildlife conservation. Whilst these proposed developments are likely to raise living standards for some communities in this region, the landscape changes may result in the loss of critical wildlife habitats and corridors, and adversely affect people's way of life. While the potential socio-cultural and economic impacts of the LAPSSET project have not been studied extensively in this region, my primary focus will be on the interface between ecology and linear infrastructure, specifically for lions. The intention is that this study will form part of a PhD in a collaboration with Ewaso Lions, a local NGO in northern Kenya.

Thanks for coming!



STRATEGIC PARTNERSHIP

BOOKS



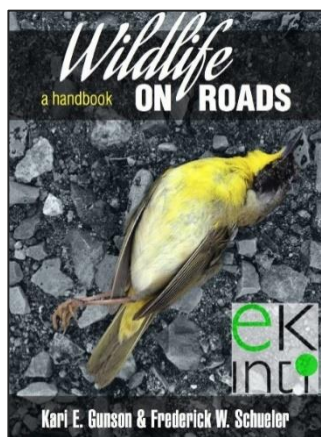
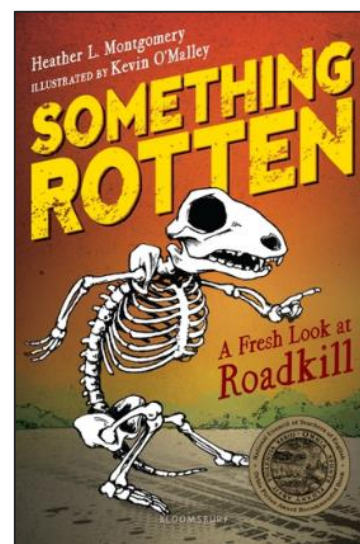
A limited number of copies of the international award-winning **Handbook of Road Ecology** will be made available for ACLIE delegates at half-price. The Handbook of Road Ecology is an authoritative volume with contributions from over 100 authors from 25 different countries, and addresses issues from planning through to design, construction, maintenance and monitoring and evaluation. (The Handbook was awarded the IENE Project Award in 2016 and won The Wildlife Society Edited Book of the Year 2016. Please order via the ACLIE website (<https://www.eiseverywhere.com/ehome/321729/755912/>). Books can be collected from the registration desk during the ACLIE conference. More info about the Handbook is available at www.handbookofroadecology.org

Something rotten: a fresh look at roadkill

Author: Heather L. Montgomery / Illustrator: Kevin O'Malley / Publisher: Bloomsbury Children's / ISBN: 9781681199009 / Formats: Hardback, Kindle / Pages: 176 / \$10.19

Purchasing Options: www.Amazon.com, www.Bloomsbury.com

"With wry humor, gory detail, and great enthusiasm, this book is not for the faint of heart, but be prepared to laugh along the way and to learn a lot. . ." *School Library Journal*



Kari Gunson founded Eco-Kare International in Ontario, Canada in 2009 in response to an urgent need to implement wildlife-friendly solutions into road networks. Previous to Eco-Kare, Kari worked in Banff National Park as part of a research team, monitoring the effectiveness of Canada's first wildlife overpasses and underpasses - one of Canada's greatest conservation success stories - that continues to be replicated. Kari is an active writer, and has recently engaged in self-publishing her first book with co-author Dr. Fred Schueler titled **'Wildlife on Roads'** available at <https://eco-kare.com/>. This handbook guides accurate data collections for application to road mitigation solutions.



Roadkill Hotspot