# IENE 2016

## Integrating Transport Infrastructure with Living Landscapes

Organisers

Cerema

FRB Fondation pour la recherche sur la biodiversité

Co-organisers

République Française – Ministère de l'Environnement, de l'Énergie et de la Mer

République Française – Ministère des Affaires Étrangères

Université Lyon III Jean Moulin

ADEME – Agence de l'Environnement et de la Maîtrise de l'Énergie

IENE 1996 - 2016

20th anniversary

2016

Lyon

August 30th September 2nd, 2016

Lyon - France

IENE 2016 International Conference
August 30th - September 2nd 2016
Lyon, France

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This is the version of the book,
which will be available for download on the conference
website: http://iene2016.iene.info.

# IENE 2016

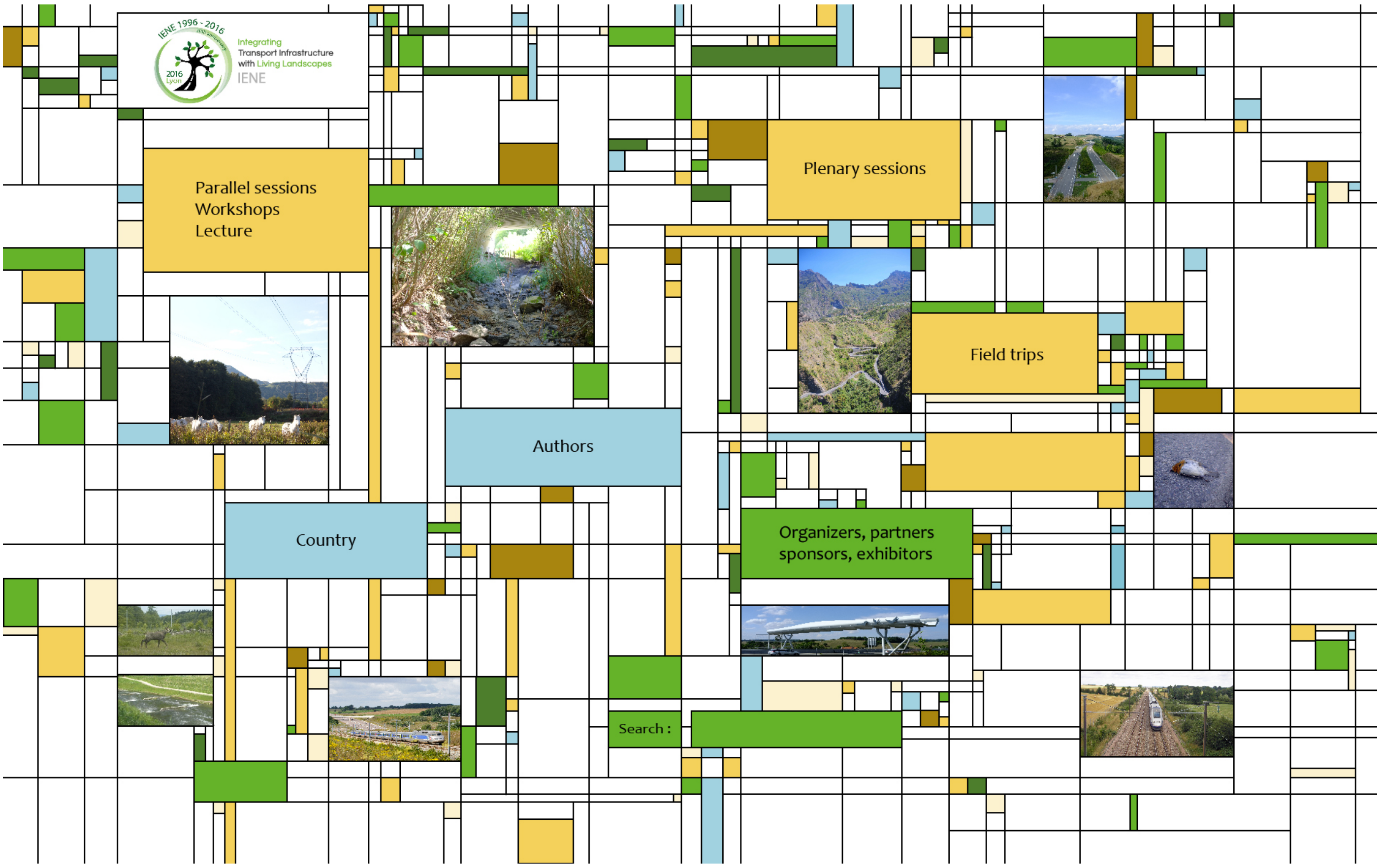
## 5th IENE International Conference on Ecology and Transportation

## August 30th - September 2nd, 2016
## Lyon, France

# More information about the IENE 2016 Conference?

If you need further information concerning the IENE 2016 Conference in Lyon
*(Programme, Location & Venue, Organisation & Contacts, etc.),*
please visit our website:

**http://iene2016.iene.info/**




## www.postconf.iene.info

For the IENE’s 20th birthday, the IENE 2016 organisation team is creating a post conference website!

This platform of information will be a unique opportunity for you to communicate, share and benefit from valuable data on road ecology!

You will be able to enjoy surfing and working with this website from November 2016!

The IENE adventure continues!

# Table of Contents

# IENE Membership

## IENE – Harmonising Transportation and Nature

### Infra Eco Network Europe

IENE stands for Infra Eco Network Europe. It is a network of experts working with various aspects of transportation, infrastructure and ecology.

The network was initiated in 1996 to provide an independent, international and interdisciplinary arena for the exchange and development of expert knowledge with the aim to promote a safe and ecologically sustainable pan-European transport infrastructure.

IENE arranges international conferences, national workshops and symposia, initiates collaboration projects and helps answering questions that require a joint international expertise.

This year, 2016, we celebrate the 20th anniversary of IENE!

### IENE conferences

IENE International Conferences on Ecology and Transportation provide a recurring interdisciplinary forum for the exchange of current research, knowledge and practical experience between the sectors of environment and transport, between scientists and practitioners, in Europe and worldwide.

The conferences aim at presenting cutting-edge research, identifying urgent questions and problems, discussing effective solutions and outlining the paths for upcoming activities in transport and infrastructure ecology.

Each IENE international conference develops its specific thematic focus, but also allows discussions on a broader spectrum of topics from within the general scope of IENE.

### Become a member of IENE

The IENE membership is individual and entirely free of charge. It entitles you to receive information from the network and the secretariat, and to contribute to the knowledge exchange between members. To become a member of IENE, please visit the website (www.iene.info/become-a-member).

### More information

Interested in more information about IENE and the activities of the network so far? Please visit our website: www.iene.info or contact the Secretariat on info@iene.info.

# More information

Visit our website: www.iene.info or contact the IENE

Secretariat: info@iene.info

You can also be part of the IENE community by joining our private Facebook Group and discuss about the conference with other IENE 2016 participants.

This is the opportunity to discuss about more practical information such as tips for travel companies, hotels or even the best restaurants in Lyon!

You can also follow us on Twitter: @IENE2016 to be updated on the last news about the conference.

Moreover, as mentioned before, a website will be available after the IENE 2016 conference, with abstracts, photos, videos, and much more, for exhaustive pieces of information about IENE conferences.

# IENE – Harmonising Transportation and Nature

## IENE 2016 – Lyon, France

## “Integrating Transport Infrastructures with Living Landscapes”

The IENE 2016 conference emphasises the “Integration” of transport infrastructure with its surrounding environment in a dynamic and “Living Landscape”. In Europe and in a majority of the western world countries, most infrastructure were built decades ago at a time when protection of the environment was not a priority. The recent raise in ecological awareness has fostered the development and adaptation of methods to design better integrated infrastructures that limit fragmentation and account for ecosystems’ sustainability. Transportation and infrastructure are significant drivers of the global biodiversity loss. Even though roads, railroads, waterways or energy networks typically occupy a small portion of an area, they affect the entire landscape by modifying natural processes, altering surrounding habitats through soil destruction, pollution, noise and introduction of alien species and isolating populations and causing the death of many wild animals.

Solutions do exist to avoid or mitigate the pressure on the environment and to preserve ecosystem services. Integration, though is not simply reducing negative effects and enhancing potential positive ones – it requires a wider perspective and a clear strategy for transforming the transport networks. These solutions can be found in more holistic and comprehensive transdisciplinary approaches or in techniques such as ecological engineering, by recreating habitats or connectivity, reducing traffic noise for animals, control of alien invasive species etc.

Such measures can and should be implemented as a standard in infrastructure development, maintenance or adaptation. Their effectiveness depend on the interplay between the transport sector and other sectors of society. Consultation, communication, knowledge transfer, and public education are just as essential here, as legal frameworks, appropriate policies, technical development and environmental science. European policy (e.g., Green Infrastructure) is clearly developing in this direction, recognising the transport sector’s endeavour to create a greener, sustainable future.

IENE provides an interdisciplinary arena through it s conferences and workshops with the aim to develop international collaboration in research and practice, enhance the exchange of knowledge between disciplines and develop harmonised standards and procedures that can be referred to by international scientists, practitioners, planners and decision makers.

The IENE 2016 international conference emphasises that transport infrastructure can be planned, designed and adjusted as an ecologically well-adapted, safe and efficient system. IENE, together with the French Ministry of Environment, Energy and Sea, the French Research Foundation for Biodiversity, the Centre For Studies and Expertise on Risks, Environment, Mobility, and Urban and Country planning are proud to welcome you to the IENE 2016 Conference in Lyon, France.

For the 20th anniversary of IENE, no less than 260 scientific and technical papers will be presented to 400 participants from 46 countries, illustrating the growing success of IENE conferences. Africa, the continent which has the biggest potential of transport infrastructures construction, will have the honour this year, beneficiating of a special workshop and being represented by 10 participants from 7 african countries.

**Welcome!**

**Anders Sjölund**

**IENE**

# Useful Information

## Insurance

The organizers of the conference will not provide insurance and do not take responsibility for any loss, accident or illness that might occur during the conference or in the course of travel to or from the meeting site. It is, therefore, the responsibility of the participants to check their coverage with their insurance provider.

## Electrical equipment

The normal electric current in France is 230 volts AC in 50 cycles, and plugs and sockets may differ from those in other parts of the world, so travellers should bring adapters or transformers for electrical appliances such as shavers, computers etc.

## Telephone numbers

Emergency (ambulance, police, fire brigade) ☎ 112

## Currency, credit cards, payment

The monetary unit in France is the Euro. Bank notes are printed in values of 5, 10, 20, 50, 100, 200 and 500 Euros, coins in 1, 2, 5, 10, 20 50 cents and 1 or 2 euros. You can get cash with your Visa, MasterCard, Maestro or Cirrus card at any DAB, called "Distributeurs automatiques de billets". DAB's are available all over the city.

Major credit cards (some restriction may apply to American Express) are widely accepted throughout France at banks, hotels, stores, restaurants, taxis, car rental companies, and for air, ship and rail tickets. Please note that in order to pay or withdraw cash with your credit card it requires that you have a card with chip and PIN (Personal Identification Number). The older magnetic-stripe cards won't work.

Travellers' cheques are generally accepted as payment throughout France, and change will be given in Euros. Please note that a nominal fee is charged when using the cheques as payment.

## Sessions' language

Sessions will mainly be held in English. Simultaneous translation will be provided for French/English talks in Room C

## Food

Adapted lunches are provided for special diets and allergies mentioned in your registrations (e.g. Special Requests)

## For more information about France, travel advice, visit the website

http://www.en.lyon-france.com/
or http://www.int.rendezvousenfrance.com.
Some basic French vocabulary: http://ielanguages.com/french1.html


# Lyon

## A brief overview of the culture and history of the city of light

The history of Lyon begins on Fourvière Hill, where vestiges of the original Roman city (Lugdunum, meaning the 'City of Light') are still evident. Founded in 43BC by Roman consul Lucius Munatius Plancus, it went on to become one of the most important cities in Gaul and for more than 300 years, was one of the biggest trading towns in the Empire.

In the years that followed the Roman collapse, Lyon retained its premier political position under a succession of conquering rulers; first as part of Lotharingia, then the Kingdom of Burgundy and finally as a part of the Holy Roman Empire. While not much architecture from this period remains, the buildings created after Lyon was annexed by Phillip le Bel of France in 1342 do.

Even more can be seen from the 15th century, in particular the Renaissance period, when Lyon enjoyed a rebirth of its own. This came as a result of its increasing importance as a place for trade under the auspices of the Dukes of Savoy, as well as its pre-eminence in the silk making and printing businesses.

Lyon's pre-eminence in the silk trade continued well into the 20th century, only really coming to an end in the middle of the 20th century.

**Lyon, the city of light**

The Festival of Lights is one of Lyon's most famous Festivals to date when the city definitely lives up to its title as the city of lights.

Designers from all over the world partake in the wonderful event. Video, Music and Sound effects are used to accompany the vibrant images dotted around the city.

The exceptional spectacle showcases the city at its best and incorporates buildings, rivers and parks into the show. This enables tourists and locals alike to experience many different routes and areas throughout Lyon over the 4 day event in the beginning of December.

http://www.en.lyon-france.com/Agenda/Unmissable/Lyon-Festival-of-Lights

**Did you know?**

• Croix Rousse Hill, the former home of the city's silk workers, is crisscrossed with passages known as traboules.

• St Blandina was martyred in the city's Roman Amphitheatre of the Three Gauls.

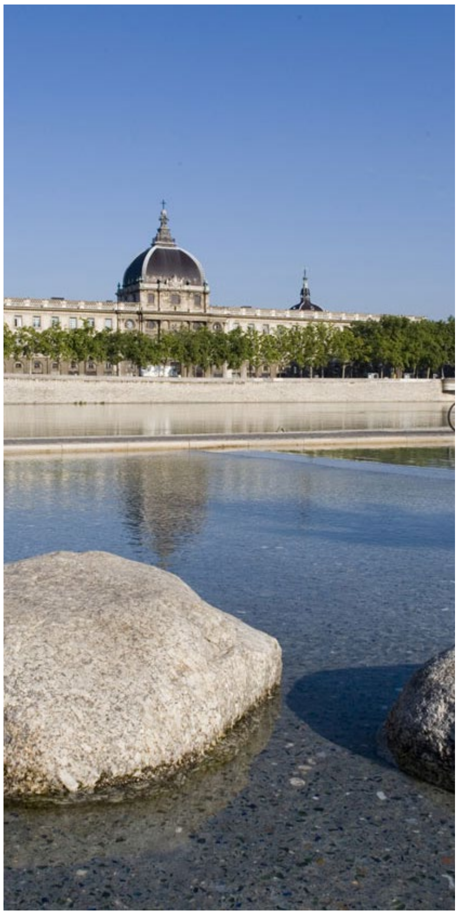
http://www.worldtravelguide.net/lyon/history

Wednesday August 31st
Thursday September 1st
Friday September 2nd
Index of authors

ONLYLYON
TOURISME ET CONGRÈS










# Organisation

## Host

IENE 2016 international conference is funded and co-organised by the French Ministry of Environment, Energy and Sea in collaboration with IENE and the organisers, the French Research Foundation for Biodiversity (FRB) and the Cerema (Centre For Studies and Expertise on Risks, Environment, Mobility, and Urban and Country planning).

## Organisation Committee

The OC contains members of the hosting and funding partners of the conference, the IENE Steering Committee, the IENE Secretariat, the Program Committee and the Conference Secretariat

**Chair:** **Philippe Courtier**, Ministry of Environment, Energy and Sea, representing the hosting authority

**Vice:**

**Anders Sjölund** Swedish Transport Administration representing the IENE Steering Committee
**Yannick Autret** - Ministry of Environment, Energy and Sea - representing the Program Committee and the Conference Secretariat
**Anne-Marie Le Bastard** - Foundation for Research on Biodiversity - representing the Program Committee and the Conference Secretariat
**Eric Guinard** - Cerema - representing the Program Committee and the Conference Secretariat
**Justine Guiny** - Foundation for Research on Biodiversity and Ministry of Environment, Energy and Sea - Representing the Program Committee and the Conference Secretariat
**Virginie Billon** - Cerema - representing the Program Committee
**Romuald Loridan** - Ministry of Environment, Energy and Sea - representing the Program Committee

## Conference Secretariat

The Conference secretariat (CS) is responsible for all practical, economical and technical tasks within the conference.

**Chair:**

**Anne-Marie Le Bastard** (Foundation for Research on Biodiversity)
**Yannick Autret** (Ministry of Environment, Energy and Sea)
**Justine Guiny** (Foundation for Research on Biodiversity and Ministry of Environment, Energy and Sea)
**Eric Guinard** (Cerema) – website
**Virginie Billon** (Cerema) – field trips

# Programme Committee

| | |
|---|---|
| Alex Bager | Brazilian Road Ecology Center |
| Anders Sjölund | Swedish Transport Administration |
| Andreas Seiler | SLU |
| Annika Jägerbrand | VTI |
| Antonio Mira | University of Evora |
| Bjorn Iuell | STATKRAFT |
| Bruno Villalba | Agroparistech |
| Carme Rosell | Minuartia |
| Charlotta Faith-Ell | WSP |
| Christer Moe Rolandsen | NINA |
| Clara Grilo | University of Aveiro |
| Claude Miaud | CEFE |
| Daniel Smith | University of Central Florida |
| Darryl Jones | Griffith University |
| Denis François | IFSTTAR |
| Edgar Van der Grift | Alterra |
| Elke Hahn | Federal Ministry for Transport |
| Eric Guinard | CEREMA |
| Filippo Favilli | EURAC |
| Fraser Shilling | Road Ecology Center, UC-Davis |
| Jacques Baudry | INRA |
| J-O Helldin | Calluna AB |
| Jochen Jaeger | Concordia University |
| Lazaros Georgiadis | |
| Manuela Panzacchi | NINA |
| Marco Dinetti | Ecologia Urbana |
| Marguerite Trocmé | Ofrou |
| Marita Böttcher | Federal Agency of Nature Conservation, DE |
| Mark Hörstermann | BUND |
| Mathias Herrmann | OEKO-LOG |
| Mattias Olsson | Enviroplanning AB |
| Michal Bíl | Transport Research Centre |
| Nuria Selva | Polish Academy of Sciences |
| Paul J. Wagner | Washington State Department of Transportation |
| Philippe Thiévent | CDC Biodiversité |
| Rodney Van Der Ree | University of Melbourne |
| Romain Sordello | MNHN |
| Sylvie Vanpeene | IRSTEA |
| Tony Sangwine | Highways Agency |
| Vaclav Hlavác | AOPKCR |
| Virginie Billon | Cerema |
| Wendy Collinson | Endangered Wildlife Trust |
| Yannick Autret | MEDDE |

## Organisers

## Co-organisers

## Sponsors and field trips partners

# Partners

# Exhibitors

# Integrating Transport Infrastructure with Living Landscapes

## Programme at a glance

| Time | Tuesday 08/30 | Wednesday 08/31 | Thursday 09/01 | Friday 09/02 | Time |
|---|---|---|---|---|---|
| 08:00 | **Field Visit 1 - Switzerland** (Departure Lyon or Geneva - Arrival Lyon)<br>**Field Visit 2 - A 89** (Departure and Arrival Lyon)<br>**Field Visit 3 - Life Corridor Isère** (Departure and Arrival Lyon)<br>**Field Visit 4 - RTE Power Lines and A7** (Departure and Arrival Lyon) | **Registration - Welcoming Desk** | **Registration - Welcoming Desk**<br>**Plenary 3** – Traffic verges and biological diversity: Realized possibilities, realities and prospects - **Heinrich Reck - Room C** | **Registration - Welcoming Desk**<br>**Plenary 5** – Limiting the environmental impacts of the tropical infrastructure tsunami - **William F.Laurance - Room C** | 08:00 |
| 09:00 | | **Opening Session - Room C** | **Plenary 4** – Interaction and adjustment: essential concepts in biodiversity evolution processes for landscapes fragmented by infrastructure - **Yves Luginbühl - Room C** | **Plenary 6** – Implementation of Green Infrastructure in the EU - **Jos Jonkhof - Room C** | 09:00 |
| 10:00 | | **Break** | **Break** | **Break** | 10:00 |
| 11:00 | | **Plenary 1** – The evolution of Road Ecology reflected through 20 years development of the Infra Eco Network, Europe (IENE) - **Anders Sjölund - Room C**<br>**Plenary 2** – Bern and Landscape conventions: crossed points of view - **Maguelone Dejeant-Pons and Iva Obretenova - Room C** | 2.1 Wildlife crossing structures - Part 2/3 - **Room L**<br>2.2 Guidelines and experiences - **Room D**<br>2.3 Bats and infrastructure crossing - **Room C**<br>2.4 Green infrastructure networks - **Room K**<br>2.5 How to implement ecological restoration in civil engineering sector? The power of participation - **Room 3** | 3.1 Wildlife crossing structures - Part 3/3 - **Room 3**<br>3.2 No-Net-Loss Strategy and compensatory measures - marine biodiversity - **Room D**<br>3.3 Managing vegetation along infrastructure verges - Part 2/2 - **Room K**<br>3.4 Ecological engineering - **Room L**<br>3.5 A French policy of ecological network : the Green and Blue Infrastructure (la Trame verte et bleue) - **Room C** | 11:00 |
| 12:00 | | **Lunch and Poster session 1** | **Lunch and Poster session 2** | **Lunch** | 12:00 |
| 13:00 | | | | 3.6 Wildlife monitoring and field studies - Part 3/3 - **Room L**<br>3.7 Roadkill and citizen science: examples from Africa, Europe and USA - **Room C**<br>3.8 Habitat and Conduit - **Room D**<br>3.9 Integration with Landscape plans - Part 2/2 - **Room K**<br>3.10 Wildlife and Railway workshop - **Room 3** | 13:00 |
| 14:00 | **Field Trip 5 - Banks of Saône River renaturation (free visit - Departure and Arrival Lyon)** | 1.1 Aquatic and terrestrial fauna passages - **Room D**<br>1.2 Infrastructure and biodiversity in Asia - **Room C**<br>1.3 Wildlife crossing structures - Part 1/3 - **Room L**<br>1.4 Managing vegetation along infrastructure verges - Part 1/2 - **Room K**<br>1.5 KDE+ A method for identification of animal–vehicle– collision hotspots - **Room 3** | 2.6 Infrastructure and biodiversity roadkill in Africa - **Room C**<br>2.7 Wildlife monitoring and field studies - Part 2/3 - **Room L**<br>2.8 Integration with Landscape plans - Part 1/2 - **Room K**<br>2.9 No-Net-Loss Strategy and compensatory measures - **Room 3**<br>2.10 Interactions between linear Infrastructure and territories: A new European handbook! - **Room D** | **Break** | 14:00 |
| 15:00 | | **Break** | **Break** | | 15:00 |
| 16:00 | | 1.6 Infrastructure, ecosystems and landscape : research and action in France - **Room C**<br>1.7 Tree avenues and biodiversity - **Room D**<br>1.8 Wildlife monitoring and field studies - Part 1/3 - **Room L**<br>1.9 New prevention technologies - **Room K**<br>1.10 Policy and Strategic planning: infrastructure bundling - **Room 3** | 2.11 Natural revegetation, road side management and ecological restoration - **Room C**<br>2.12 Infrastructure, amphibians and reptiles (Special tribute to Miklos Puky) - **Room D**<br>2.13 Global Carcass & Accident Reporting Systems - **Room L**<br>2.14 Systematic reviews and maps: transport infrastructure - perspectives and challenges - **Room K** | 3.11 Wildlife-vehicle accidents - **Room K**<br>3.12 Vision 2050: Ecologically Sustainable Transport System - **Room D**<br>3.13 Evidence of efficacy - **Room L**<br>3.14 Habitat and Conduit: Effects on pollinators - **Room C** | 16:00 |
| 17:00 | | | | **Closing session - Room C** | 17:00 |
| 18:00 | **Unformal get together at Lyon Metropole Building with light food and refreshments** | 1.11 Side Event - renaturation under High voltage line - **Room C**<br>1.12 Side Event - Tree Avenues Awards 2016 - **Room D**<br>1.13 Wildlife detectors to reduce animal-vehicle collisions: sharing experience - **Room L**<br>1.14 Towards global guidelines for infrastructure development - a project proposal - **Room K**<br>1.15 SIDE EVENT - Roadkill reporting systems around the world - experience sharing **Room 3** | **IENE Declaration**<br>**IENE General Assembly - Room C** | | 18:00 |
| 19:00 | **IENE steering committee** | **Free time / Dinner** | **Gala Diner**<br>**IENE Awards**<br>**Poster Award** | | 19:00 |
| 20:00 | **Free time / Dinner** | | | | 20:00 |

**Networking meeting room (salon des symboles)**

**Room C: simultaneous translation (French/English - English/French)**

- Workshops
- Talk sessions
- Side events
- Plenary sessions

# Detailed Programme

## Tuesday August 30th, 2016

| Id | Start/end | Room | Session | Presentations and Authors |
|---|---|---|---|---|
| FT1 | 06:45 AM - 06:30 PM | FT1 | Field trip 1 - Highway and railway integrations into the ecological networks of the Swiss Plateau (Vaud canton) - Marguerite Trocmé | |
| FT2 | 07:30 AM - 05:30 PM | FT2 | Field trip 2 - West of Lyon – Environnemental integration of a new motorway: the A89 in the Massif Central - Philippe Chavaren | |
| FT3 | 07:30 AM - 06:00 PM | FT3 | Field trip 3 - Recreation of ecological networks, mutualized compensatory measures and visit of the National Natural Reserve of the Grand Lemps peatland - Anne-Sophie Croyal, Dominique Pallier, Sandra Quivet, Yves Urbain, Grégory Maillet | |
| FT4 | 07:30 AM - 06:00 PM | FT4 | Field trip 4 - Reconnecting ecological networks through existing infrastructures: motorway A7 and High voltage line in the Drôme - Cedric Heurtebise, Michel Aujoulat | |
| FT5 | 02:00 PM - 05:30 PM | FT5 | Field trip 5 - Banks of Saône River renaturation - Nélia Dupire | |
| | | | Unformal get together at Lyon Metropole Building with light food and refreshments<br>IENE steering committee | |

## Wednesday August 31st, 2016

| Id | Start/end | Room | Session | Presentations and Authors |
|---|---|---|---|---|
| | 08:00 | Atrium sud | Registration - Welcoming Desk | |
| OP | 09:00 AM -10:00 AM | C | Opening Session | |
| | | Cour sud | Break | |
| P1 | 10:30 AM -11:15 AM | C | The evolution of Road Ecology reflected through 20 years development of the Infra Eco Network Europe (IENE) - Anders Sjölund | |
| P2 | 11:15 AM -12:00 PM | C | Bern and Landscape conventions: crossed points of view - Maguelone Dejeant-Pons, Iva Obretenova | |

| Id | Start/end | Room | Session | Presentations and Authors |
|---|---|---|---|---|
| PS1 | 12:00 PM - 01:30 PM | Cour sud | Lunch and Poster session 1 | An International Comparison of AVC Clustering Patterns on Roads - Michal Bíl |
| | | | | Assess Ecosytem Services provided by Green Spaces along Linear Transport infrastructure: Exploratory approach - Labarraque dorothee |
| | | | | Assessing the importance of intersections between linear transportation infrastructures and fluvial corridors on plant diversity: first results on road bridges - Eric Tabacchi, Quentin Fernandez, Anne-Marie Planty-Tabacchi, Didier Alard, Blaise Touzard |
| | | | | Assessing the potential of linear infrastructure verges for conservation and dispersal of wild pollinators in landscapes - The PolLinéaire approach - Denis François, Violette Le Feon, Jean-François Bretaud, Eric Guinard, Mickaël Henry, Christophe Pineau, Bernard Vaissiere |
| | | | | Can linear infrastructure elements contribute to conservation of grassland biodiversity? - Erik Öckinger |
| | | | | Citizen's perceptions of ecosystem services in managed space on road interchanges in Abidjan (Côte d'Ivoire) - Bi Tra Aimé Vroh |
| | | | | Compensatory measures for Smooth Snakes during road construction in Sweden - Tim Hipkiss, Petter Bohman, Mats Lindqvist |
| | | | | Current state of road ecology in Japan - Yushin Asari, Takane Shikano, Miyuki Tanizaki, Misako Noro, Yoshiki Yamada, Hisashi Yanagawa |
| | | | | Detecting existing crossing structures with optimization potential for wildlife by calculating a Structure-Permeability-Index - Kim Krause |
| | | | | Development of landscape fragmentation in the Czech Republic - Dusan Romportl, Vladimír Zýka |
| | | | | Development of microsatellite marker for identifying Japanese squirrels-Noninvasive genetic sampling on the road - Yoichi Sonoda, Masatoshi Nakamura, Yusuke Ueno, Masahiko Matsue, Masao Kurihara |
| | | | | Do roads select their prey? A comparison of bird roadkill data with local availability - Sara Maria Santos, António Mira, Pedro Alexandre Salgueiro, Pedro Costa, Denis Medinas, Pedro Beja |
| | | | | Effects of habitats fragmentation in a human-dominated landscape (France) and mitigation measures to limit lynx (Lynx lynx) vehicle collisions - Alain Morand, Jean Carsignol |
| | | | | Evaluation of effects of the pairing between road and rail infrastructures on the functionning and the perception of the crossed territories - Angelique Godart, Charlotte Le bris, Jean Carsignol, Sophie Noiret, Depigny Bertrand, Agnès Rossot Darmet |
| | | | | Evidence of usage of Estonia`s first ecoduct by mammals - Maris Kruuse |
| | | | | Green Infrastructure Networks in Austria - Daniel Leissing, Horst Leitner, Roland Grillmayer, Gebhard Banko |
| | | | | How do we Positively Change Public Perception of the Importance of Infra Eco Solutions? - Camiel Meijneken |
| | | | | How to attenuate the barrier effect of linear infrastructures? A method for prioritizing existing crossings to improve wildlife regional connectivity. - Céline Clauzel, Anne Mimet, Jean-Christophe Foltête |
| | | | | Impacts on Wildlife Genetic Diversity in Road-Effect Zones - Karl Jamison Jarvis, Samuel A. Cushman, Paul Beier, Brett G. Dickson, Jason A. Wilder, Erin L. Landguth |
| | | | | Implementing a collision survey protocol over the national road network. Review and prospects after two years of monitoring - Bretaud Jean-Francois |
| | | | | Implementing local actions for biodiversity and extend them at European level : a feedback from LIFE Elia-RTE project - Simon de Voghel |

| Id | Start/end | Room | Session | Presentations and Authors |
|---|---|---|---|---|
| PS1 | 12:00 PM - 01:30 PM | Cour sud | Lunch and Poster session 1 | Integrating biodiversity into an intermodal transport hub project thanks to Eco-design - Pouchelle Hippolyte |
| | | | | Landscape analysis in the East Link projekt an important tool for sustainable ecology - Cecilia Kjellander, Kajsa Nilsson |
| | | | | Latest technologies to assess utilization of fauna underpasses by wildlife - Jonathan Jumeau, Yves Handrich |
| | | | | LIFE+ OZON - defragmentation of the Sonian Forest - Steven Vanonckelen |
| | | | | Over or under the road? – Effectiveness of some bat road crossing mitigation measures - Morten Christensen, Esben Terp Fjederholt, Julie Dahl Møller, Hans J. Baagøe, Morten Elmeros |
| | | | | Primary monitoring to small bridges and culverts used by wildlife along Qinghai-Tibet railway - Yun Wang |
| | | | | Road bund landscapes as habitat: a main asset for rodents in an intensive farming landscape - Jonathan Jumeau, Yves Handrich |
| | | | | Roadkill Data Collection using Citizen Science in Austria - Florian Heigl, Wolfgang Steiner, Carina Stretz, Kathrin Horvath, Franz Suppan, Thomas Bauer, Gregor Laaha, Johann G. Zaller |
| | | | | Safeguarding wild animals and vehicles on the main roads of Lithuania: an assessment of the effectiveness of measures - Linas Balčiauskas, Laima Balčiauskienė |
| | | | | Study of behavior of sika deer nearby railroad tracks and effect of alarm call - Minoru Shimura |
| | | | | The Dawei Road project: An international cooperation of IENE on sustainable planning of large linear infrastructure trans-boundary project in a Biodiversity Hotspot of Southeast Asia. - Lazaros Georgiadis |
| | | | | The promise and reality of using genetic techniques to quantify the impacts of linear infrastructure and evaluate the effectiveness of mitigation - Kylie Soanes |
| | | | | The use of crowd sourcing to conduct research and create support for wildlife crossings - Mark Van Heukelum, Anne Martine Kruidering |
| | | | | Use of the non-specialised structures as a wildlife passages, Lyulin Motorway, Bulgaria - Maria Nikolaeva Kachamakova, Diana Peneva Zlatanova |
| | | | | Using Citizen Science in French National Road Departments to collect data on wildlife roadkills. - Lucille Billon, Elisabeth Wattebled, Perrine Vermeersch, Romain Sordello, Julien Touroult |
| | | | | Viability of linking bridges in the area of environmental corridors in Germany - Udo Tegethof |
| | | | | Working for biodiversity on linear infrastructures : need of appropriate and efficient tools such as mapping system and stakeholder involvement - Simon de Voghel |
| | | | | Your Steps Towards Ecological Connectivity - The GreenAlps Project - Filippo Favilli, Isidoro De Bortoli |
| | | | | Defragmentation of the motorway “A63 Landes” for the critically endangered European mink: evaluation of the use and effectiveness of underpasses restored on existing hydraulic bridges - Christine Fournier-Chambrillon, Vanessa Maurie, Manon Batista, Romuald Hugues, Eric Barlet, Pascal Fournier |
| 1.1 | 01:30 PM - 03:00 PM | D | Aquatic and terrestrial fauna passages<br><br>Chair: Antonio Righetti | Design of fauna underpasses - Antonio Righetti |
| | | | | Effects on fish from sedimentation ponds for traffic run-off may be related to pah transfer from sediment to biota - Sissel Brit Ranneklev, Merete Grung |
| | | | | Fish, waterways and roads – the challenges of combining hydrology and dynamic systems with stationery and static infrastructure - Fabrice Ottburg, Matt Blank, Paul Wagner |
| | | | | Stream sections under road bridges as conservation hot-spots of native crayfish and fish species - András Weiperth, Blanka Gál, János Farkas, Géza Gelencsér, Miklós Puky |

| Id | Start/end | Room | Session | Presentations and Authors |
|---|---|---|---|---|
| 1.2 | 01:30 PM - 03:00 PM | C | Infrastructure and biodiversity in Asia<br><br>Chair: Andreas Seiler | Do more roads finally spell the end for tigers? - Ashley Brooks |
| | | | | Integrating ecosystem services and wildlife into road planning in Myanmar: the case of the Dawei road - Hanna Helsingen, Nirmal Bhagabati |
| | | | | Plan for Ecological Corridors: Reconnect the Baekdudaegan in South Korea - Donggul Woo, Taeyoung Choi |
| | | | | Road-Transport Infrastructure Development under China-Pakistan Economic Corridor Programme: Implications for biodiversity and ecological conservation - Khalid Farooq Akbar |
| | | | | Fostering Sustainable and Resilient Infrastructure and its Financing - Raul Frazao |
| 1.3 | 01:30 PM - 03:00 PM | L | Wildlife crossing structures - Part 1/3<br><br>Chair: Edgar van den Grift | Bats and invertebrates provide evidence of ecoducts' role as key elements of the green infrastructure - Carme Rosell, Marc Fernandez, Joana Colomer, Ferran Navàs, Carles Flaquer, Maria Bas, Mònica Laje, Carles Boronat |
| | | | | Estimating crossing rates at wildlife crossing structures: How to improve our monitoring methods? - Edgar A van der Grift |
| | | | | Evaluation of the use and effectiveness of underpasses implemented on the new high-speed rail-road SEA between Tours and Bordeaux to maintain optimal permeability for semi aquatic mammals - Pascal Fournier, Thierry Charlemagne, Delphine Quintard, Catherine Bout, François Gillet, Estelle Laoue, Vanessa Maurie, Nicolas Tranchant, Laurent Palussiere, Vinciane Leduc, Alain Bigot, Johan Michaux, Christine Fournier-Chambrillon |
| | | | | Large and non-specific bird mortality in a high-speed railway traversing a Spanish agrarian landscape - Juan E Malo, Israel Hervas, Eladio L Garcia de la Morena, Cristina Mata, Jesus Herranz |
| | | | | You shall pass! A mechanistic evaluation of mitigation efforts in road ecology - Christer Moe Rolandsen |
| 1.4 | 01:30 PM - 03:00 PM | K | Managing vegetation along infrastructure verges - Part 1/2<br><br>Chair: JO Helldin | Facing the ongoing landscape fragmentation – designing the ecological network to protect habitat connectivity - Dusan Romportl |
| | | | | Influence of road-field boundary structure and management practices on the functional composition of road-field plant communities. - Clémence Chaudron, Rémi Perronne, Francesca Dipietro |
| | | | | Managing vegetation under overhead high-tension lines : from a constraint to an opportunity for biodiversity - Simon de Voghel |
| | | | | Seed dispersal by myrmecochorous ants in road verges: the influence of soil disturbances from roadworks. - Peter G Spooner |
| | | | | Study of woody vegetation along roads in the Beauce landscape, Loir-et-Cher, France - Gilles Grisard, Gabriel Michelin, Aurélie Poumailloux |
| 1.5 | 01:30 PM - 03:00 PM | 3 | KDE+ A method for identification of animal–vehicle–collision hotspots<br><br>Chair: Michal Bíl | A Workshop on KDE+: A method for identification of animal–vehicle–collision hotspots. - Michal Bíl |
| | | Cour sud | Break | |
| 1.6 | 03:30 PM - 05:00 PM | C | Infrastructure, ecosystems and landscape : research and action in France<br><br>Chair: Yannick Autret / Barbara Livoreil | Club of Linear Infrastructures and Biodiversity (CILB): an original partnership - Viviane Degret, Guerrero Anne, Christine Bourbon, Gaëtan Quesnel, Jean-Francois Lesigne |
| | | | | FRB, a science-policy-society interface for informed decision-making - Barbara Livoreil |
| | | | | GASBI a French original initiative: developers and scientists working together in collective intelligence to integrate biodiversity in upstream development projects - Sylvie Vanpeene, Thierry Tatoni, Carine Ritan |

| Id | Start/end | Room | Session | Presentations and Authors |
|---|---|---|---|---|
| | | | | IDRRIM : The French Institute for Roads, Streets and Mobility Infrastructure - Marc Tassone, Patrick Porru |
| | | | | ITTECOP: an Institutional framework for integrated research on infrastructures, landscapes and biodiversity - Yannick Autret, Bruno Villalba |
| 1.7 | 03:30 PM - 05:00 PM | D | Tree avenues and biodiversity<br><br>Chair: Chantal Pradines | Avenue trees: a wealth of red list species, but still too little specific studies concerning tree lined transport infrastructures - Chantal Pradines |
| | | | | Complete inventory of trees along roads in the Czech Republic - Jaroslav Kolařík |
| | | | | Mapping of tree avenues with LiDAR – method development, database structure and landscape analysis. - Lisa Maria Sjölund |
| | | | | Tree avenues and solidary trees along roads in Sweden – monitoring and maintenance - Åsa Röstell, Tove Adelsköld |
| | | | | Tree-lined roads - the green infrastructure as an important part within transport infrastructure - Katharina Brückmann |
| 1.8 | 03:30 PM - 05:00 PM | L | Wildlife monitoring and field studies - Part 1/3<br><br>Chair: Andreas Seiler | A new biodiversity impact assessment tool for road network planning - Richard Bischof, Ola-Mattis Drageset, Markus A. K. Sydenham, Katrine Eldegard |
| | | | | Road ecology researchers should pay more attention to the spatiotemporal dependence of the roadkills' aggregation. - Almir Picanço de Figueiredo, Ludmilla Moura de Souza Aguiar |
| | | | | Roads and bats: use of existing gantries for the restoration of ecological connectivity. - Fabien Claireau, Sébastien Puechmaille, Benjamin Allegrini, Cédric Heurtebise, Nathalie Machon, Christian Kerbiriou |
| | | | | Video analysis of animal-train encounters in Sweden - Andreas Seiler, Mattias Olsson, Pär Söderström, Anders Forsberg, Anders Sjölund |
| | | | | Wireless camera systems and web-informatics for environmental monitoring of transportation corridors - Fraser M Shilling, David P Waetjen |
| 1.9 | 03:30 PM - 05:00 PM | K | New prevention technologies<br><br>Chair: Carme Rosell | Acclimation of drivers to a Roadside Animal Detection System - Molly Kathryn Grace, Daniel Joseph Smith, Reed Frederick Noss |
| | | | | Dynamic Wildlife Warning System - Gert Hamberg |
| | | | | Is it possible to relocate a cormorant roost affected by new transport infrastructures? - Ferran Navàs, Ramon Griell, Miguel Ángel Pindado, Rosell Carme |
| | | | | The reliability and effectiveness of a radar based animal detection system and road crossing behaviour of large ungulates - Marcel Huijser, Brice Sloan |
| | | | | Utilising telemetry and remote sensing technology to evaluate the effectiveness and use of the KA45 highway underpasses by brown bears (Ursus arctos) in the region of Kastoria, W. Macedonia, Greece - Maria Konstantinos Psaralexi, Yorgos Mertzanis, Ioannis Athanasiadis, Elias Aravidis, Georgina Examilioti, Alexios Giannakopoulos, Yorgos Iliopoulos, Eli Katsiri, Paris Kouris, Yorgos Lazarou, Nikolaos Patsinakidis, Maria Petridou, Sussane Riegler, Armin |
| 1.10 | 03:30 PM - 05:00 PM | 3 | Policy and Strategic planning: infrastructure bundling<br>Chair: JO Helldin | Minimizing road effects through the bundling of infrastructures: Current state of practice, guidelines, and research needs - Jan Olof Helldin, Jochen Jaeger |
| | | | | The effects of the pairing of heavy transport infrastructure on the territories: what lessons? - Michel Deshaies |

| Id | Start/end | Room | Session | Presentations and Authors |
|---|---|---|---|---|
| 1.11 | 05:15 PM - 06:45 PM | C | Side Event - renaturation under High voltage line<br><br>Chair: Viviane Degret | Application of urban metabolism theory in energy landscape making: designing with flows - Roberta Pistoni |
| | | | | Developing natural forest edges in electrical corridors to ensure electrical safety and to enhance biodiversity in wooded areas - Simon de Voghel, Jean-François Godeau |
| | | | | Restoring Natura 2000 habitats under overhead high-tension lines : example of peatlands, heathlands and calcareous grasslands restoration in Belgium and France - Simon de Voghel |
| | | | | The high-voltage network as an opportunity for nature conservation? - Viviane Degret, Elodie Russier, Auréline Doreau, Simon de Voghel |
| | | | | Using electrical grid to increase the connectivity of protected natural areas - Simon de Voghel, Jean-François Godeau |
| 1.12 | 05:15 PM - 06:45 PM | D | Side Event - Tree Avenues Award<br><br>Chair: Chantal Pradines | Tree avenues award - Chantal Pradines, Alexandre Gady |
| 1.13 | 05:15 PM - 06:45 PM | L | Wildlife detectors to reduce animal-vehicle collisions: sharing experience<br>Chair Sylvie Vanpeene | Wildlife detectors to reduce animal-vehicle collisions : sharing experience - Sylvie Vanpeene, Anne-Sophie Croyal |
| 1.14 | 05:15 PM - 06:45 PM | K | Towards global guidelines for infrastructure development - a project proposal<br>Chair: Rodney van der Ree and Andreas Seiler | Towards global guidelines for infrastructure development - a project proposal - Rodney van der Ree, Kate Newman, Anders Sjolund, Lazaros Georgiadis, Elke Hahn, Andreas Seiler |
| 1.15 | 05:15 PM - 06:45 PM | 3 | Side Event - Roadkill reporting systems around the world - experience sharing<br>Chair: Fraser Shilling | SIDE EVENT - Roadkill reporting systems around the world - experience sharing - Fraser Shilling |

## Thursday September 1st, 2016

| Id | Start/end | Room | Session | Presentations and Authors |
|---|---|---|---|---|
| | 08:00 | Atrium sud | Registration - Welcoming Desk | |
| P3 | 08:30 AM - 09:15 AM | C | Traffic verges and biological diversity: Realized possibilities, realities and prospects - Heinrich Reck | |
| P4 | 09:15 AM - 10:00 AM | C | Interaction and adjustment: essential concepts in biodiversity evolution processes for landscapes fragmented by infrastructure - Yves Luginbühl | |
| | | Cour sud | Break | |

| Id | Start/end | Room | Session | Presentations and Authors |
|---|---|---|---|---|
| 2.1 | 10:30 AM - 12:00 PM | L | Wildlife crossing structures - Part 2/3<br><br>Chair Sylvie Vanpeene | Analysing ecological network for identifying, reducing, mitigating impacts of infrastructures - Sylvie Vanpeene |
| | | | | Making a change in the life of riverine species - removal of 300 barriers in northern Sweden - Ida Schönfeldt, Torbjörn Nilsson |
| | | | | Wildlife collision data as an indicator of the effectiveness of mammal mitigation measures across the National Road Network in Ireland. - Sarah-Jane Phelan, Vincent O'Malley, Brendan Kennedy, Eugene Finnerty |
| | | | | Use of wildlife crossing structures by ungulates in relation to human activity and migration periods - Ole Roer, Karianne Thoger-Andresen |
| | | | | Wildlife surveys following the construction of modified culverts – Developing and providing a vibration-trap - Fagart Sylvain, Heurtebise Cédric |
| 2.2 | 10:30 AM - 12:00 PM | D | Guidelines and experiences<br><br>Chair: Marguerite Trocmé | A management model for maintenance of roadsides with high biodiversity values along public roads in Sweden - Mats Lindqvist, John Rolander, Maria Pettersson |
| | | | | Increased understanding of the extent of road kills in central Italy and development of a new prevention technology – results from a 4-year LIFE project - Annette Mertens, Simone Ricci, Umberto Sergiacomi, Roberta Mazzei |
| | | | | New guideline on highway verge design and management - Marguerite Trocmé |
| | | | | Spatial structure of populations of deer around Paris since 1950: consequences of the development of transport infrastructures. - Vincent Vignon |
| | | | | Tools for a risk-adapted management concept to prevent animal-vehicle collisions along transport routes - Jens-Ulrich Polster, Sven Herzog |
| 2.3 | 10:30 AM - 12:00 PM | C | Bats and infrastructure crossing<br><br>Chair: Daniel J Smith | Artificial night-time lighting reduces the use of wildlife crossing structures by insectivorous bats in southeast Australia - Manisha Bhardwaj, Kylie Soanes, Jose Lahoz-Monfort, Lindy Lumsden, Rodney van der Ree |
| | | | | Improving the effectiveness of mitigation and monitoring for bats on roads and railways - Anna Berthinussen, John Altringham |
| | | | | Roads and railroads as barriers for bats in Sweden - Johnny de Jong |
| | | | | Temporary guidance structure for bats during construction works - Pouchelle Hippolyte |
| | | | | Vegetated fauna overpass significantly facilitates crossing capacity of forest microbats - Darryl Noel Jones |
| 2.4 | 10:30 AM - 12:00 PM | K | Green infrastructure networks<br><br>Chair: Michal Bil | Designing a network of wildlife corridors across heterogeneous mountain landscape – the Carpathian case study - Dusan Romportl, Vladimír Zýka, Miroslav Kutal |
| | | | | Do we have a proper idea of how much investment for defragmentation is needed? Experiences about financial, spatial and temporal demands for effective connection of ecoducts by designing ecological corridors - Björn Schulz, Heinrich Reck, Marita Böttcher |
| | | | | Find a second life for old regional railway tracks in France allying transport perspective for the future and protection of the environment - Xavier Orthlieb |
| | | | | How to save large carnivore populations in Western Carpathians? - Vaclav Hlavac, Petr Anděl |
| | | | | Innovative methods and organizational approaches to improving biodiversity offsets in France: the example of the new Nimes – Montpellier railway line. - Fabien Quetier, Grégoire Goettelmann, Thomas Menut, Xavier Rufray, Rénald Boulnois |
| 2.5 | 10:30 AM - 12:00 PM | 3 | How to implement ecological restoration in civil engineering sector? The power of participation<br>Chair: Adrián Mohmed Sanz | A Tale of two Regions Towards a multi-level approach of decision-making processes concerning transport infrastructure in France - Cécile Blatrix |
| | | | | How to implement ecological restoration in civil engineering sector? The power of participation - Adrián Mohmed Sanz |

| Id | Start/end | Room | Session | Presentations and Authors |
|---|---|---|---|---|
| PS2 | 12:00 PM - 01:30 PM | Cour sud | Lunch and Poster session 2 | A integrated mapping tool for harmonizing ecological assessment and transport infrastructure planning. - Pierre Jorcin, Benjamin Allegrini, Olivier Peyre |
| | | | | Abandoned tunnels as habitats for bats and measures to improve habitat quality - Thomas Schuh |
| | | | | Analysis of linear road barriers and their permeability for wildlife species in the Czech landscape - Ivo Dostál, Jiří Jedlička, Josef Svoboda |
| | | | | Bats and linear land transport infrastructures [Guidelines] - François Nowicki |
| | | | | Bats and road collisions: building a risk prediction model incorporating landscape variables - Charlotte Roemer, Yves Bas, Aurélie Coulon |
| | | | | A test of wildlife warning reflectors as a way to reduce risk of wildlife-train collisions |
| | | | | Do animals use wildlife crossings in the Netherlands? An analysis of 450 crossing structures - Gerard Smit, Jeroen Brandjes, Dimitri Emond, Dennis Wansink |
| | | | | Ecological connectivity and ecosystem plasticity in a transformed corridor habitat – case study of A4 motorway in Southern Poland - Joanna Nabielec, Wojciech Michał Tokarz |
| | | | | Ecological landscaping Development of Watercourse Crosssing .Highway A89 . France - Cécile Dauriat |
| | | | | Ecologically stealth construction works » for the reinstatement of the corridor's functionality through an existing highway - Labarraque Dorothee, Habasque Gilles |
| | | | | Enhancing wildlife connectivity along California's highways: the cas of the state route (SR) 241 wildlife fence in Orange County, California, USA - Valarie L McFall |
| | | | | Environmental commitments of the Société du Grand Paris for the Grand Paris Express project - Etienne Pihouee |
| | | | | Exclusion habitats – a way to avoid unnecessary conflict when building new transport infrastructure - Jan Olof Helldin, Anders Sjölund, Anders Jacobson, Leif Andersson |
| | | | | Functional connectivity of biodiversity across an accumulation of large-scale transportation infrastructures in the South-West of France. - Jonathan Remon, Sylvain Moulherat |
| | | | | GeneDbase – database for evaluation of road barrier effect road on wildlife genetic variability - Martin Ernst, Tomáš Libosvár, Tomáš Šikula |
| | | | | Impacts of pairing transport infrastructures on biodiversity (plants, butterfly and reptiles) inside interstitial zones between infrastructures - Nadia Michel, Jean Carsignol, Charles Uyttenhoven, Colin Van Reeth, Virginie Billon, Severine Hubert, Eric Le Mitouard, Joris Biaunier, Sophie Noiret |
| | | | | Impacts of pairing transport infrastructures on composition and structures of landscapes and on functional connectivity of ecological networks - Nadia Michel, Jean Carsignol, Marc Hervé, Manon Balbi, Cécile Douay-Bertrand, Virginie Billon, Sophie Noiret |
| | | | | Implementing measures to avoid wildlife-vehicle collisions and other environmental impacts in an old road inside a State Park in Brazil - Juliana Moreno Pina, Camilo Fragoso Giorgi, Paul Joseph Dale |
| | | | | Influence of historical and present landscape patterns on plant communities of road-field boundaries - Clémence Chaudron, Francesca Di Pietro, Rémi Perronne, Sébastien Bonthoux, |
| | | | | Is an operational index an efficient way to assess naturalness along land transport infrastructures? - Romain Fillon, Pierre Pech |
| | | | | Landscape and road variables describing clusters of ungulate vehicle collisions on southern Swedish roads - Andreas Seiler, Magnus Sjölund, Richard Andrášik, Jiří Sedoník, Michal Bíl, Carme Rosell, Marina Torellas |
| | | | | Landscape architecture process to think the energy transition at school : a spreading concern - Auréline Doreau, Antoine De Vergnette, Antoine Gabillon, Julien Peguet, Jean Robaudi, Jérémy Di Stefano, Marine Naceri, Sonia Wotus, Clothilde Josserand, Qixuan Yang, Olivia Zanchi |

| Id | Start/end | Room | Session | Presentations and Authors |
|---|---|---|---|---|
| PS2 | 12:00 PM - 01:30 PM | Cour sud | Lunch and Poster session 2 | Landscape-change frequency and land-use dynamics around High-speed railway (HSR) projects at large scale: diffuse impacts on biodiversity and their mitigation - Jean-Marc Foures, Pierre Pech |
| | | | | Main landscape and road-related variables describing ungulate-vehicle collisions hazardous locations in Catalonia. - Marina Torrellas, Carme Rosell, Marc Fernández-Bou, Richard Andrášik, Jiří Sedoník, Michal Bíl, Ferran Camps, Andreas Seiler, Ferran Rodà |
| | | | | Multimodal platforms of transport and services. The logistic landscapes in Region Nord-Pas de Calais/France – - Fabrice Raffin |
| | | | | New tools for Motorway assessment - Gaia Sgaramella |
| | | | | On toads and roads: The case of Spångavägen and Kyrksjölöten – tunnel mitigation is effective for spring migration, but toads are still killed in large numbers - Jan Olof Helldin, Anna Koffman, Christina Söderström-Lööf, Erik Jondelius, Silviu Petrovan, Michael Hartup |
| | | | | Practical aspects of the ecological management along highway and national roads motorway verges in Flanders (Belgium) - Marleen Moelants, Andy Vankerckvoorde |
| | | | | Research and Popularization, for Dormouse Bridge and Animal Pathways as corridor for protecting Arboreal Animals - Minato Shusaku |
| | | | | Road 73 in Sweden: Follow-up studies of compensation measures - Malin Delvenne, Torbjörn Persson |
| | | | | Species richness of some arthropod groups in highway rest areas in Hungary - Balázs Kiss, Sándor Koczor, Blanka Gál, András Weiperth, Éva Szita |
| | | | | Sustainable development of road lighting, its impact on the environment and effects of switching to LED (light emitting diodes). - Annika K. Jägerbrand, Jan-Olof Helldin |
| | | | | The importance of roadside vegetation on plant diversity in Northern Germany - Kerrin Müller, Alica Tetzlaff, Heinrich Reck |
| | | | | Wildlife crossing structures monitoring in the Catalonia's road network - Jordi Solina Angelet, Mònica Laje |
| | | | | Wildlife road kills in southeastern Brazil: A spatiotemporal analysis towards mitigation - Carlos Henrique de Freitas, Eleonore Zulnara Freire Setz |
| | | | | Wildlife's reaction towards oncoming vehicles - Anke Benten |
| 2.6 | 01:30 PM - 03:00 PM | C | Infrastructure and biodiversity roadkill in Africa<br><br>Chair: Wendy Collinson | HIT AND RUN! Reducing Wildlife-Vehicle-Collisions in Protected Areas. - Wendy Jane Collinson, Lizanne Roxburgh, Harriet Davies-Mostert |
| | | | | Low-level fences reduce roadkill at hotspots: a South African example - Wendy Jane Collinson, Warwick Davies-Mostert, Harriet Davies-Mostert |
| | | | | Road kills and parasites, South Africa - Ali Halajian, Wilmien J Luus-Powell, Sareh Tavakol, Katlego David Kunutu, Makubu Mokgawa |
| | | | | Samango monkey road kill mitigation in the Soutpansberg, South Africa - Birthe Linden, Quentin Hota-Lacueva, Ian G Gaiger |
| | | | | Watch the road: Assessing roadkill in Addo Elephant National Park - Wendy Jane Collinson, Gareth David Nuttall-Smith, Lizanne Roxburgh, Daniel M Parker |
| 2.7 | 01:30 PM - 03:00 PM | L | Wildlife monitoring and field studies - Part 2/3<br><br>Chair: Andreas Seiler | Biodiversity in Sustainable Urban Drainage Systems – Good or Bad? - Sondre Meland |
| | | | | Measuring simultaneously habitat loss and fragmentation due to infrastructures: a novel Habitat Functionality metric - Bram Van Moorter, Ilkka Kivimäki, Robin Devooght, Manuela Panzacchi |
| | | | | MoRIS: Model of Routes of Invasive Spread. Human-mediated dispersal, road network and invasion parameters - Jérôme GIPPET |
| | | | | What are the effects of road-kills on mammal population's persistence? - Clara Grilo, Kylie Soanes, Aliza le Roux, Elena Koroleva, Flávio Ferreira, Sarah Gagne, Yun Wang, Alex Bager, Luis Borda-de-Água |
| | | | | Wildlife Crossings Identification for Road Development in Guyana - Evi A.D. Paemelaere, Curtis Bernard, Esteban Payán, David Singh |

| Id | Start/end | Room | Session | Presentations and Authors |
|---|---|---|---|---|
| 2.8 | 01:30 PM - 03:00 PM | K | Integration with Landscape plans - Part 1/2<br><br>Chair: Philippe Clergeau | Brandenbark™: Mitigation/Management tool for projects involving bark roostings bats - Zachary Baer, Mark Gumbert, Joshua Adams, Piper Roby, Price Sewell, L. Kate Baer, Michael Brandenburg<br>Building an ecoduct in an agricultural environment - a challenge for people and animals - Katja Claus<br>Influence of the regional landscape connectivity on the location of roe deer roadkill hotspots. - Xavier Girardet, Céline Clauzel, Jean-Christophe Foltête<br>Model based dynamic defragmentation tool for Flanders (Belgium) - Joris Everaert, Inge Uljee, Marleen Moelants, Liesbet Van Laer, Luc Janssens, Guy Engelen<br>Tendering for ecological value in a Dutch road expansion: evaluation of the results - Victor Loehr |
| 2.9 | 01:30 PM - 03:00 PM | 3 | No-Net-Loss Strategy and compensatory measures<br><br>Chair: Fabien Quetier | Compensation of impacts on Nature and Landscape - Thomas Schuh, Lukas Umgeher<br>ES'team - Ecosystem Services and the 'Avoid, Mitigate and offset' approach - Labarraque dorothee<br>Integrating transportation and conservation planning at the regional scale: An example from Florida, USA - Daniel J Smith, Stephen D Tonjes, Thomas Roberts<br>Roadless conservation in central Africa: the challenge of applying the mitigation hierarchy to infrastructure development in large intact forest landscapes - Fabien Quetier, Pauwel De Wachter, Hélène Dessard, Camille Jepang, Laurène Feintrenie, Juliette Chamagne, Donald Midoko Iponga, Claude Garcia, Annabelle Morcrette, Solène Happert, Charles Bassama<br>Roadless space is greatly diminished by logging in intact forest landscapes of the Congo Basin - Fritz Kleinschroth, John R Healey, Sylvie Gourlet-Fleury, Frédéric Mortier, Radu Stoica |
| 2.10 | 01:30 PM - 03:00 PM | D | A new european handbook on roads and Wildlife!<br><br>Chair: Anders Sjöllund / Edgar van den Grift | Interactions between linear Infrastructure and territories: A new European handbook! - Eugene O'Brien, Morten Elmeros, Anders Sjölund, Edgar van den Grift |
| | | Cour sud | Break | |
| 2.11 | 03:30 PM - 05:00 PM | C | Natural revegetation, road side management and ecological restoration<br><br>Chair: Astrid Skrindo Brekke | Environmental challenges encountered during planning and construction of a new highway through the south east of Norway - Lene Sørlie Heier<br>From plan to practice in development projects: ecological restoration in the mitigation hierarchy framework - Dagmar Hagen, Astrid Skrindo<br>Near-natural methods promote restoration of species-rich grassland vegetation—revisiting a road verge trial after nine years - Inger Auestad, Knut Rydgren, Ingvild Austad<br>Roadside allotment gardens to produce living landscapes ? - Magali Paris, Grégoire Chelkoff, Marine Linglart<br>Trade-offs in multifunctionality of road verges and their delivery of ecosystem services - Hans Martin Hanslin |
| 2.12 | 03:30 PM - 05:00 PM | D | Infrastructure, amphibians and reptiles (special tribute to Miklos Puky)<br><br>Chair: Blanka Gál | Amphibians and land transport infrastructure: from land management to ecological engineering. - Alain Morand, Jean Carsignol<br>Intelligent systems for mapping amphibian roadkills - Neftali Sillero, Marc Franch, Cristiano Silva, Gil Lopes, Fernando Ribeiro, Paulo Trigueiros, Luís Seco<br>Making light in amphibian road tunnels; Novel automated technology shows large seasonal, life stage and species-specific variation in amphibian usage in the UK - Silviu Petrovan, Michael Hartup |

| Id | Start/end | Room | Session | Presentations and Authors |
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| 2.12 | 03:30 PM - 05:00 PM | D | Infrastructure, amphibians and reptiles (special tribute to Miklos Puky)<br><br>Chair: Blanka Gál | Motorway and road edges as amphibian, reptile and small mammal habitats in Hungary - Blanka Gál, János Farkas, Ferenc Kádár, András Weiperth, Miklós Puky†, Balázs Kiss |
| | | | | Roads and Ecological Infrastructure: Concepts and Applications for Small Animals - Kimberly Marie Andrews, Priya Nanjappa, Seth P. D. Riley |
| 2.13 | 03:30 PM - 05:00 PM | L | Global Carcass & Accident Reporting Systems<br><br>Chair: Fraser Shilling | Carcass Removal and Detectability: Reducing the Uncertainty Surrounding Wildlife-Vehicle Collision Surveys - Rodrigo Augusto Lima Santos, Sarah Maria Santos, Fernando Ascensão |
| | | | | How many animals are really killed on highways - Tatjana Gregorc, Marjana Hönigsfeld Adamič |
| | | | | Next Generation of Carcass and Accident Reporting Systems - Fraser M Shilling, David Paul Waetjen, Kathryn Harrold |
| | | | | Seeking roadkill data through public awareness, partnerships and citizen science - Wendy Jane Collinson, Claire Patterson-Abrolat, Laura Goodman, Thandiwe Rakale, Miles le Roux, Charmaine van Wyk, Lizanne Roxburgh |
| | | | | The Evolution of Global Carcass & Accident Reporting Systems - Fraser M Shilling |
| | | | | U. S. Rocky Mountain States' Use of Wildlife Vehicle Collision Carcass Data to Plan for Wildlife Mitigation - Patricia C Cramer |
| 2.14 | 03:30 PM - 05:00 PM | K | Systematic reviews and maps: transport infrastructure - perspectives and challenges<br><br>Chair: Barbara Livoreil | Can linear transportation infrastructure verges constitute a corridor and/or a habitat for insects in temperate landscapes? A systematic review - Arzhvael Jeusset, Romain Sordello, Yves Bertheau, Aurélie Coulon, Marianne Vargac, Julien Touroult, Sylvie Vanpeene, Hervé Jactel, Isabelle Witté, Nadine Deniaud, Frédérique Flamerie, Emmanuel Jaslier, Véronique Roy, Eric Guinard, Eric Le Mitouard, Patric |
| | | | | Systematic review: Methodology and case studies: infrastructure verges as corridor for biodiversity - Barbara Livoreil |
| | | | | Transport infrastructure : biodiversity vectors in urban areas ? - Romain Fillon, Pierre Pech |
| | 05:15 PM - 06:45 PM | C | IENE 2016 Declaration - General Assembly | |

## Friday September 2nd, 2016

| Id | Start/end | Room | Session | Presentations and Authors |
|---|---|---|---|---|
| | 08:00 | Atrium sud | Registration - Welcoming Desk | |
| P5 | 08:30 AM - 09:15 AM | C | Limiting the environmental impacts of the tropical infrastructure tsunami - William F. Laurance | |
| P6 | 09:15 AM - 10:00 AM | C | Implementation of Green Infrastructure in the EU - Jos Jonkhof | |
| | | Cour sud | Break | |

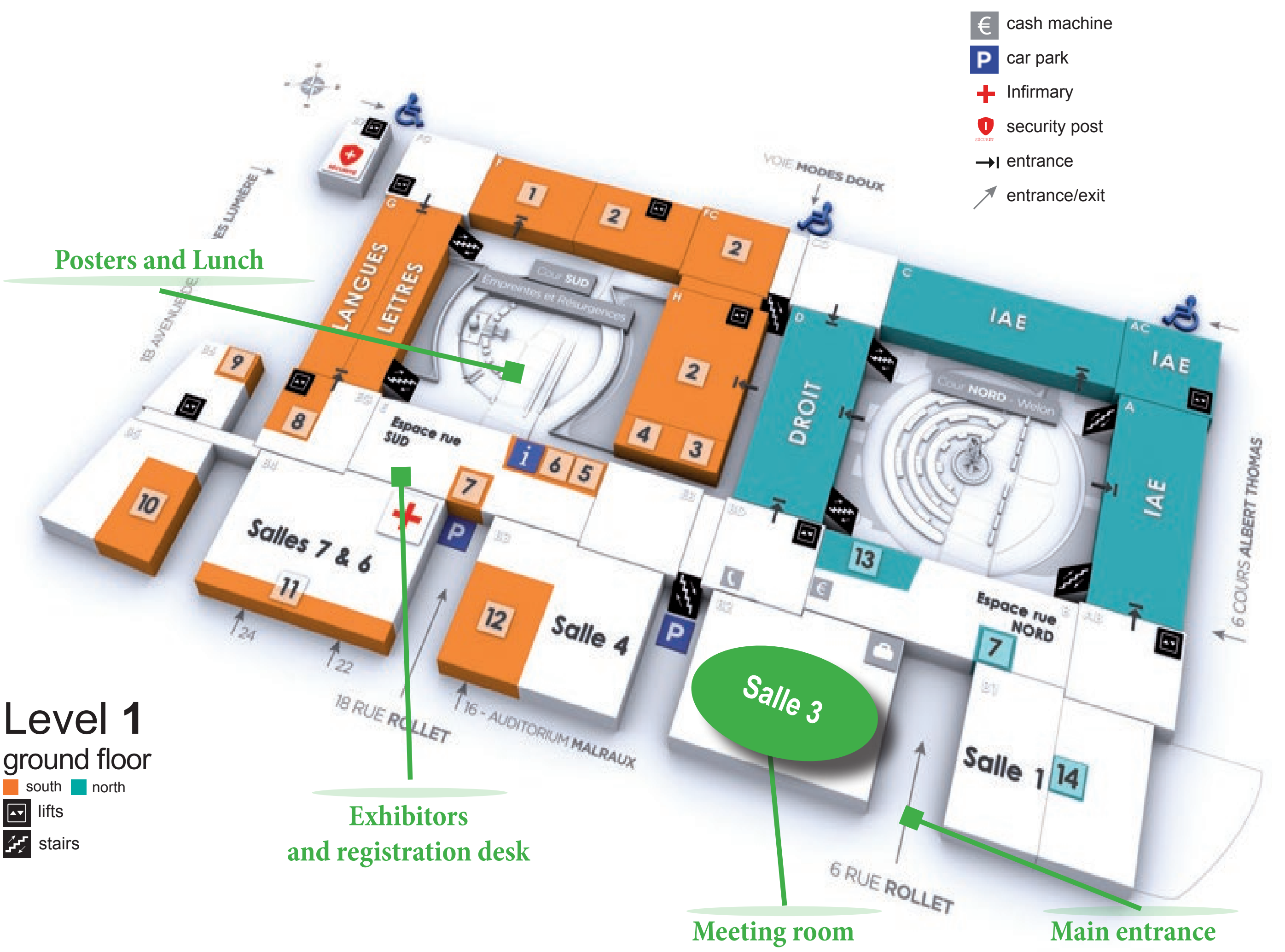
| Id | Start/end | Room | Session | Presentations and Authors |
|---|---|---|---|---|
| 3.1 | 10:30 AM - 12:00 PM | 3 | Wildlife crossing structures - Part 3/3<br><br>Chair: Andreas Seiler | A highway or wall to wildlife? Barriers for wildlife corridors in Slovakian transport infrastructure. A review from a pilot area in North Banská Bystrica County - Nuno Guimarães, Jerguš Tesák, Peter Urban, Gabriela Ligasova |
| | | | | Effects of low and medium traffic roads on bat activity and species richness - Denis Medinas, Vera Ribeiro, João Tiago Marques, Hugo Rebelo, Ana Márcia Barbosa, António Mira |
| | | | | Impacts on moose and deer of railway fencing in northern Sweden - Åsa Karlberg, Jan Olof Helldin |
| | | | | Simulating population effects of infrastructure permeability and the performance of mitigation strategies - Andreas Seiler, Guillaume Chapron, Julian Klein, Edgar van der Grift, Peter Schippers |
| | | | | Successful Wildlife Crossing Structure Designs in the United States Mountain West - Patricia C Cramer |
| 3.2 | 10:30 AM - 12:00 PM | D | No-Net-Loss Strategy and compensatory measures - marine biodiversity<br><br>Chair: Gilles Lecaillon | How maintain marine fish population in a context of high anthropic pressure: the role of shallow coastal zones – ecological function and fish nursery restoration - Philippe Thievent, Philippe Lenfant |
| | | | | Planning for Transportation and Ecosystem Adaptation to Sea Level Rise - Fraser M Shilling |
| | | | | Potential role of infrastructures in the restoration of marine biodiversity - Philippe Thievent, Martin Perrot |
| | | | | Time, space, skills, partners and innovation management for port integration - Jean-Michel Bocognano |
| | | | | Using a commercial harbor for fish nursery - Philippe Thievent, Gilles Lecaillon |
| 3.3 | 10:30 AM - 12:00 PM | K | Managing vegetation along infrastructure verges - Part 2/2<br><br>Chair: André Evette | Breeding habitat selection and flight characteristics of a farmland raptor species in response to highway in Western France - Alexandre Villers |
| | | | | Invasion by Asian knotweed (Fallopia spp.) along linear landscape features: spatial dynamics and perspectives in mountainous environment. - François-Marie Martin, André Evette, Fanny Dommanget, Vincent Breton, Laurent Borgniet, Nathan Daumergue, Marylise Cotter, Virginie Billon, Joris Biaunier, Anne Honnegger, Thomas Spiegelberger, Abry Guillaume, Jean-Jacques Brun |
| | | | | Unintended spillage of viable oilseed rape seeds along transportation routes in Austria: ecological risk assessment and management of feral plants - Kathrin Pascher |
| | | | | IPBES: key findings on the opportunities of right-of-way infrastructures for pollinators - Pierre-Edouard Guillain |
| 3.4 | 10:30 AM - 12:00 PM | L | Ecological engineering<br><br>Chair: Eric Guinard | A method to assess impacts of LTI projects on a territory and its biodiversity stakes - Éric Guinard, Nicolas Gouix, Élodie Hamdi, Jocelyne Cambecèdes, Gérard Largier, Daniel Marc |
| | | | | Ecological importance and management measures for verges and embankments associated with transport infrastructure in Flanders (Belgium) - Andy Van Kerckvoorde, Marleen Moelants |
| | | | | Substrata on Wildlife Overpasses - Germany - Udo Tegethof, Clemens Heidger |
| | | | | The Untapped Potential of Retrofitting: Upgrading Existing Infrastructure to Reduce Fragmentation Impacts and Enhance Wildlife Passage - Julia Kintsch, Sandra Jacobson, Barbara Charry, Kelly McAllister |
| | | | | Wetlands and management of runoff upstream of roadways and railways - Pascal Breil, Camille Fressignac, Lilly-Rose Lagadec, Yannick Matillon, Andréa Nullans, Blandine Chazelle, Benoit Sarrazin, Dominique Vallod |

| Id | Start/end | Room | Session | Presentations and Authors |
|---|---|---|---|---|
| 3.5 | 10:30 AM - 12:00 PM | C | The Green and Blue Infrastructure (la Trame verte et bleue): A French policy of ecological network<br>Chair: Romuald Loridan / Didier Labat | A French policy of ecological network : the Green and Blue Infrastructure (la Trame verte et bleue) - Romuald Loridan |
| | | | | Reconnection of Habitats and migration corridors across and along road networks – from national programs to European initiatives about needful improvements for the European Green Infrastructure - Marita Böttcher |
| | | Cour sud | Lunch | |
| 3.6 | 01:00 PM - 02:30 PM | L | Wildlife monitoring and field studies - Part 3.3<br><br>Chair: Riccardo Brozzi | How to evaluate potential ecological effects of dredging operations in French navigated rivers ? - Alexis Guilpart, Amélie Charnoz, Nicolas Huybrechts, Sylvie Nouvion-Dupray |
| | | | | Individuals Matter: Predicting Koala Road Crossing Behaviour in South-east Queensland - Cathryn Elizabeth Dexter |
| | | | | Restoring a viable population of lynx in the French Vosges Mountains: insights from a spatially explicit individual-based model - Laetitia Blanc, Stephanie Kramer-Schadt, Cyril Bernard, Fridolin Zimmermann, Eric Marboutin, Estelle Germain, Olivier Gimenez |
| | | | | Taking into account environmental benefits of urban infrastructural projects' vegetation in Life Cycle Assessment : state-of-the-art and prospective approaches - Anne Cécile de Bortoli |
| 3.7 | 01:00 PM - 02:30 PM | C | Roadkill and citizen science: examples from Africa, Europe and USA<br><br>Chair: Wendy Collinson | AVC Report Application www.srazenazver.cz: Summary of Experience from the User and Administrator Points of Views - Michal Bíl |
| | | | | Driver knowledge and attitudes on animal vehicle collisions in Northern Tanzania - John Kioko |
| | | | | Maine Audubon Wildlife Road Watch Citizen Scientist Observations - Barbara Charry, Fraser Shilling |
| | | | | Putting the citizen in science: using volunteer-based data to determine the effect of vehicular traffic on endangered western leopard toad (Amietphrynus pantherinus) in Noordhoek, Cape Town - Wendy Jane Collinson, Donnavan Kruger, Jeanne Tarrant, Alison Faraday, Richard Faraday, Louis H Du Preez |
| | | | | Using citizen science to survey roadkill over large spatio-temporal scales: the example of South Africa - Stéphanie Périquet |
| 3.8 | 01:00 PM - 02:30 PM | D | Habitat and Conduit<br><br>Chair: Daniel J Smith | Absurdity or reality? Roadside verges are a premium habitat and act as a large-scale corridor, while even motorways are a minor barrier for the hazel dormouse (Muscardinus avellanarius) - Juliane Kelm, Björn Schulz, Göttsche Matthias, Thomas Steffens, Heinrich Reck, Kathrin Friebe |
| | | | | Constructed stormwater systems extended to provide biodiversity- neutral roads - Zhenhua Sun, Sondre Meland, Ekaterina Sokolova, John E. Brittain, Svein Jakob Saltveit, Sebastien Rauch |
| | | | | The Function Deterioration or Loss of Deer-Vehicle Collision Prevention Facilities Caused by Snow Accumulation - Misako Noro, Takane Shikano, Masato Sato, Fumihiro Hara |
| | | | | The Influence of Roads, Land Use, Fire and Flood on Movement, Home Range and Habitat Use of Florida Box Turtle and Gopher Tortoise in the Ocala National Forest Ecosystem, Florida, USA - Daniel J Smith |

| Id | Start/end | Room | Session | Presentations and Authors |
|---|---|---|---|---|
| 3.9 | 01:00 PM - 02:30 PM | K | Integration with Landscape plans - Part 2/2<br>Chair: Charlotta Faith-Ell | A model for inclusion of biodiversity in a Swedish system for sustainability assessment of transport infrastructure - Charlotta Faith-Ell<br>Impact of linear transport infrastructures on ecological continuities and landscapes: comparison and connection of tools and methods. - Alexandra Joyce Locquet<br>Method to secure fulfilment of environmental goals in road and rail infrastructure planning. Part I - Annika K. Jägerbrand, Hans Antonson, Charlotta Faith-Ell, Sara Janhäll<br>Tunnel Euralpin Lyon Turin: a big railway infrastructure in alpine environment. The challenge of respecting biodiversity - Elena Luchetti |
| 3.10 | 01:00 PM - 02:30 PM | 3 | IENE Railway-Wildlife working group<br><br>Chair: Andreas Seiler | IENE Railway-Ecology working group - Andreas Seiler, Anders Sjölund, Elke Hahn |
| | | Cour sud | Break | |
| 3.11 | 03:00 PM - 04:30 PM | K | Wildlife-vehicle accidents<br><br>Chair: Michal Bil | A Comparison of Certain Methods for Spatial Analysis of Animal-vehicle Collisions - Michal Bíl<br>Are animal-vehicle collisions a random event? – Analysis of the spatial distribution of accident data - Andreas Seiler, Magnus Sjölund, Richard Andrasik, Carme Rosell, Marina Torrellas, Jiri Sedonik, Michal Bíl, Annika Jägerbrand<br>Road-kill hot spots can change over the time, variables explaining them do not - Rafael Barrientos, Mireia Plaza<br>Spatial patterns of road mortality in medium- to large-sized mammals of the Cerrado and Pantanal - Fernando Ascensão, Emília Patrícia Medici, Arnaud L.J. Desbiez<br>On the identification of high mortality rate hotspots - Luis Borda-de-Agua, Fernando Ascensão, Rafael Barrientos, Henrique Miguel Pereira |
| 3.12 | 03:00 PM - 04:30 PM | D | Vision 2050: Ecologically Sustainable Transport System<br><br>Chair: Eugene J Obrien | Developing natural habitats under overhead electric lines: a win-win strategy for biodiversity and society - Simon de Voghel, Jean-François Godeau<br>Environmental potential of urban gondolas - Delphine Giney<br>Nature 2050 is a long-term action program to restore biodiversity and adapt territories to climate change. - Jean Clinckemaillie<br>Optimal settlement and road network configurations for habitat connectivity - results from modelling coupled habitat and human networks - Maarten Jan van Strien, Adrienne Grêt-Regamey<br>Procedures for the Design of Roads in Harmony with Wildlife - Eugene J OBrien, András Weiperth, Dennis Wansink, Georg Tschan |
| 3.13 | 03:00 PM - 04:30 PM | L | Evidence of efficacy<br><br>Chair: Cédric Heurtebise | Effectiveness of bat mitigation on roads - Morten Elmeros, Jasja Dekker, Inazio Garin, Hans Jørgen Baagøe, Morten Christensen<br>Efficiency of compensating measures for the Annex IV-species Common spade-foot toad Pelobates fuscus at a highway between Kliplev and Sønderborg in southern Denmark - Marianne Lund Ujvári, Per Klit Christensen<br>Roadkill: Are mitigation measures effective for small and medium-sized mammals? - Judith Plante, Jochen A.G. Jaeger<br>Use by large mammals of wildlife crossing structure on an overpass in western France. Results of the first three years of camera-trap surveys - Cédric Heurtebise |

| Id | Start/end | Room | Session | Presentations and Authors |
|---|---|---|---|---|
| 3.14 | 03:00 PM - 04:30 PM | C | Habitat and Conduit: Effects on pollinators<br><br>Chair: Denis François | Greening highway corridors to support butterfly metapopulations in protected areas: new technology for restoration of semi-natural vegetation using root hemiparasites - Jan Mladek, Tomas Sikula |
| | | | | Motorway edges as refugee for butterflies – preliminary results of case study from the Czech Republic - Vladimír Hula, Jana Niedobová |
| | | | | The habitat value of power line rights-of-way for pollinators (bees and butterflies) in agricultural landscapes - Violette Le Féon, Héloïse Blanchard, David Martinière, Jean-François Bretaud, Eric Guinard, Mickaël Henry, Christophe Pineau, Bernard E. Vaissière, Denis François |
| | | | | TRANSFER project - railways ecological transparency - Anne Guerrero, Michel Baguette, Sébastien Roue, Romain Sordello, Jean Carsignol, Virginie Stevens |
| CS | 04:30 PM - 05:30 PM | C | Closing session | |

Talk sessions
Talk sessions
Breaks/lunch et poster sessions
Workshops
Plenary sessions - Opening session - Closing session
Side events




# Level 1
ground floor

south north
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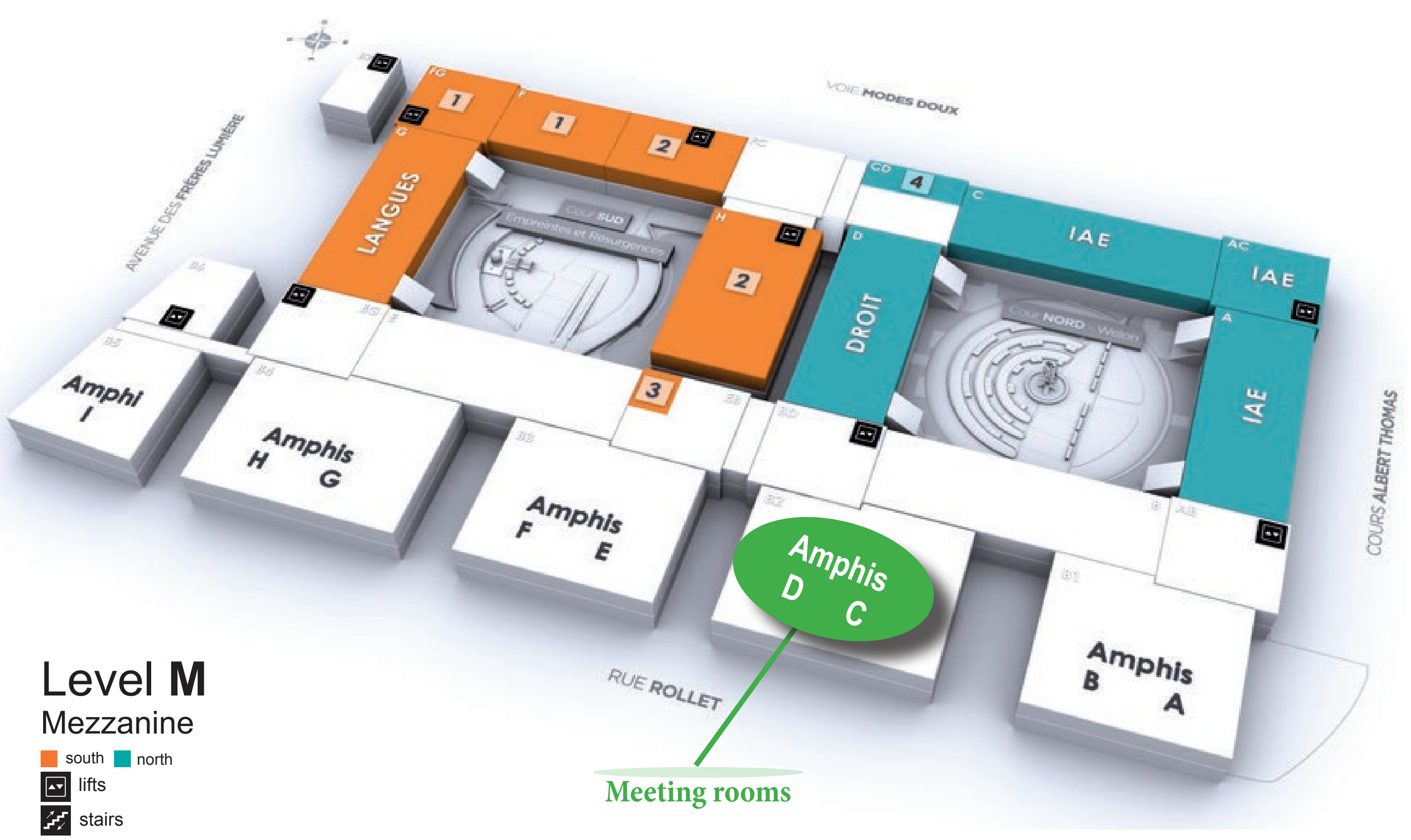
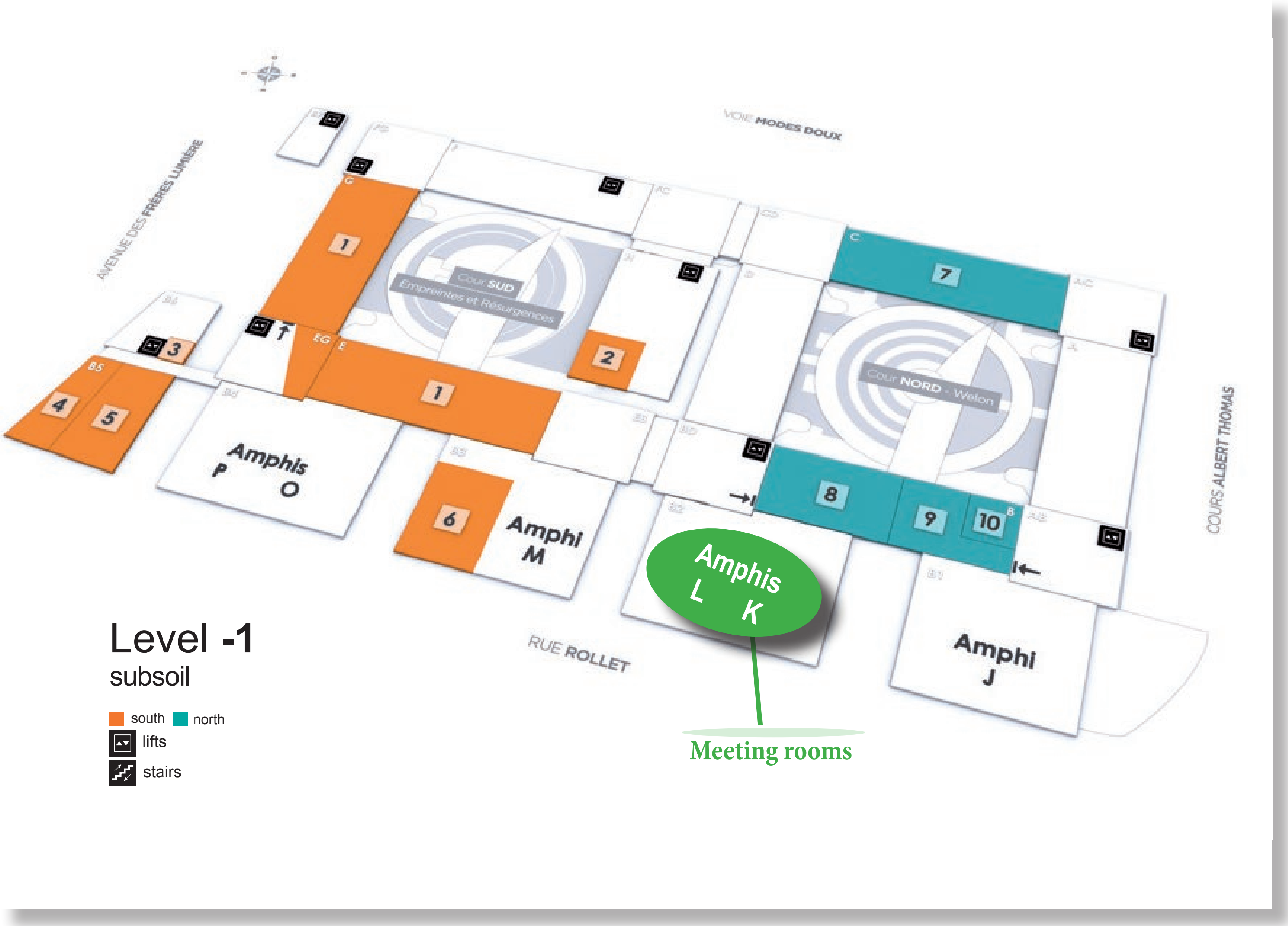



# Level M
Mezzanine

south north
lifts
stairs


Level -1
subsoil
south
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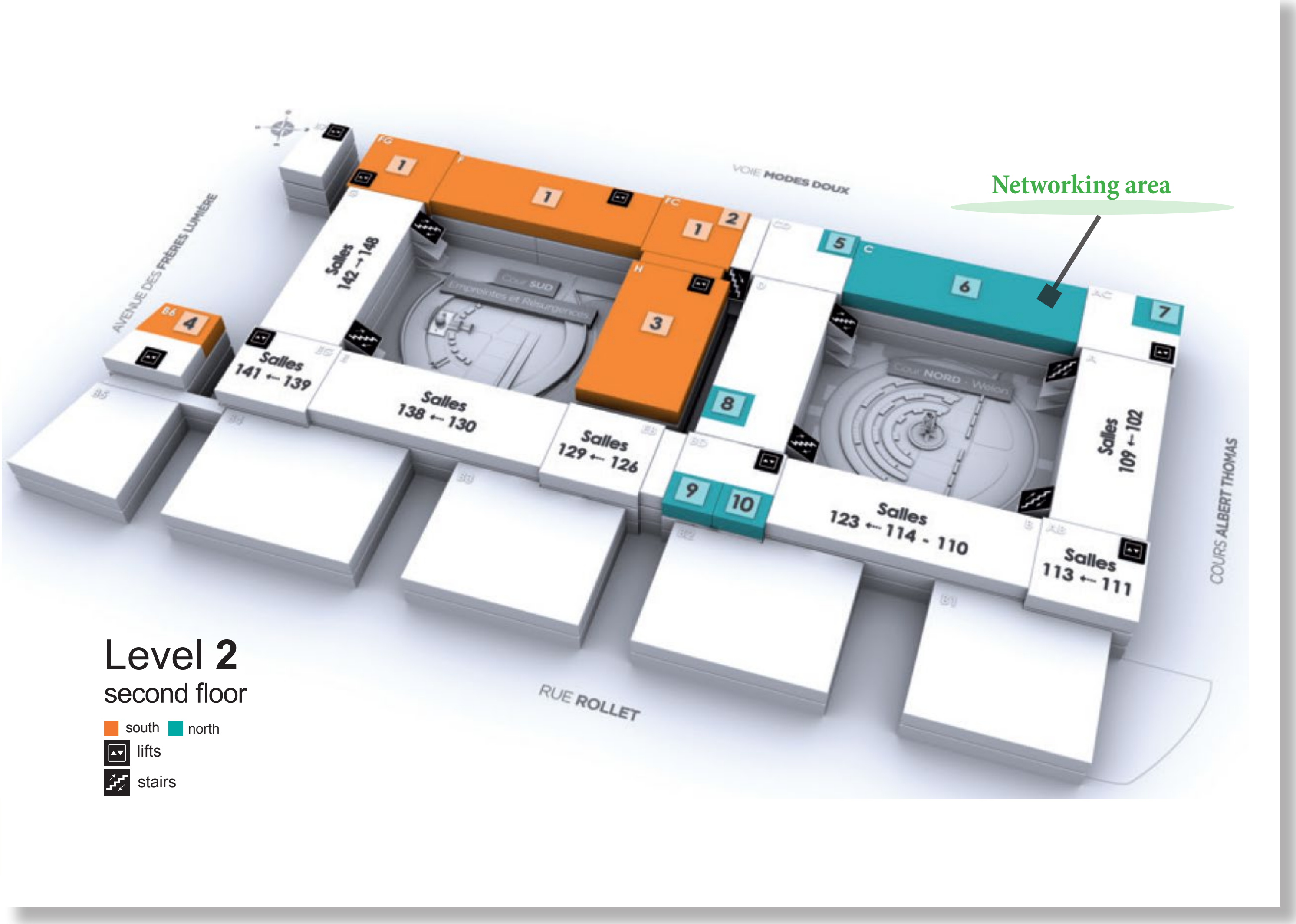
VOIE MODES DOUX
AVENUE DES FRÈRES LUMIÈRE
COURS ALBERT THOMAS
RUE ROLLET
Cour SUD
Empreintes et Résurgences
Cour NORD - Welon
Amphis P O
Amphi M
Amphis L K
Amphi J
Meeting rooms


Level 2
second floor
south
north
lifts
stairs
Networking area
VOIE MODES DOUX
AVENUE DES FRÈRES LUMIÈRE
COURS ALBERT THOMAS
RUE ROLLET
Salles 142 → 148
Salles 141 ← 139
Salles 138 ← 130
Salles 129 ← 126
Salles 123 ← 114 - 110
Salles 113 ← 111
Salles 109 ← 102

# IENE Awards

IENE recognizes and awards outstanding efforts made to reduce the detrimental effects of transport infrastructure on nature and enhance its potential for a positive influence. Such efforts may appear as extraordinary impact assessments, mitigation plans or technical measures at local, national or regional scale; research achievements, information, education or promotion activities.

The IENE awards are given in two variants.

- **The IENE Personal Award**
  appreciates outstanding engagement and special achievements made by individuals that are not necessarily related to a particular activity.
- **The IENE Project Award**
  appreciates extraordinary work accomplished by initiatives, activities or plans.

The chosen awardees of 2015* and 2016 are:

**Jean Carsignol (Personal Award 2015)**

*"For his outstanding achievements and personal engagement concerning the mitigation of negative impacts of infrastructure on nature. During the past decades, he has accomplished extraordinary work concerning road ecology in France. Thanks to his dedication and engagement, the subject has evolved significantly and he has inspired and supported many researchers and practitioners – not only in France."*

**Miklós Puky (Special Award 2015)**

The IENE Steering Committee decided to give a special award to Miklós Puky, who was a member of the IENE SC, a valued colleague and a dear friend, and unexpectedly passed away in March 2015.

*"For his long and enthusiastic dedication to IENE and its topics. With well-documented knowledge in ecology in general and amphibians in particular, he made an impressive work to engage people, students and children in nature conservation. He was a highly influential ecologist who tirelessly continued to contribute to the development of road ecology and will be missed by friends and colleagues all over the world."*

**Lars Nilsson (Personal Award 2016)**

*"For his personal commitment and extraordinary achievements concerning the mitigation of negative effects of transport infrastructure on nature and biodiversity. Apart from his important work concerning road ecology in Sweden he played a major and crucial role in the restart of IENE in 2009, as well as in the following years."*

**Handbook of Road Ecology (Project Award 2016)**

*"With a global coverage and beautifully done, the Handbook of Road Ecology connects current scientific knowledge and practical requirements to address the pressing issues of transportation infrastructure development. The book has 114 authors from over 25 countries. Rodney van der Ree and his co-editors Daniel Smith and Clara Grilo brought together the world's leading researchers, academics, practitioners and transportation agency personnel to present the current status of the ecological sustainability of the linear infrastructure. The success of the book has been impressive and it is a very inspiring book that is attracting more people to the field of road ecology. It simply is by far the best book ever written in this field."*

* In 2015 there was no winner of the Project Award due to lack of nominations.

# Field Trips

# Tuesday August 30th

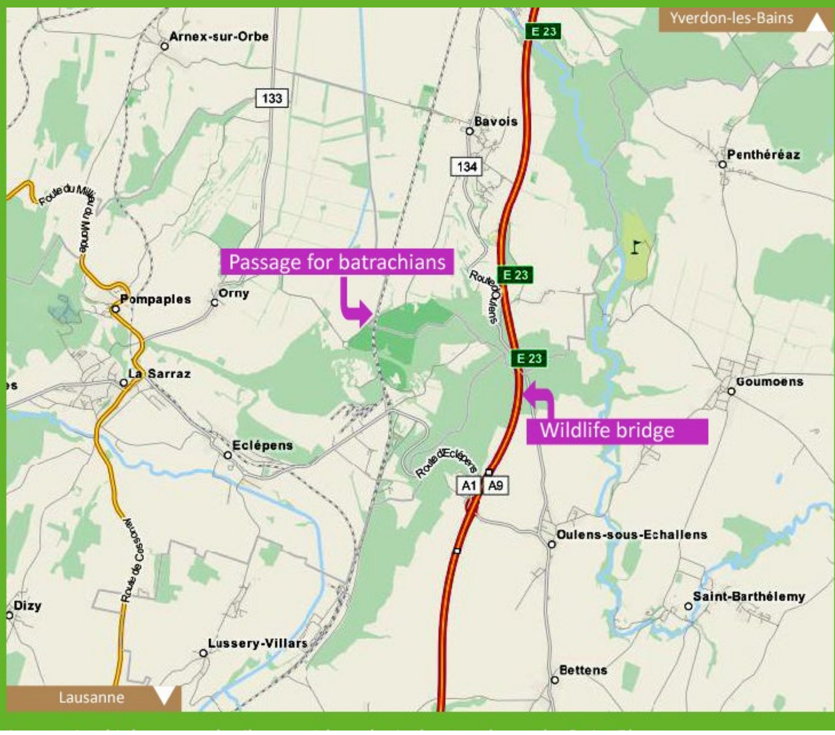
# Field trip 1 - Switzerland – Highway and railway integrations into the ecological networks of the Swiss Plateau (Vaud canton)

**Author(s):** Marguerite Trocmé

**Contact:** Marguerite Trocmé, Federal Roads Office (FEDRO), Mrs Marguerite Trocmé, Director of Environment, Department, Federal department of environment, transportation, energy and communication, DETEC

**E-mail:** marguerite.trocme@astra.admin.ch

Integration highways and railways with ecological networks on the Swiss Plateau




The Swiss transport network contains more than 70'000 km of roads, and 5'000 km of railways and . has the 5th most densest road network in the world. The majority of the population and the infrastructures are gathered on the Swiss Plateau and as a consequence, ecological corridors are highly disturbed in this region.In the canton of Vaud,the Oulens-sous-Echallens and Eclépens area, acts as an ecological hub on the Swiss Plateau. This rural area includes natural elements with important ecological values such as the Venoge river and the chalky Mormont mountain (classified as a protected national landscape). Both the N1 highway, connecting east and west, and the railway crossing the country from north to south, run through those natural elements.

**Site n°1:** N1 highway's wildlife overpass at Oulens-sous-Echallens. is an integral part of the national remediation plan for the wildlife corridors, and was built during highway's maintenance works in 2011.

**Site n°2:** amphibian tunnel, built during the rehabilitation of the railway tunnels and access through the Mormont mountain.

**Site n°3:** Ecological compensation's measure for deforestation linked to railway rehabilitation works, with the creation of a clearing to increase the forest's biological diversity and the value of the woodland's lanscape

# Field trip 2 - West of Lyon – Environmental integration of a new motorway: the A89 in the Massif Central

**Author(s):** Philippe Chavaren

**Contact:** Philippe Chavaren, Head of the Nature, Landscape and Green Constructions Division ASF network Direction Technique de l'Infrastructure 74, allée de Beauport – CS 90304 – 84278 Vedène Cedex; France

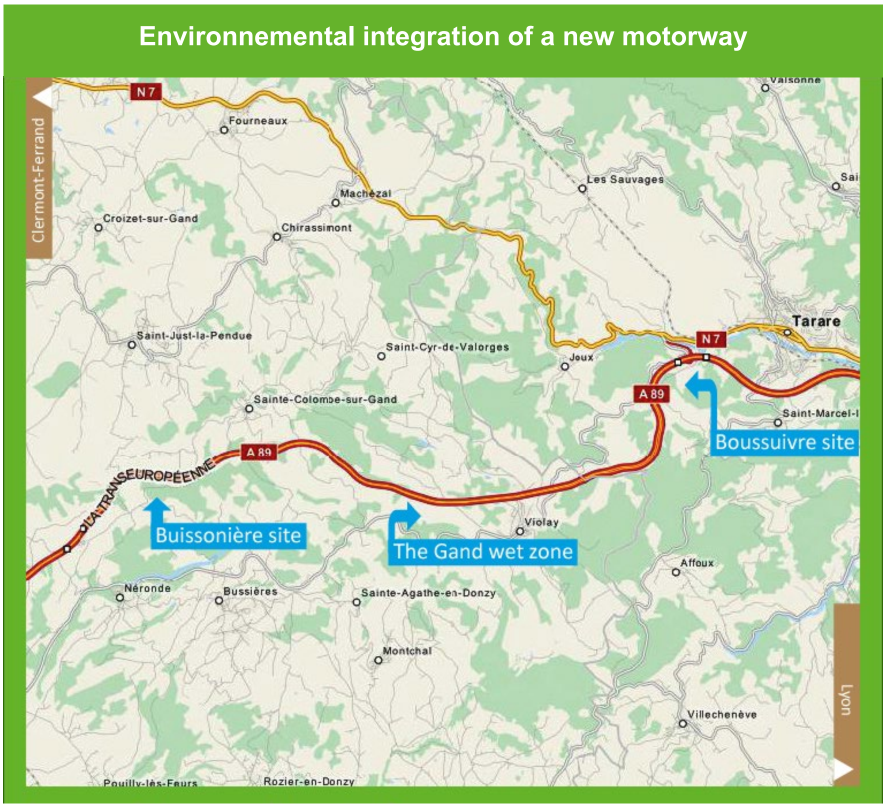
**E-mail:** philippe.chavaren@vinci-autoroutes.com

**URL:** http://www.vinci-autoroutes.com//

**Site n°1:** Avoiding, reduction and compensatory measures in sensitive areas Protection of river strong aquatic fauna stakes: white-clawed crayfish, sculpin, fario trout…Ecological engineering to close off a river and recreate expanding flood areas

**Site n°2:** Compensatory measures in the Gand wet zone Recreation of a river and it's connected wetland building an oversized hydraulic structure

**Site n°3:** Reduction measures to protect water systems, landscape and ecological continuities Large and small fauna underpasses Bat overpass Rainwater treatment basins



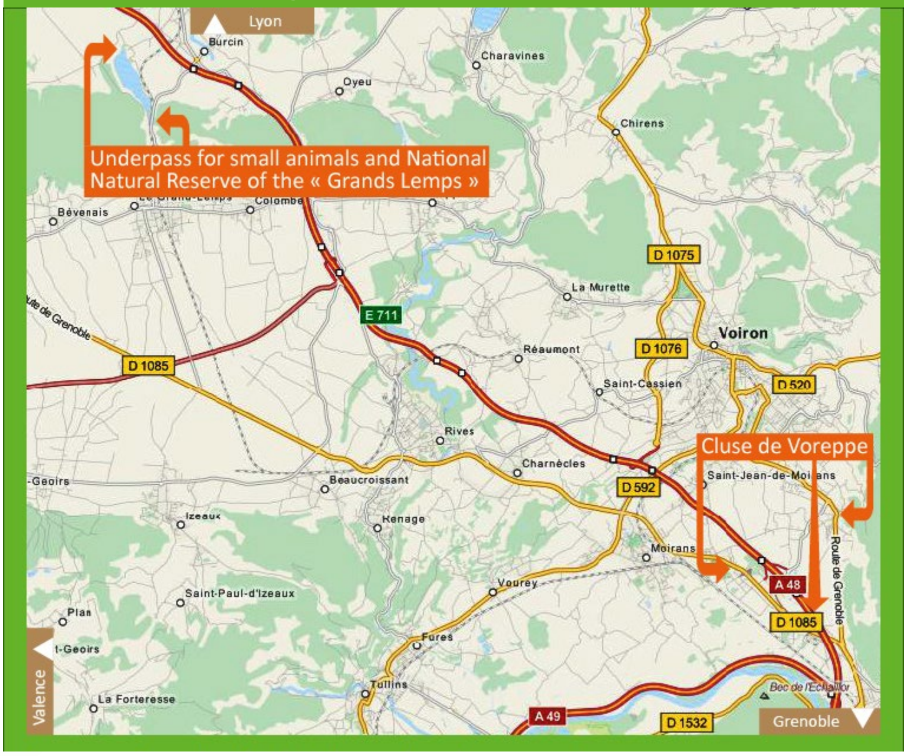
# Field trip 3 - Recreation of ecological networks, mutualized compensatory measures and visit of the National Natural Reserve of the Grand Lemps peatland

**Author(s):** Anne-Sophie Croyal, Dominique Pallier, Sandra Quivet, Yves Urbain, Grégory Maillet

**Contact:** Anne-Sophie Croyal, Coordinatrice des continuités écologiques Département de l'Isère Service Développement Durable - Direction de l'Aménagement 7 rue Fantin Latour BP 1096 - 38022 Grenoble Cedex 1 Tel.: +33 (0)4 76 00 64 30

**E-mail:** anne-sophie.croyal@isere.fr

Recreation of ecological networks and compensatories measures




The Department of Isère coordinated a project of restoration and conservation of 6 wildlife corridors in the Grésivaudan Valley and the Voreppe Gorge between 2008 and 2015. These two sites were identified as priorities in the Isère ecological network in 2001. Two studieswere conducted in 2004 and 2006 by the Grenoble Region's Urban Planning Agency and theSwiss research firm Econat to define the corridors and the actions to be implemented. Following these studies, a working consultation was held with both the financial partners (Europe, Rhône-Alpes Region, the Water Agency and AREA) and technical partners (municipalities and inter-municipal districts, hunting and fishing associations, Chamber of agriculture, and LPO). This «Corridors of Life» project also included advocacy, communication, management of the corridor space and actions to mitigate points of conflict: creation of a small wildlife passage, developments on and under motorways but also the installation of wildlife detectors or two developments under county (departmental) roads.

**Site n°1:** Life corridor of the Cluse de Voreppe Wildlife warning system
Fauna underpass crossing a local roas

Global strategy of compensatory measures linked to motorways interchanges projects and overpass project crossing A48, to recreate a local green and blue infrastructure

**Site n°2:** National Natural Reserve of the Grand Lemps peatland Design and management of the 2nd largest small fauna passage underpass in Europe

Visit of the peat-bogs garden

# Field trip 4 - Reconnecting ecological networks through existing infrastructures: motorway A7 and High voltage line in the Drôme

**Author(s):** Cedric Heurtebise, Michel Aujoulat

**Contact:** Cedric Heurtebise

**E-mail:** cedric.heurtebise@vinci-autoroutes.com
michel.aujoulat@rte-france.com


The Vinci Autoroutes-réseau ASF network is carrying out redevelopment programmes on its existing motorway network to promote biodiversity, study needs, make improvements and monitor them. These programmes are part of the implementing guidelines of the national policy «Trame Verte et Bleue» and may give concrete form to certain actions of the Regional Ecological Coherence Schemes (SRCE).Managing Vegetation under High and Very High Voltage Power Lines The RTE, is the managing body of high and very high voltage power transmission lines and responsible for achieving the balance between the production and consumption of electricity. It delivers electricity to any point in the territory from its production sites to industrial sites that are directly connected to the network and to distribution networks serving end consumers. To ensure the safe supply of electricity to all, the challenge in wooded areas is to ensure that the vegetation is not too close to electrical cables. The LIFE Elia-RTE Project Initiated in 2011, the European project LIFE Elia-RTE (www.life-elia.eu) is partly funded by Europe (the LIFE programme) and brings together Elia, the managing body of the Belgian electricity transmission network and RTE, with the same aim: trying out innovative methods of vegetation management under power lines in order to preserve biodiversity. The project benefits from the expertise and know-how of two Belgian environmental protection associations: CARAH and SOLON.

**Site n°1:** Motorway A7, wildlife overpass at the Grand Boeuf site Stakes and ecological engineering above a motorway in service

Monitoring tools and results

**Site n°2:** Creating green and blue corridors under electrical overhead lines in the national natural reserve of Ramières (LIFE 10 NAT/BE/709) Stop the isolation of great crested newt local populations: restored educational pond and created new ecological link up to the Drôme valleyExcavation of pools for great crested newt

Management of a damp meadow using equine grazing

**Site n°3:** Creation of the Roublion fish passage upstream of the Motorway A7 Ensuring the continuity of rivers to restore the free movements of fish fauna

Monitoring systems and results (fish fauna and European beaver)

# Field trip 5 - Banks of Saône River renaturation

**Author(s):** Nélia Dupire

**Contact:** Nélia Dupire, Chargée de mission - Centre de ressources sur la biodiversité Service observation et valorisation des données Délégation du développement urbain ; cadre de vie/ Direction de la planification

**E-mail:** ndupire@grandlyon.com

**URL:** http://www.lesrivesdesaone.com/

Along the banks of Saône, you will discover a development project that reactivates the nature strength and builds bridges to reconnect banks with the city of Lyon. This project contributes to a local green and blue infrastructure, as part as the green and blue infrastructure french policy. During this walk, you will see how protected species of plants have been taken into account and which still requiere compensatory measures. In order to prevent biodiversity loss, an experimentation is currently being carried out during the harvest with the multiplication of native seeds and by replanting them on the banks, to enhance wild population.

# Abstracts

# Wednesday August 31st

## Plenary Presentation- P1

# The evolution of Road Ecology reflected through 20 years development of the Infra Eco Network Europe (IENE)

**Author(s):** Anders Sjölund

**Contact:** Anders Sjölund, Swedish Transport Administration

**E-mail:** anders.sjolund@trafikverket.se

**URL:** http://www.iene.info/

Road ecology, a science of growing importance for biodiversity and transport. 20 years ago the Infra Eco Network Europe (IENE) was established based on a growing insight of the great importance transport infrastructure have in biodiversity. The term Road Ecology didn't exist and was launched six years later. Still IENE and Road ecology is very closely connected. The evolution of Road Ecology, from a Science focused on explaining ecological impact from Roads through explaining ecological functions to influencing transport planning and transport development can be explained through the Eyes of IENE and its 20 years of existence.

## Plenary Presentation- P2

# Bern and Landscape conventions: crossed points of view

**Author(s):** Maguelone Dejeant-Pons, Iva Obretenova

**Contact:** Maguelone Dejeant-Pons, COE - European Landscape Convention

**E-mail:** Maguelonne.Dejeant-Pons@coe.int

The Bern Convention on the Conservation of European Wildlife and Natural Habitats The Council of Europe is the oldest European organisation, which now covers all the European Continent with its 47 member countries. It has been the first organisation to recommend, already in 1961, the creation of a permanent international system of co-operation on nature protection. Since 1965, the Council of Europe has pioneered such cooperation through the creation of the European Diploma for Protected Areas, a prestigious international award granted, after careful examination, to areas of extraordinary ecological value and of exemplary management. Today, the Network of areas holding the European Diploma is composed of 74 zones from 29 countries across the European continent, with a most recent award of the Diploma in 2015. Since the early 1970's, the organisation has gradually cantered its work on nature conservation and protection of natural resources, until the opening to signature of the Bern Convention, in 1979. Today, the Convention has 51 Contracting Parties, among which 4 African states and the European Union. At the time of its birth the Bern Convention was unique for recognising the intrinsic value of wild flora and fauna, which needs to be preserved and passed to future generations as it constitutes a "natural heritage of aesthetic, scientific, cultural, recreational, economic and intrinsic value". The approach of protecting both species and habitats, including migratory ones, was innovative and forward-looking. The Convention has its own mechanisms for standard setting and monitoring of compliance by its Parties. It further benefits from a unique cooperation with the non-governmental sector through its case-files system, as NGOs but also citizen groups or even individuals can alarm on an alleged breach of the Convention by any Party. The Convention regularly receives such complaints, including on issues which concern the energy and transport sectors and their possible negative impact on the landscapes, habitats and species through fragmentation and other various cumulative impacts. In 1989, the creation of the Emerald network of Areas of Special Conservation Interest was recommended by the Convention, as a tool for its Contracting Parties to implement their legal obligations. It is thus often forgotten that it is the Bern Convention that is at the origin of the adoption of what many call "the cornerstone of Europe's nature conservation policy", the EU Habitats and Birds Directives. The adoption of the Calendar for the implementation of the Emerald Network (2011-2020), in the aftermath of the agreement on the world Aichi biodiversity Targets, triggered sustained commitment from the national authorities of all Contracting Parties to the Convention which are non-EU member states towards the network constitution. By June 2016, the Network covers nearly 3 500 candidate or fully certified Emerald Network sites in 16 countries, covering almost 600 000 km² and an average of 12% of the national territories of the countries involved. Nowadays, the vocation of the Emerald Network is to complete the Natura 2000 Network beyond the EU in a coherent manner.

# Talk- 1.1

## Aquatic and terrestrial fauna passages

# Design of fauna underpasses

**Author(s):** Antonio Righetti

**Contact:** Antonio Righetti, B+S AG, Bern

**E-mail:** a.righetti@bs-ing.ch

Background and approach To reconstruct interrupted national wildlife corridors, functional wildlife passages (overpasses and underpasses) that cross transportation infrastructure are necessary. The corresponding VSS norm SN 640694 recommends the implementation of wildlife over-passes. However, in practice it is not always feasible to build overpasses. The-refore, underpasses are also planned and constructed. Unlike for overpasses, the VSS or the federal government do not provide standards for dimensions of such underpasses. 24 underpasses in Germany, France, The Netherlands, Austria and Switzerland were assessed with a field study or by using existing data. In the field study, the underpasses were surveyed with camera traps for at least three weeks and frequencies of usage by wildlife per 24 hours were estimated. Furthermore, local experts were interviewed with a standardised survey. For each underpass, further local factors that could affect the usage of the underpass, like forest area, wildlife density, guiding structures, accessibility as well as anthropogenic disturbance, were recorded. The data was analysed making use of pairwise Pearson correlations, linear regression models and regression trees. Subsequently, the results were compared with current literature and discussed. Results, discussion Roe deer accepted almost all assessed underpasses. Despite the regular occurrence in the surroundings of many underpasses, red deer and wild boars each passed only three structures. Animals mainly crossed at night (84%). On ave-rage, 1.1 wildlife crossings and 3.1 crossings by humans or pets were recorded per 24 hours. The most important factors that enhanced the usage of underpasses by wildlife were the area of forest in a radius of 2 km and the area of guiding structures 100 m around the underpasses. Anthropogenic disturbance had a negative effect on the usage by wildlife. From approximately two human crossings per 24 h, less wildlife crossings can be ex-pected. No significant correlation was found between acceptance of ungulates and the width (10-54 m), height (2-10 m) or openness (0.58-16.7) of the underpasses. Results from the literature review highlight the importance of the location of underpasses within forested areas and a functional connectivity network as well as the strong potential effect of anthropogenic disturbances. Authors agree furthermore that many groups of animals – including un-gu-lates – use wildlife overpasses clearly more often than underpasses. In some countries the-re are regulations and recommendations for the dimensions of underpasses, but these di-men-sions vary greatly between countries. Recommendations When planning and implementing fauna passages in national wildlife corridors, the fol-lo-wing should be considered: In principle, the aim should be to implement wildlife overpasses instead of underpasses.Wildlife underpasses should be located within forest areas or at least be well connected to the surrounding forest habitats with guiding structures on either side of the underpass. The functionality of these elements should be secured for the long-term. Sources of anthropogenic disturbance within or in the direct surrounding of wildlife under-pas-ses have to be prevented. Nevertheless the present research don't allowed to derive re-com-mendations for optimal dimensions of wildlife underpasses, practice shows that such guidelines are necessary.

## Talk- 1.1

### Aquatic and terrestrial fauna passages

# Effects on fish from sedimentation ponds for traffic run-off may be related to pah transfer from sediment to biota

**Author(s):** Sissel Brit Ranneklev, Merete Grung

**Contact:** Sissel Ranneklev, Norwegian Institute for Water Research (NIVA)

**E-mail:** SRA@niva.no

Contaminated runoff from roads, including tunnel wash water is an important source of pollution to the aquatic environment. To minimise the impact from direct release of runoff waters, mitigating actions such as sedimentation ponds have been installed in areas with dense vehicle traffic. These ponds often have established ecosystems. The purpose of this study was to investigate a) if the fish from the ponds showed reduced condition or if biomarkers indicated effects of run-off; b) the transfer of PAHs from runoff material to organisms could explain the effects observed. Levels of CYP1A enzyme and DNA single trand breaks were higher in fish from a sedimentation pond than from the nearby river. The condition index of the fish from both the sedimentation pond and the river were significantly reduced compared to levels found fish from a pristine lake unaffected by traffic. Also PAHmetabolites in the bile of fish from the sedimentation pond and the nearby river were two orders of magnitude higher than fish living in the pristine lake. The results indicate that the fish were affected by the run-off from traffic, and were in accordance with previous results indicating a relationship between contaminants related to traffic and responses in fish. The results will be discussed in light of the isomer composition of the PAHs in different aquatic matrices from the ponds (water, sediment, plants and organisms) as means for source apportionment of the PAHs.

## Talk- 1.1

### Aquatic and terrestrial fauna passages

# Fish, waterways and roads – the challenges of combining hydrology and dynamic systems with stationery and static infrastructure

**Author(s):** Fabrice Ottburg, Matt Blank, Paul Wagner

**Contact:** Fabrice Ottburg, Wageningen University ; Research Centre, Alterra Environmental Science Group Team Animal Ecology

**E-mail:** fabrice.ottburg@wur.nl

This presentation focuses on fish that use fresh-water systems and provides solutations to minimise the effects of roads and road-stream crossings on fish and fish habitat. In order to complete their life cycles, fish need to move throughout waterways in their range to reach their spawning grounds, rearing areas or food resources. Streams providing necessary habitat are often in close proximity to or crossed by roads and railways, which can lead to habitat degradation and barriers fish movement. By degrading and isolating habitats, barriers can decrease fish populations and in some cases contribute to the total loss of a species.Steps typically taken to create and protect roads near streams include straightening channels or placing very large rocks or concrete reinforcement to stabilise banks. These generally result in loss of habitat and potential impacts to fish and wildlife populations. The dynamic character of streams and rivers and their changing nature needs to be accommodated in planning, expanding or operating transportation infrastructure where roads and other linear infrastructure cross water or occur in a floodplain. This is necessary not only to minimise direct ecological effects to habitat and fish, but also to help reduce the potential damage to infrastructure from flooding, erosion and channel movement. Damage to infrastructure can often lead to additional environmental impacts. New infrastructure should avoid waterways where feasible and any crossings that are needed should be designed to allow the natural flow and function of the waterway. Existing road crossings that are barriers to the movement of fish should also be modified to be more natural and improve connectivity or fish and the support of natural stream function.This abstract is based on two chapters which recently have been published in Handbook of Road Ecology (Van der Ree, Smith and Grilo edt., 2015). This involves chapter 44 'Form and function: a more natural approach to infrastructure, fish and stream habitats' written by Paul Wagner and chapter 45 'Solutions to the impacts of road and other barriers on fish and fish habitat' written by Fabrice Ottburg and Matt Blank.

# Talk- 1.1

## Aquatic and terrestrial fauna passages

# Defragmentation of the motorway “A63 Landes” for the critically endangered European mink: evaluation of the use and effectiveness of underpasses restored on existing hydraulic bridges

**Author(s):** Christine Fournier-Chambrillon, Vanessa Maurie, Manon Batista, Romuald Hugues, Eric Barlet, Pascal Fournier

**Contact:** Christine Fournier-Chambrillon, Grege

**E-mail:** c.fournier-chambrillon@wanadoo.fr

Creation of underpasses on roadways is a main action for reducing wildlife road mortality and habitat fragmentation, particularly for the critically endangered European mink Mustela lutreola. As part of the carriageway widening of the motorway A63 between Salles and Saint-Geours-de-Maremne, through 104 km of the remaining French European Mink population in south-western France, 33 existing hydraulic bridges were rehabilitated to implement underpasses from 35 to 90 meters long. Various types of passageways were built using diverse materials and techniques specially adapted to the local characteristics of each bridge, taking into account the hydraulic constraints and the limitation of impacts on watercourses and habitats during the fieldwork. Evaluation of the use and effectiveness of 28 underpasses were monitored between April 2013 and December 2014, during seven sessions of about 50 days. Eighty-two passageways of six different types (wood or concrete ledges, pontoons …) were monitored using ink footprint traps. Eighteen species or species-group were identified, showing the crossing of Mammals through all underpasses and 81/82 passageways. Small Carnivores were detected on 24 underpasses, among which 11 including Otter Lutra lutra, and 9 including European or American mink Neovison vison. At the end of the study, five indicators were used to determine the level of utilization of the passes by the fauna: the frequency of detection of the « small » micromammals, the rate of crossing of « large » micromammals and of small carnivores, the specific diversity of small carnivores (including Otter) as well as the total specific diversity. The utilisation rate by the mammal fauna differed between underpasses: a “very low” rate was recorded for seven of them, a “low” rate for six, a “middle” rate for seven, and a “good” rate for the eight last. Causes of this effectiveness variability could not be clearly identified, except some problems of connexion to the river bank, or of access to the bridge. However, the utilisation rate by small carnivores tripled from 2013 to 2014, suggesting a habituation (reduction of shyness), thus a probable increase with time of the effectiveness of the underpasses, after 40 years of partitioning by the former road RN10. These rehabilitations confirm the possibility of adapting the underpasses and their effectiveness to all the types of existing bridges, since we break preconceived ideas and since the design and the fieldwork are accompanied by a mammal specialist of these topics.

## Talk- 1.1

### Aquatic and terrestrial fauna passages

# Stream sections under road bridges as conservation hot-spots of native crayfish and fish species

**Author(s):** András Weiperth, Blanka Gál, János Farkas, Géza Gelencsér, Miklós Puky

**Contact:** András Weiperth, H-1113 Budapest, Karolin út 29

**E-mail:** weiperth.andras@okologia.mta.hu

Most biological studies on linear infrastructures focus on fragmentation, road kills, invasion by exotic species, effect of air, noise and chemical pollution on animal behaviour or the effect of preventing measures. Relatively little attention is given to the habitat function of different types of streams and channels under the road, motorway and railway bridges. In the last decades the results of monitoring indicated that not only the ecological status of water bodies are changed negatively by human activities, but also the population of several native aquatic animals are substantially reduced in Hungary. Recently the researches have few information about the role of aquatic habitats in streams beneath and around bridges. In 2013 a research program was started by MTA Centre for Ecological Research and Vox Vallis Development Association (managing organisation of Koppányvölgy Natúrpark in Somogy County). Crayfish and fish faunistical assemblages were surveyed by electrofishing once in each season beneath and around seven bridges of the Koppány-stream. Each sampling area is a section consisting the neighbouring upstream and downstream from the bridge as well, and the sampling sites were characterised by 11 environmental variables. Apart from the wastewater load there are intensive anthropogenic effects on the catchment area, most of all the diffuse contamination as the consequence of the intensive crop production, which imposes a considerable risk on the natural values of the stream and its tributaries. The presentation summarises results of three research seasons between 2013 and 2015. One native crayfish species was presented by samplings. All of the 137 individuals could only be caught under the bridges, where the current velocity and sediment composition were optimal for them. A total of 3571 individuals of 29 fish species were caught, with 2031 individuals of 23 species being juveniles. Four of the species was non-native (Carassius gibelio, Neogobius fluviatilis Pseudorasbora parva, Lepomis gibbosus). The reophil cyprinid fish species (Alburnoides bipunctatus, Cobitis elongatoides, Gobio gobio komplex, Romanogobio vladykovi) were caught in the middle and upper section of Koppány stream only in the sampling sites at bridges, because the current velocity and the sediment composition were optimal at different water levels at these sections. The non-native and native eurytop species were represented equally in each section, but in summer, in the low water level period the abundance of each fish species were higher under the bridges. The results presented that aquatic habitats under bridges had key role in conservation of native reophil species composition in a modified stream.

## Talk- 1.2

### Infrastructure and biodiversity in Asia

# Do more roads finally spell the end for tigers?

**Author(s):** Ashley Brooks

**Contact:** Ashley Brooks, WWF Tigers Alive Initiative

**E-mail:** abrooks@wwfnet.org

Tigers occupy a site because there is prey present. They persist in the long term due to habitat connectivity at the landscape scale. As this connectivity breaks down, otherwise healthy tiger populations become isolated, are increasingly in contact with people, and their numbers typically decline and disappear from that area. The devastating decline of the global tiger population by 97% over the 20th Century was in large part brought about by such habitat fragmentation and loss. However, the speed and scale of these historic forces are set to dramatically increase over the next 30 years through unprecedented investments in linear infrastructure spanning the entire tiger range. Linear infrastructure poses significant threats to the ecological health of tiger landscapes through gradual fragmentation and loss of connectivity, and providing access to new areas. As human populations rise rapidly, the pressure to produce more food and fiber from finite land and resources grows at an equal pace. The resulting rural landscapes become a patchwork of settlements, agriculture and crops, and interspersed with natural environment. And all linked via extensive transport infrastructure. The pace of economic growth across the tiger range1 is expected to continue at speed. The region is already the global population center, and is rapidly becoming the largest economic and consumption zone and the home to the majority of the world's middle class. The speed of economic development and resource demand mean that significant increases in road networks and economic corridors will be needed to serve the expansion. Remnant natural habitat in remote and trans-boundary areas is also increasingly sought after for development, access and extraction. It is these remote and previously inaccessible areas where the remaining 3,200 tigers currently reside. Tiger survival is thus in an unenviable position up against fundamental human and economic development across its range. Finding the right balance and mutually agreeable actions and plans is therefore critical to achieving the dual objectives of tiger conservation and human development. Considering the historical failure to protect core tiger areas and landscapes, it is vital to put in place long term infrastructure actions at both the site and national levels that ensure the persistence of tigers while fostering human and economic development. To this end, WWF is working at a range of sites across the tiger range to support the maintenance of ecological corridors and landscape connectivity. The opportunity exists to demonstrate that the impending expansion of infrastructure does not have to proceed at the cost of tiger recovery and protection. Solutions exist but they need to be delivered. Indeed, the persistence of tigers across commodities landscapes and transport networks can be an indicator for the quality of development that emerges there. This presentation will give an overview of the current context of tiger recovery and the status of infrastructure and infrastructure planning across tiger landscapes. It will also show how WWF is currently responding to the challenges, and expose the deep gaps in our abilities to reconcile tiger recovery and national economic imperatives.

# Talk- 1.2

## Infrastructure and biodiversity in Asia

# Integrating ecosystem services and wildlife into road planning in Myanmar: the case of the Dawei road

**Author(s):** Hanna Helsingen, Nirmal Bhagabati

**Contact:** Hanna Helsingen, Green Economy Team Leader, World Wide Fund for Nature (WWF) Myanmar

**E-mail:** hanna.helsingen@wwfgreatermekong.org

Poorly planned linear infrastructure can have many negative impacts, degrading essential benefits that people in Myanmar derive from their natural environment and biodiversity. The Dawna Tenasserim Landscape in southern Myanmar is one of the last large intact forest landscapes in the region, harboring a rich array of wildlife. The forest blocks in Tanintharyi link two forest blocks in Thailand, the Western Forest Complex and Kaeng Krachan Forest Complex. Establishing an ecological corridor would support wildlife and ecosystem services, critical to the well-being of people in the area. The Dawei Special Economic Zone (SEZ) and its planned road link will cut across the Tenasserim Hills connecting Dawei with Bangkok, via Kanchanaburi. If not planned and constructed thoughtfully by taking into account the impacts on nature and society, this area stands to lose much of its wildlife and ecological integrity, with serious consequences for the well-being of local people and Myanmar's economy. To address this issue, a tool called InVEST was used to assess the natural capital of the area and the ecosystem services they provide: carbon, water yield and soil retention. This information was used to show how the road impact but also depend on ecosystem services and scenarios of land use change scenarios show how the provision of these services could change. Species expert opinion and local data was used to model species corridors in order to inform decisions on design and location of bridges and culverts along the Dawei road that could be adapted to accommodate various species. The findings highlight a number of environmental issues from the planned road, both direct and indirect but also identify measures, including wildlife crossings that can mitigate these impacts. The work on the Dawei road can help inform national transport planning in Myanmar as well as the rest of South East Asia. As Myanmar's transport infrastructure develops and comes closer to forests and key biodiversity areas (KBAs), it is critical that ecosystem services and wildlife are taken into account in planning, design and construction of roads and railways.

## Talk- 1.2

### Infrastructure and biodiversity in Asia

# Plan for Ecological Corridors: Reconnect the Baekdu daegan in South Korea

**Author(s):** Donggul Woo, Taeyoung Choi

**Contact:** Donggul Woo, National Institute of Ecology, Korea

**E-mail:** donggul.woo@gmail.com

The Korean transportation network is the 11th densest network in the world, composed of over 265,000 km of roads and 3,000 km of railways. Within this highly developed transportation network, the Baekdudaegan mountain range, running through most of the Korean Peninsula, provides habitats for wildlife as well as significant ecological corridors. Despite its ecological importance, this vast mountain range is disconnected at the Chupungryeong Pass by a railway and three roads, including a highway. These railway and roads divide the landscape and pose an immense threat to wildlife movement in the heart of the Baekdudaegan mountain range. To alleviate the threat, we conducted landscape connectivity assessment as a part of a larger plan to restore ecological corridors in the Baekdudaegan mountain range. Emphasizing focal species, such as the yellow-throated marten (Martes flavigula), the leopard cat (Prionailurus bengalensis), the Korean hare (Lepus coreanus) and the Siberian flying squirrel (Pteromys volans), we investigated the habitat fragmentation through camera traps and assessing road kills. Our research revealed the significant disconnection between the fragmented habitats. No focal species were found in the two middle sections located between the roads and railway. In 2015, the Korean Congress granted a plan to build wildlife crossings at the Chupungryeong Pass. According to this plan, three 50 m wide consecutive wildlife overpasses will be constructed over each road and railway to connect the fragmented areas. Multiple governmental and non-governmental organizations are committed to this grand plan to purchase land adjacent to the crossings, construct the crossings, evaluate the effectiveness of the structures. We plan to monitor the population dynamics and gene flow of species from three taxonomic groups, such as a ground beetle, forest bird, and mammal, which are vulnerable to fragmentation, pre and post of the construction. This is the first initiative in South Korea to build an ecological corridor with multisector collaborations and partnerships as well as systematic monitoring and evaluation. We expect that the plan will be the first step to help re-establish wildlife connectivity at the Baekdudaegan mountain range and provide a comprehensive example of the systematic establishment of ecological corridors.

## Talk- 1.2

### Infrastructure and biodiversity in Asia

# Road-Transport Infrastructure Development under China-Pakistan Economic Corridor Programme: Implications for biodiversity and ecological conservation

**Author(s):** Khalid Farooq Akbar

**Contact:** Khalid Akbar, Prof (Retd). of Botany Govt. Post-graduate College Sahiwal Pakistan

**E-mail:** kakbar5813@gmail.com

Last year, China and Pakistan signed MOUs and agreements for a regional mega infrastructure development programme (China-Pakistan Economic Corridor, CPEC) worth 46$bn. This programme is part of a Chinese master plan titled "One Belt, One Road" including a planned network of road, rail, oil & gas pipelines and maritime routes stretching from China to South and Central Asia, to increase Chinese influence in the region and bridge the region's infrastructure gap. The proposed CPEC economic corridor will connect the north-western Chinese province of Xinjiang with the Pakistani port of Gwadar through a network of roads measuring around 3000 kms, providing Pakistan its much-needed economic infrastructure. This road network will reduce the distance between China (Kashghar, 4376 km from Beijing) and the Arabian Sea to 2500 km as opposed to the existing distance of 13000 km and reduce the shipping time from 45 days to just 10 days. The proposed roads under this programme will pass through the areas of Pakistan which are rich in biological and ecosystem diversity. These areas contain the nation's most important natural forests, diverse ecosystems, extensive mineral reserves, a wealth of biodiversity, and a rich cultural and archaeological heritage. These roads will pass through world's famous mountain ranges (Himalaya, Karakoram, Hindu Kush). These mountain ecosystems contain nearly 50% of the total floral and faunal diversity of Pakistan. After that, these roads will pass through plateaus of Potohar and Balochistan which have unique topography and biodiversity. In future, there are plans to extend this road network to the Central Asia and Iran by building additional roads which will pass through the Western provinces of Khyber PakhtunKha and Baluchistan increasing the pressures on biodiversity of these areas. Road networks present challenges for biodiversity by land take, loss and degradation of habitats, habitat fragmentation, increasing pollution and road mortality, barrier effects, noise, land use impacts and emission of green house gases. On the other hand, road verges also provide a vegetated cover along the length of the road. This may act as a corridor for flora and fauna to move around the landscape, and is considered by some to mitigate/compensate for the effects of fragmentation. The combined effects of CPEC road and rail infrastructure development programme pose large scale conservation and ecological consequences including serious threats to biodiversity and ecology of different regions of Pakistan. In this paper, the potential impacts of large scale road development projects under CPEC programme on the conservation of biodiversity in different regions of Pakistan and ecosystems are presented. It also includes recommendations for a longstanding programme of scientific research, monitoring, evaluation and communication to mitigate negative impacts and enhance positive impacts of road construction and operation projects under CPEC programme.

# Talk- 1.2

## Infrastructure and biodiversity in Asia

# Fostering Sustainable and Resilient Infrastructure and its Financing

**Author(s):** Raul Frazao

**Contact:** Raul Frazao

**E-mail:** raul.frazao@gib-foundation.org

**URL:** http://www.gib-foundation.org

Global Infrastructure Basel Foundation (GIB) is a Swiss foundation based in Basel, Switzerland, working to promote the development and financing of sustainable and resilient infrastructure globally. Active since 2008, GIB works with multiple stakeholders ranging from city representatives to project developers and infrastructure financiers. By successfully launching SuRe® at COP 21, GIB is actively supporting infrastructure development on the project level. SuRe® was developed by GIB and Natixis through a multi-stakeholder process e.g. through EIB, GEF, Mirova, Bouygues Construction, General Electrics, WWF, OECD and many others, which makes SuRe® fundamentally different from other standards. SuRe® is a global voluntary standard and helps to integrate state-of-the-art sustainability and resilience aspects into infrastructure development and upgrade. SuRe® integrates leading standards and consists of 65 criteria divided into 14 themes spanning environmental, social and governance (ESG) aspects. SuRe® aims to drive the integration of sustainability and resilient aspects into infrastructure through:- establishing a common language and understanding of sustainable and resilient infrastructure projects between project developers, financiers, local authorities and end-users;- providing guidance on how to manage sustainability and resilience aspects of infrastructure projects, both from a risk management and a benefit creation perspective, and starting from as early as possible in the projects' life cycles.SuRe® combines sustainability and resilience recognising the mutually beneficial relationships between both issues and the need to take a long-term view to infrastructure development in order to meet both present and future generations' needs. SuRe® can be used to leverage both public and private investments in infrastructure in a way that ensures cost-effective access to critical services while strengthening resilience, maximising social benefits and limiting the environmental footprint. SuRe® contributes moreover to the fulfilment of the Sustainable Development Goals (SDGs). The scope of SuRe® is not limited to greenfield projects. While project developers are encouraged to apply SuRe® as early as possible in the life cycle of an infrastructure, the standard can also be applied during the refurbishment and upgrading of brownfield projects. SuRe® will be compliant with the guidelines of ISEAL, the umbrella organisation for voluntary standards. To integrate sustainability and resilience also into the financial service value chain, GIB developed Credit SuRe, a credit rating blueprint based on SuRe®. It aims to enhance credit ratings of sustainable and resilient infrastructure projects by integrating sustainability and resilience into infrastructure project assessment in order to reflect the true risk of a project, thereby facilitating access to international debt markets. Furthermore, GIB provides with InSuRe an ESG risk assessment tool for insurers and underwriters based on SuRe® as well as UNEP's Principles of Sustainable Insurance (PSI). Considering sustainability and resilience factors in the underwriting process is likely to align pricing mechanisms for sustainable and resilient infrastructure projects and lead to affordable insurances whilst also supporting an insurers' investment decisions. GIB also provides services such as capacity building workshops and implementation services and has long-lasting experience in the South American, African and Asian markets.

## Talk- 1.3

### Wildlife crossing structures - Part 1/3

# You shall pass! A mechanistic evaluation of mitigation efforts in road ecology

**Author(s):** Christer Moe Rolandsen

**Contact:** Christer Rolandsen, Norwegian Institute for Nature Research - NINA

**E-mail:** christer.rolandsen@nina.no

The transportation infrastructure is rapidly expanding and are being upgraded to move goods and people in and out of populated areas. The impacts of roads and traffic are globally recognized as threats to the functioning of healthy ecosystems, and mitigation strategies are increasingly being adopted around the world. However, not all impacts can be fully mitigated, and not all mitigation measures are equally effective. Wildlife crossing structures encompass a broad range of natural (e.g. tunnel roofs) or artificial (e.g. grey and green bridges, culverts, underpasses) structures designed to provide habitat connectivity and reducing animal-vehicle collisions (AVCs). There is much to learn about their effectiveness and how they contribute to the preservation of green infrastructure, e.g. how many and what kind of structures do we need to reach the goals of mitigation. We attempted to contribute to this knowledge gap by studying the movements of 55 GPS-marked moose (Alces alces) in a study area surrounding Oslo Airport Gardermoen, in Norway. Within the study area the bigger roads are to a large degree fenced to avoid AVCs, and there is a large number of different crossing structures. Some of these were specifically built as wildlife passages while others were not. Our approach was to use Step Selection Functions (SSFs) to quantify to what degree different landscape features could be traversed by a moose (step). This model examined the effects of different land cover categories, landscape features, and different road related features such as wildlife fences, crossing structures and traffic volume. Crossing structures where split in three categories based on their expected suitability for wildlife use; 1) wildlife passages, 2) multi-use passages, and 3) grey passage (road bridge or underpass crossing another (fenced) road). Based on parameters from this model we discuss the effectiveness of different crossing structures for moose and how these results can inform us about how frequent such structures should be built to counteract the barrier effect of wildlife fences. We also discuss the effect of disturbance from road including traffic volume on moose movement as well as the effect of other landscape features.

## Talk- 1.3

### Wildlife crossing structures - Part 1/3

# Evaluation of the use and effectiveness of underpasses implemented on the new high-speed rail-road SEA between Tours and Bordeaux to maintain optimal permeability for semi aquatic mammals

**Author(s):** Pascal Fournier, Thierry Charlemagne, Delphine Quintard, Catherine Bout, François Gillet, Estelle Laoue, Vanessa Maurie, Nicolas Tranchant, Laurent Palissiere, Vinciane Leduc, Alain Bigot, Johan Michaux, Christine Fournier-Chambrillon

**Contact:** Pascal Fournier, Grege

**E-mail:** pfournier@wanadoo.fr

**URL**: http://www.grege.net/

As part of the construction of the 302 km new high-speed rail-road between Tours and Bordeaux, the highest level of mitigation measures to ensure continuous connectivity and permeability for semi aquatic mammals was implemented, particularly for the critically endangered European mink Mustela lutreola and the vulnerable Otter Lutra lutra. 173 crossing and bridges under the line were equipped for semi aquatic mammals, on every stream, from little ditches to main watercourses. Various types of passageways were built depending of the hydraulic facility: natural banks, 1 to 3 levels of staged concrete walkways on one side only or on both sides, culverts. A 5-year monitoring is ongoing to evaluate the use and effectiveness of these different types of underpasses for micro to medium sized mammals, using complementary methods: (1) monitoring of otter spraints places on the passageways and upstream to the infrastructure (2) ink footprint traps, placed on every passageway, even in the riverbed, targeting all mammal species, (3) hair-trap tubes targeting small mammals and (4) faeces-trap tubes targeting shrews, hair and faeces species being identified by genetic typing, (5) camera traps, to study the behaviour of the animals. In 2015, 45 first underpasses dispatched along the rail-road were monitored during 3 sessions of about 30 days. Survey of 253 potential otter spraints places revealed that in the south of the study area where the species is common, all types of underpasses were used efficiently, since habitats situated upstream were substantial and attractive. 3662 passages of 16 free-ranging mammal species or species-group were recorded in all the 33 underpasses monitored by footprint traps. 483 passages of small carnivores were recorded in 31 underpasses, with a significant preference for the highest available level of walkways by the common genet, stone and pine martens, and weasels, whereas otters preferred the river bed, and passages of polecats were insufficient to conclude. Genetic analyses of hairs and faeces revealed the presence of 10 free-ranging small mammal species in the surroundings of the 23 underpasses monitored with hair- and faeces-trap tubes, among which 6 were detected on the passageways, including the aquatic shrew Neomys fodiens. These preliminary results are promising, but the 5-year survey of in total 159 underpasses will be essential to correctly evaluate and compare, according to the local environmental parameters and the type of underpasses, the crossing of the different species through the infrastructure, especially as the habituation of the species and the ongoing reconstruction of plant-covered accesses are two undeniable components for the frequent use of the underpasses by the fauna.

## Talk- 1.3

### Wildlife crossing structures - Part 1/3

# Estimating crossing rates at wildlife crossing structures: How to improve our monitoring methods?

**Author(s):** Edgar A van der Grift

**Contact:** Edgar van der Grift, Alterra Wageningen URP.O. Box 476700 AA Wageningen Netherlands

**E-mail:** edgar.vandergrift@wur.nl

**URL:** http://www.alterra.wur.nl

Wildlife crossing structures are - usually in combination with wildlife fencing - aiming to reduce wildlife-vehicle collisions and facilitate wildlife movements across roads. Some sort of monitoring is often carried out immediately after construction of the crossing structures to assess whether they are used by the target species and what their crossing rates are. Various survey methods and sampling schemes are used, depending on e.g. the research question, the type of crossing structure, the target species and the available resources. Comparisons between research methods address the question which methods or sampling schemes are preferable over others, but such studies are rare. Partially based on the SAFEROAD project (www.saferoad-cedr.org), we evaluated four case studies that illustrate the importance of choosing proper monitoring methods. Case 1: comparison of the use of camera traps versus track beds in assessing crossing rates at two overpasses (Highway N524, Netherlands). Case 2: comparison of the use of one, two, or three track beds at two overpasses (Highway N524, Netherlands). Case 3: comparison of the use of ink track plates at one or at both entrances of seven underpasses (Highway A50, Netherlands). Case 4: comparison of different durations of monitoring at an overpass (Highway A27, Netherlands). Based on the results of these case studies we will provide practical guidelines for selecting appropriate survey techniques and sampling schemes to evaluate wildlife use of crossing structures.

## Talk- 1.3

### Wildlife crossing structures - Part 1/3

# Large and non-specific bird mortality in a high-speed railway traversing a Spanish agrarian landscape

**Author(s):** Juan E Malo, Israel Hervas, Eladio L Garcia de la Morena, Cristina Mata, Jesus Herranz

**Contact:** Juan Malo, Terrestrial Ecology Group, Departamento de Ecología, Universidad Autónoma de Madrid, C. Darwin 2, 28049 Madrid, Spain

**E-mail:** je.malo@uam.es

**URL:** http://teguam.es/miembros/juan-e-malo-arrazola/

Human activities alter ecosystems where they are built and they frequently shape in the mid- or long-term their structure and function. Thus, it is essential to know how new infrastructures and technologies impact species in order to properly evaluate their foreseeable effects if they become widespread. In this context, it is urgent to estimate the magnitude and characteristics of bird mortality by high-speed railways (HSR) since (i) they remain almost unknown, (ii) HSR extension is planned or under works in several countries to compete with aircraft transport, and (iii) due to circulation speeds over 250 km/hour it might be expected that almost no bird can avoid being overrun by an approaching train. A seasonal monitoring of bird mortality was conducted in two sections of HSR adjacent to a Natura 2000 site totaling 10.6 km within Toledo Province (Central Spain), and it was complemented with experiments on carcass detectability and scavenging to correct sampling biases. In parallel birds in the surroundings were sampled seasonally (24 transects 500m length) and frequency of bird crossing the infrastructure was estimated from fixed observation stations (574 stations 10’ each). Avian community showed a year round average abundance of 280.1 birds/km2, being dominated by common species from open agrarian landscapes. However, species of conservation concern like Otis tarda and Falco naumanni were also frequent. The average frequency of birds crossing the HSR was estimated to be 276.3 individuals/km hour, 55.2% of them flying within the collision risk area under the catenary. Mortality data corrected for sampling biases allowed the estimation of total bird kill to amount 91.3 death birds by HSR km and year. Both the frequency of infrastructure crossing and bird mortality correlated significantly across species with their abundance in the area ($r=0.77$, $p<0.001$ and $r=0.26$, $p<0.05$). Thus, bird kill by the high speed train is a little selective process even though some species (e.g. Alectoris rufa, Pica pica, Columba livia) suffer a disproportionate loss due to their behavior regarding the infrastructure. Moreover, not only passerines but large and very large species like Otis tarda, Bubo bubo and Buteo buteo were also killed, denoting both an environmental and safety threat. We therefore conclude that avian mortality in high-speed railways is an issue of concern due to the actual features stated in the study. Thus, it is necessary (i) to pay attention to the problem along the planning of the infrastructure as well as (ii) develop the appropriate corrective measures to minimize avian mortality with a special focus on site of special ornithological interest.

## Talk- 1.3

### Wildlife crossing structures - Part 1/3

# Bats and invertebrates provide evidence of ecoducts' role as key elements of the green infrastructure

**Author(s):** Carme Rosell, Marc Fernandez, Joana Colomer, Ferran Navàs, Carles Flaquer, Maria Bas, Mònica Laje, Carles Boronat

**Contact:** Carme Rosell, Minuartia wildlife consultancyDepartment of Animal Biology- University of Barcelona

**E-mail:**crosell@minuartia.com

**URL:** http://www.minuartia.com

Large overpasses, called ecoducts or green bridges, are considered one of the best options for providing ecological connections across linear transport infrastructures. In Catalonia (NE Spain), several ecoducts have been constructed over roads and railways. Two of them (155 and 86 m wide) were built over the newly fenced C-37 road, which opened in 2009 in a mountain forest area. A monitoring project was undertaken from November 2014 to July 2015, to determine which species of invertebrates and vertebrates used the structures and their surroundings. Different monitoring techniques were applied, including invertebrate and small mammal traps, photo and video cameras, bird censuses and bat detectors. This presentation focuses on invertebrates and bats, which are often excluded from monitoring of wildlife passages. Invertebrates were captured in the ground layer in a network of 27 sample points. Entomology nets were used to capture animals found in the herbaceous vegetation and bushes. The taxa determination was undertaken with the help of binocular equipment (an in-depth study of the samples is still underway). Bats were detected by two bat detectors (Song Meter SM3, Wildlife Acoustics), equipped with SMX-US microphones. Two detectors were activated simultaneously from 21 to 24 h on 22 consecutive nights in the spring. Species were identified using SonoBat V.3.3.1 and Avisoft-SASLab Pro V.5.2.01 software. The number of records was counted, and the species were determined when possible, as some species cannot be differentiated by ultrasound registration. A total of 179 invertebrate taxa were identified: 45 in the ground soil and 134 in the vegetation. The most abundant and diverse groups were Heteroptera, Homoptera, Orthoptera and Coleoptera in the vegetation; and Hymenoptera, Arachnida and Diplopoda in the ground layer. A total of 2,775 bat records were obtained, of which 94% were registered over the ecoduct, and the remaining 6% in the surroundings. Most records were of moving bats (95%), 3.7% were hunting, and 1% were engaged in social activity. At least 11 species were identified using the ecoduct: Rhinolophus ferrumequinum, Rhinolophus hipposideros, Myotis myotis/blythii, Myotis emarginatus, Myotis daubentonii/capaccinii, Pipistrellus pipistrellus, Pipistrellus kuhlii/nathusii, Pipistrellus pygmaeus/Miniopterus schreibersii, Hypsugo savii, Nyctalus leisleri/Eptesicus serotinus, Barbastella barbastellus and Tadarida teniotis. The taxa most frequently detected were Pipistrellus kuhlii/nathusii (1305 records over the ecoduct, 90 in the surroundings) and Nyctalus leisleri/Eptesicus serotinus (614 records over the ecoduct, and 26 in the surroundings). These results suggest the existence of a funnel effect guiding bats' flight across the structure. The proper restoration of ecoducts and optimal connection with habitats each side of the structure are considered key to the successful results that were obtained. The results suggest that ecoducts play an important role in biodiversity conservation, as they not only provide a crossing point for medium and large mammals, as established in many monitoring projects, but also funnel bats' flight and even provide habitats for a high diversity of small fauna. Therefore, ecoducts should be considered as important elements in the green infrastructure networks.

## Talk- 1.4

### Managing vegetation along infrastructure verges - Part 1/2

# Seed dispersal by myrmecochorous ants in road verges: the influence of soil disturbances from roadworks

**Author(s):** Peter G Spooner

**Contact:** Peter Spooner, Charles Sturt University

**E-mail:** pspooner@csu.edu.au

The maintenance of habitat connectivity is desirable in facilitating seed dispersal for the conservation of many species and plant communities. Occasional long-distance dispersal (LDD) events, although rare and stochastic processes, are important for habitat colonization and the maintenance of genetic connectivity. Minor rural road networks constitute an important landscape element, and have gained recent attention for their role in potential LDD events. As minor roads are maintained by anthropogenic inputs, they possess novel environments which provide habitat conditions advantageous to some plants, depending on their life history attributes. Seed dispersal by ants, or myrmecochory, is a significant ant-plant mutualistic relationship that occurs in many ecosystems worldwide. In myrmecochory, a food 'reward', in the form of a specialized fleshy appendage called an elaiosome, is attached to the seed. Attracted to this food reward, ants move seeds into their nests to consume the elaiosomes, and then discard the seeds into the surrounding area. The extent to which ants may facilitate occasional LDD in road corridors largely depends on the habitat conditions which prevail in relation to human disturbances. In Australia and elsewhere, minor roads are maintained by anthropogenic inputs, often in the form of periodic soil disturbances form roadwork's activities. Field studies were conducted in a typical fragmented agricultural landscape in southern New South Wales, which contained a large network of minor rural roads and associated remnant vegetation. 24 road segments were selected that possessed both disturbed and undisturbed zones. Seeds of Acacia pycnantha, a common myrmecochorous shrub, were offered to ants at multiple bait stations in both zones to ascertain seed fates, seed dispersal distances, and to identify the main seed dispersing ant species. As expected, ant species richness was greater in the undisturbed zones. However disturbance tolerate species were present in large numbers in the disturbed zones. Mean seed dispersal distances was greater in the disturbed zone (mean 35m, maximum 120m), where large meat ants (Iridomyrmex purpureus) were responsible for most of the seeds dispersed, and appeared to thrive in habitat conditions as a result of soil disturbances from roadworks. Field observations also recorded secondary dispersal events away from nests – which may further aid in seed dispersal. The implications this study in terms of developing a better understanding of the importance of this mutualism, and role of minor rural roads in promoting LDD, will be discussed.

## Talk- 1.4

### Managing vegetation along infrastructure verges - Part 1/2

# Managing vegetation under overhead high-tension lines : from a constraint to an opportunity for biodiversity

**Author(s):** Simon de Voghel

**Contact:** Simon de Voghel, LIFE Elia-RTE project

**E-mail:** devoghel.simon@gmail.com

Vegetation is a key issue when dealing with electrical safety of high-tension lines crossing forest areas. As an alternative to the regular vegetation destruction, the LIFE Elia-RTE project implements 7 innovative actions in Belgium and France. Investing in our innovative vegetation management techniques creates stable natural habitats that combine electrical safety and shelter threatened animal and plant species. A cost-benefit analysis showed that these methods were cheaper (1.4 to 3.9 times on 30 years) than the ongoing vegetation management. Local stakeholders are also involved, thus increasing social acceptance. These actions are promoted in Europe by the team among Transmission System Operators.

# Talk- 1.4

## Managing vegetation along infrastructure verges - Part 1/2

# Study of woody vegetation along roads in the Beauce landscape, Loir-et-Cher, France

**Author(s):** Gilles Grisard, Gabriel Michelin, Aurélie Poumailloux

**Contact:** Gilles Grisard, CDPNE

**E-mail:** g.grisard.cdpne@orange.fr

**URL:** http://www.cdpne.org

The studies carried out by CDPNE (Comité Départemental de la Protection de la Nature et de l'Environnement) on the green infrastructure ("Trame Verte et Bleue") in different parts of the Loir-et-Cher county since 2010 showed the importance of road verges as refuge areas for biodiversity in intensive agricultural landscapes. Animal and plant species need to move to achieve their life cycle. To do so, they need a diverse landscape. Safeguarding biodiversity in agricultural landscapes delivers many ecosystem services such as the stabilization of populations of pest insects, the improvement of fertility and soil quality, the limitation of pollution related to heavy metals from traffic, etc. Some parts of the Loir-et-Cher county, in particular the Beauce region, have undergone deep changes due to intensive farming and they have lost many of the landscape features that are important for the movement of species. The overall diversity of plant species in the Beauce region is low. They are mainly limited to agricultural species in the fields. In this context, road verges provide one of the main refuges for many species. They also serve as corridors in these openfield landscapes. The study undertaken by the CDPNE aimed at enhancing the knowledge about the ecological functions of the woody vegetation along roads in the Beauce landscape, in order to promote management practices favourable to biodiversity. The work carried out involved: - an inventory and map of the existing roadside trees and shrubs, - the definition of a typology of woody vegetation patterns and the identification of 5 study fields with flora and fauna inventories for an ecological analysis, - a survey of existing management practices and recommendations for good practices. Roads may have important negative impacts on biodiversity (fragmentation of habitats, mortality, pollution…). Yet, this study shows that road verges may also constitute refuge zones and habitats in an intensive farming environment. The woody vegetation pattern and the characteristics of the surroundings are key elements to the suite of species met. Verges not only create habitats, they also contribute to ecological continuity and support ecosystem services.

## Talk- 1.4

### Managing vegetation along infrastructure verges - Part 1/2

# Facing the ongoing landscape fragmentation – designing the ecological network to protect habitat connectivity

**Author(s):** Dusan Romportl

**Contact:** Dusan Romportl, researcher

**E-mail:** dusan.romportl@vukoz.cz

Central and Eastern Europe are facing the ongoing process of landscape fragmentation caused by construction of new highways and roads. To enhance protection of landscape permeability and connectivity of habitats suitable for dispersing or migrating animals, ecological networks are the most effective tool. In case of the Czech Republic so called Terrestrial System of Ecological Stability has been established, however, this network doesn't fulfill the aims of complex landscape permeability protection. Therefore new network of wildlife corridors has been proposed, based on habitat suitability approach. Lynx, wolf and bear were selected as umbrella species, for which habitat suitability maps were prepared using MAXENT approach. Output of habitat suitability model was verified by VHF telemetry data from several field studies and resistance surfaces were designed using CIRCUITSCAPE approach. According to spatial and habitat requirements, core areas of potential occurrence as well as stepping stones were delineated. Finally, proposal of coherent ecological network was carried out using Linkage Mapper, compared with formerly defined networks and extensively verified in field.

## Talk- 1.4

### Managing vegetation along infrastructure verges - Part 1/2

# Influence of road-field boundary structure and management practices on the functional composition of road-field plant communities

**Author(s):** Clémence Chaudron, Rémi Perronne, Francesca Dipietro

**Contact:** Clémence Chaudron, UMR CNRS 7324 CITERES, Université François Rabelais de Tours

**E-mail:** chaudron.c@gmail.com

Management practices made on road verges are currently implemented to preserve biodiversity in agricultural landscapes. These boundaries are generally constituted of four elements – i.e. the safety zone, the berm, the ditch and the embankment – which differ in terms of taxonomic composition, primarily due to differences in the nature and intensity of anthropogenic disturbances. The influence of mowing practices on taxonomic composition of plant communities has been extensively studied; however a better understanding of plant response to various disturbances using trait-based approaches could be a relevant supplement to taxonomic approaches to guide management practices. Management programs usually involve differences in the frequency and timing of mowing, nevertheless it has been shown that the proximity of road verges to field margins can also lead to additional disturbances from arable fields. Although most studies have investigated the relationships between management practices carried out on road verges elements and changes in plant communities within these managed elements, only a few have also focused on the potential influence of road verge management practices in adjacent field margins. We addressed two questions: (1) How road-field elements shape the functional composition of plant communities? (2) How road-field management practices influence the functional composition of plant communities within each element? We sampled the berm, the embankment and the field margin of 40 road-field boundaries of cereals fields located in Central-Western France, where local authority experienced a delayed mowing of some berms from early to late summer. We characterised management practices made on each element, i.e. mowing frequency and/or timing, inputs of herbicide and nitrogen fertilizers. We extracted from databases nine functional traits known to be influenced by management practices studied. To determine the relationships between species traits and environmental variables, we performed partial RLQ analyses to remove confounding effect of the environmental context. Then, we used the fourth-corner statistic to quantify the link between traits, environmental factors and partial RLQ axes. Community functional response differed both between road-field elements and due to management practices made. Competitive and hemicryptophyte species were associated to berms, while ruderal and therophyte species were associated to field margins. In berms, ruderal species flowering earlier were associated to one early mowing, while competitive and nitrophilous species presenting a later flowering in June were associated to one late mowing. Moreover, in field margins, zoochorous species were associated to late mowing of the berm. Finally, both in field margins and embankments, dicotyledonous species were associated with an increase in herbicide treatment in arable field. We emphasised that mowing practices made on road verges for biodiversity issue influence the functional composition of plant communities within these green infrastructures, and can also shape the functional composition of plant communities in adjacent arable field margins. Our results should also be useful for the establishment of effective management programs on right-of-way of other linear transportation infrastructures such as electric rights-of-way.

# Workshop- 1.5

## KDE+ A method for identification of animal–vehicle–collision hotspots

## A Workshop on KDE+: A method for identification of animal–vehicle–collision hotspots

**Author(s):** Michal Bíl

**Contact:** Michal Bíl, CDV - Transport Research Centre

**E-mail:** michal.bil@cdv.cz

This workshop will cover: Methodological issues: KDE+ basicsIntroduction to KDE+ softwarePractical application to test your own dataDiscussion Presenters: Michal Bíl, Richard Andrášik, Jiří Sedoník Affiliation: CDV – Transport Research Centre, Brno, Czech Rep. Keywords: road kill; traffic accidents; hotspots; kernel density estimation; Monte Carlo simulations Workshop summary: The following workshop is a hands-on session run on computers during which participants will test the KDE+ software and apply the spatial clustering method to their own data. The KDE+ method is based on kernel density estimation and Monte Carlo simulations and objectively selects significant clusters. The strength of a cluster is important to drivers as it represents the individual danger. Road administrators are, however, more interested in mitigating locations with a high density of animal-vehicle collisions. We investigated the relationship between the strength of a cluster and the density of animal-vehicle collisions within the cluster. We found that these two attributes of a cluster can be used to express the collective danger. The clusters should therefore be ranked according to this alternative measure in order to select those locations that should receive a higher priority for mitigation. If our aim is to alert drivers regarding the most dangerous locations, we should use the strength of a cluster for ranking. Both measures can be used to rank the clusters across the entire road network. The original KDE+ method is designed for animal-vehicle collisions that are localized by GPS. However, a number of databases in European countries do not contain GPS locations or the GPS locations contain significant errors. As a result, we cannot be sure about the exact position of an animal-vehicle collision. We consequently extended the applicability of the KDE+ method to also address inaccurate position data by deriving a new kernel function that considers this uncertainty. Although the accuracy of results depends on the precision of input data, the localization of clusters is also satisfactory in the case of inaccurate position data. KDE+ is a unique method because it not only determines the significance of the clusters objectively but is also capable of processing inaccurate position data. In addition, it is not influenced by under-reporting of animal-vehicle collisions as most of the methods for crash-frequency data are. Based on our results, only half or even less of the data is sufficient for precise localization and ranking of the clusters. We have developed standalone KDE+ software which can be downloaded free of charge from www.kdeplus.cz. We have also recently programmed ArcGIS ToolBox based on the KDE+ approach. Both software will be available for testing. Information for participants: The participants are encouraged to bring notebooks with their own data. There is no need to have any GIS software on your PC if you only plan to test the standalone KDE+. ArcGIS 10.2 or higher is necessary if you wish to test ArcGIS Toolbox. The presenters also provide the participant with test data sets from actual AVC data.

## Talk- 1.6

## Infrastructure, ecosystems and landscape: research and action in France

# ITTECOP: an Institutional framework for integrated research on infrastructures, landscapes and biodiversity

**Author(s):** Yannick Autret, Bruno Villalba

**Contact:** Yannick Autret, Ministry of Ecology, Sustainable development and Energy

**E-mail:** yannick.autret@developpement-durable.gouv.fr

**URL:** http://www.ittecop.fr/

Policy makers, researchers and practitioners alike seek substantive scientific responses to professional questions, as well as methods to transfer research from lab to land. ITTECOP is a multi-disciplinary research programme on infrastructures, landscapes and biodiversity which seeks to attain this goal. The French Ministry for Ecology, Sustainable Development and Energy (MEDDE) created ITTECOP in 2008. ITTECOP is a multi-disciplinary research programme that explores infrastructure issues (affecting river, rail, energy and road transport, as well as regional interfaces such as train stations, ports and airports) with respect to landscapes in the regions concerned. This may include spatial and temporal dimensions, regional governance issues or ecological factors. ITTECOP hopes to help develop a lasting research community that evaluates the impacts of land-transport infrastructure (LTI). ITTECOP anticipates public decision-making needs in the fields of infrastructure, landscapes and biodiversity. A community of practice (made up of researchers, professionals and members of NGOs) can contribute to original thinking and support public decision-makers when evaluating LTI impacts. This is being explored in cases involving landscapes and biodiversity. For example, a project named GRAPHAB has developed landscape graphs to evaluate and mitigate the impacts of major transport infrastructure on species. As a decision-making tool, GRAPHAB can be used for decisions involving train lines or the optimization of wildlife localisation. Another project, developed in partnership with a local council, helps adapt a road project to local constraints (landscape, biodiversity and traffic issues). The research answers questions on developing bypasses and motorways in city fringe areas, identifying the requirements for bringing about changes in road manufacturing for fast point-to-point connections, and acquiring knowledge on ecosystems and corridors allowing the movement of plants and animals. ITTECOP is producing a unique research framework focused on founding infrastructures, landscapes and biodiversity projects and building a research community. The ITTECOP programme is managed by two authorities: a scientific board and a steering committee. The multidisciplinary scientific board sets scientific guidelines, prepares calls for research proposals, evaluates reports, and carries out programme facilitation and promotion actions. The steering committee is in charge of defining the programme's directions and identifying priority research proposals, in addition to taking part in programme facilitation, evaluation and optimization actions. It is made up of representatives of the Ministry's decentralised departments and services, and representatives of public and private agencies. Special attention is paid to the scientific facilitation of the programme and to optimising research projects in order to ensure knowledge is transferred to public-policy actors, researchers and practitioners. For this purpose, ITTECOP's first scientific results were published in 2013 and a web documentary released. The programme's challenge is to develop a research production framework in the field of infrastructures, biodiversity and landscape from initial studies to the transfer of knowledge. To better test this experimental structure and develop an international network of researchers and practitioners, the ITTECOP programme seeks to amplify international research connectivity.

## Talk- 1.6

### Infrastructure, ecosystems and landscape: research and action in France

# IDRRIM : The French Institute for Roads, Streets and Mobility Infrastructure

**Author(s):** Marc Tassone, Yannick Autret, Patrick Porru

**Contact:** Marc Tassone, Ministry of Ecology, Sustainable development and Energy

**E-mail:** marc.tassone@idrrim.com

**URL:** http://www.idrrim.com/en.htm

IDRRIM rallies all the public and private bodies operating in the mobility and urban spaces infrastructures sector. Created in 2010 at the initiative of the Ministry of Environment, Energy and the Sea and Territorial Development, the Assembly of the Departments of France, the national private-sector engineering and public works federations, the Institute proposes a framework for reflection and action resulting in a jointly-produced and shared repository of common data. With the role of a meeting and exchange forum, its purpose is to provide consistent responses to technical and strategic issues, as well as to promote the development of infrastructure assets and public spaces towards sustainable design and management, and an increasing optimisation of their use. IDRRIM also strives to promote and expand the reputation of French technical expertise in Europe and abroad. Bringing together 50 members representing the public and private sectors (government agencies, public and private engineering firms, partnership-based associations, training and research organizations) and more than 40 local authorities, individual companies and engineers, the Institute rallies all the public and private players of the transport infrastructure sector. Since 2010, IDRRIM association organises every year a PRIZE « Infrastructure and biodiversity » to highlight ingenious initiatives on this subject, and promote their deployment. From 2015, the topic « landscape », urban and rural, was added in order to reward also its intelligent consideration in the projects. The projects prize-winners in 2014 and 2015 will quickly be presented during this presentation to give a general idea of what is possible to do to concretely promote an increased awareness of all actors about biodiversity and landscape as reference-points.

## Talk- 1.6

### Infrastructure, ecosystems and landscape: research and action in France

# Club of Linear Infrastructures and Biodiversity (CILB): an original partnership

**Author(s):** Viviane Degret, Guerrero Anne, Christine Bourbon, Gaëtan Quesnel, Jean-Francois Lesigne

**Contact:** Viviane Degret

**E-mail:** viviane.degret@rte-france.com

The similarity of the biodiversity issues at stake for linear infrastructure operators, and the parallels between the solutions put forward to deal with these issues, brought to light the advantages of joint work by the companies. Each of these concerns has its own history, but they have joined forces in the field of biodiversity. The CILB was institutionalised through the signature of a charter in 2011, and it currently federates the following entities: ASFA, EIFFAGE, ERDF, GRTgaz, LISEA, RTE, SNCF Réseau, TIGF and VNF. These operators' desire to express their views collectively in the field of biodiversity stems from the fact that their infrastructures interact with nature. Although they are often singled out by environmental associations, they have all been taking action for a long time to minimise the impacts of their facilities: "eco-friendly" methods to maintain the right-of-ways, crossings for the various species concerned, systems to protect birds on power lines, fish passes, planting trees or sowing grassland, etc. The charter signed by the club members encourages them to move further along this path. Thus the members are committed to sharing their knowledge, their best practices and their experience of biodiversity, regarding project design and execution, together with maintenance of their facilities. They have set up networks of biodiversity experts in their companies to structure and capitalise the experience acquired, in order to ensure joint progress in protection of biodiversity. They organise and coordinate their representations and contribute to the legislative and regulatory texts. They participate in the various working groups on the green and blue belts (TVB), impact studies, and the "Avoid, reduce, and offset" doctrine. They are present in the "biodiversity" theme groups of the professional associations, at the French Foundation for Research on Biodiversity (FRB), and on the national and regional TVB committees to obtain a global perspective and participate in the decisions covering set-up adjustment. They collaborate with the French Museum of natural history (MNHN) to add their inventories to the national inventory of natural heritage (INPN) and help to enhance knowledge. These actions show what the infrastructures can bring to the TVB, with their right-of-ways and green dependencies. The task is a major one, but key issues are involved. The CILB held a seminar late in 2014, sponsored by the International Union for Conservation of Nature (IUCN) on the theme "Infrastructure corridors, ecological corridors?". It has also implemented a research programme entitled "Land Transport Infrastructures, Ecosystems and Landscapes" in collaboration with the FRB and the ministry in charge of the environment (ITTECOP): 15 projects are backed, together with a systematic review. Whereas a few years ago we were somewhat on the defensive regarding these questions of biodiversity, we have radically changed our approach, and our current attitude is much more proactive, to reconcile our "industrial" missions with preservation of biodiversity. The fact of being able to discuss concepts and practices within the club, being jointly committed to the process and providing coordinated representation enhances general awareness among the senior management and the staff alike, and boosts their will to act.

## Talk- 1.6

### Infrastructure, ecosystems and landscape: research and action in France

# GASBI a French original initiative: developers and scientists working together in collective intelligence to integrate biodiversity in upstream development projects

**Author(s):** Sylvie Vanpeene, Thierry Tatoni, Carine Ritan

**Contact:** Sylvie Vanpeene, Irstea, centre Aix en Provence 3275 route de Cézanne CS 40061 13182 Aix-en-Provence cedex 5

**E-mail:** sylvie.vanpeene@irstea.fr

GASBI is an informal reflexive group composed exclusively of scientists, including ecologists from public research and developers. Developers are motivated people working for quarries, transport companies energy, public works, renewable energy production, or road infrastructure. GASBI means « Groupe d'échanges entre Aménageurs et Scientifiques autour de la Biodiversité et des Infrastructures » (Exchange group between Planners and Scientists around the Biodiversity and Infrastructure). It works in construction and collective intelligence. The heart of its concerns is to question the change necessary to act on a key element: the integration of biodiversity in upstream development projects. As researchers and developers had a tendency to stay in their world, GASBI creates a place for dialogue and exchange between researchers and developers in conditions of independence and ethical responsibility. For 2 years, three major projects were built especially with the support of the Provence Alpes Côte d'Azur and the Fondation de France. Project "Livre Blanc": this book is an overview of scientific and technical approaches during development projects. It will encourage to give biodiversity the place it deserves, relying in particular on collaborative design and transverse modes. this book will present successful feedback and unsuccessful in two voices: voice of scientist and voice of developer. Project "cross-training": this training is created and run by scientists for developers and vice versa. It will co-build modules by and for scientists and planners to transmit the vision of the business of each and consider the co-construction of infrastructure. Project "platform": an exchange platform based on knowledge trees concept (developed by Michel Serre and Michel Authier) and a classification of skills to access those resources, mobilize and ensure the upstream integration of biodiversity issues.

## Talk- 1.6

### Infrastructure, ecosystems and landscape: research and action in France

# FRB, a science-policy-society interface for informed decision-making

**Author(s):** Barbara Livoreil

**Contact:** Barbara Livoreil, Fondation pour la Recherche sur la Biodiversité

**E-mail:** barbara.livoreil@fondationbiodiversite.fr

**URL:** http://www.fondationbiodiversite.fr/en/

The Foundation for Research on Biodiversity is a platform for the different scientific players and stakeholders in society concerned with biodiversity. It was created in 2008, following the Grenelle Environment Forum, with the support of the ministries for research and ecology and eight public research establishments, joined by LVMH in 2014. Generating innovation, promoting scientific projects in association with society and developing studies, overviews and valuations are at the core of the foundation's missions. Up until now, more than 170 structures, associations, businesses, managers or authorities have joined the FRB with the aim of facing scientific biodiversity challenges together.

## Talk- 1.7

### Tree avenues and biodiversity

# Mapping of tree avenues with LiDAR – method development, database structure and landscape analysis

**Author(s):** Lisa Maria Sjölund

**Contact:** Lisa Sjölund, GIS Consultant

**E-mail:** lisa.sjolund@sweco.se

Increased urbanization and the exploitation of green areas has resulted in fragmentation and reduced habitats for species and when more species becomes threatened, this has negative consequences on biodiversity on a landscape level. In order to strengthen and develop new areas of potential dispersal possibilities for species in the landscape effective methods are needed that produce data on a landscape level, which can later be used in landscape analysis. Due to continuous exploitation of green areas in urban environment tree avenues have become important dispersal corridors and refuges for various plant and animal species. Reliable information on tree avenues is needed if authorities are to formulate local, regional and global environmental targets to increase the number of geographically distributed tree avenues that provides the best ecological function and the maintenance or strengthening of other values. Today only a fraction of Sweden's tree avenues with high cultural historical and nature conservation values have been documented along the state road network. Data of tree avenues must also be integrated in landscape analysis to develop a sustainable environment to improve ecological function and at the same time strengthen existing values. Therefore, it is also important to map young tree avenues in order to provide data in long-term planning perspectives, as they constitute important components of sustainable spatial and temporal landscape planning. This study presents a methodological development of how avenues can be effectively mapped with a combination of several remote sensing techniques, primarily using data from Light Ranging Detection Aperture Radar (LiDAR). A tree avenue database covering Sollentuna municipality, Stockholm County, Sweden has then been created with information about the location of tree avenues with tree species, age group, number of large trees, geographical orientation and crown width. The attributes were collected using interpretation of aerial photographs, GIS operations and field work. Finally, to highlight the potential use of a tree avenue database, the data was used in two landscape ecological connectivity models (Circuitscape and Linkage Mapper) using the marsh tit (Parus palustris) as model species. The results were examined to suggest where new tree avenues should be placed and how they should be designed to strengthen the ecological relationships of the marsh tit in Sollentuna municipality. This new technical approach to evaluate tree avenues has proven to be successful. However, there are several aspects in the method that could be further developed to improve both efficiency and accuracy.

## Talk- 1.7

### Tree avenues and biodiversity

# Complete inventory of trees along roads in the Czech Republic

**Author(s):** Jaroslav Kolařík

**Contact:** Jaroslav Kolařík, SAFE TREES, Ltd.Arboricultural Academy (NGO)

**E-mail:** kolarik@safetrees.cz

**URL:** http://www.checktrees.com

Street tree inventory as a basic tool to their controll and management is performed in the Czech Republic according to a methodology, which is presently being generaly standardised within Standards for Nature and Country Conservation. Basic data about trees are available for public on web page www.checktrees.com, which enables sharing the complete data set with tree managers and arborists. Basic features include risk assessment of trees, tree care proposals, value calculation, management of bracing/cabling systems, inventory of planted trees, evidence of trees colonised by associated organisms (tree biodiversity assessment). Out of 14 districts of the Czech Republic the complete inventory along A-roads (roads of 1-st cathegory) is presently completed in 8 and in next 2 will be ready untill end of 2016. Similar tree inventories are performed in cities and vilages. At present the complete data set includes 852 995 individually assessed trees and 36 921 tree groups. Complete inventory has been finished on approx. 4 500 km of roads. Presentation will include description of the methodology and software (GIS) tools used for data collection and analysis. Basic overview of management proposals (controlls, updates, shared features) will be described.

## Talk- 1.7

### Tree avenues and biodiversity

# Avenue trees: a wealth of red list species, but still too little specific studies concerning tree lined transport infrastructures

**Author(s):** Chantal Pradines

**Contact:** Chantal Pradines, Cabinet All(i)ée

**E-mail:** chantal.pradines@wanadoo.fr

A brief literature survey about the biodiversity linked to the trees lining road infrastructures shows that they harbour or play a role in the life cycle of many red list species. Mosses and lichens, but also butterflies and beetles or bats of endangered species have been identified in studies carried out for instance in Germany, in Sweden or in France. But the number of published studies dealing specifically with the biodiversity of avenue trees is limited, in spite of the proven role of linear structures as refuges and corridors along roads. One of the consequences is for instance that avenues are underrepresented in the biodiversity atlas established in some French counties. Based on the results of the literature survey and on the need for more studies expressed by actors involved in the preservation of avenues, inside or outside the administration of the environment, we identify what kind of studies could be of interest to assert more firmly the importance of avenue trees for the biodiversity

## Talk- 1.7

### Tree avenues and biodiversity

# Tree avenues and solidary trees along roads in Sweden – monitoring and maintenance

**Author(s):** Åsa Röstell, Tove Adelsköld

**Contact:** Åsa Röstell, Tyréns AB

**E-mail:** asa.rostell@tyrens.se

Large and old trees play an important ecological role in the landscape. They are homes to a large number of species of lichens, mosses, fungi, birds, bats and invertebrates. When planted in avenues along roads the trees can also for example hold cultural and aesthetic values and function as dispersal corridors for animals and plants. However, large and old trees are becoming less common in the landscape today. Knowledge about existing avenues, their condition and values is essential for planning, management measures and to maintain biodiversity and increase road safety. In Sweden, the Swedish Transport Administration (STA) has collected data about existing avenues along roads since the early 2000s. STA:s data collection is restricted to trees along the state road network and have its focus on traffic safety, biological, cultural and aesthetical values. Policies, planning and strategic questions about avenues and tree management have been managed internally within the STA and in collaboration with other authorities. Since 2007, biologists have surveyed avenues and solitary, large trees in southwest Sweden. All state roads in the region are now mapped, and each object is regularly revisited. The data is used as support in the annual maintenance of the trees. We present data from these surveys, and discuss strengths and weaknesses with the method used.We briefly present the Swedish national collaboration initiative for avenues and tree management, including its policy statement. We further discuss general challenges and opportunities with monitoring and maintaining tree avenues and solitary trees.

## Talk- 1.7

### Tree avenues and biodiversity

# Tree-lined roads - the green infrastructure as an important part within transport infrastructure

**Author(s):** Katharina Brückmann

**Contact:** Katharina Brückmann, Bund für Umwelt und Naturschutz Deutschland (BUND, Friends of the Earth Germany), Landesverband Mecklenburg-Vorpommern e.V.

**E-mail:** Katharina.Brueckmann@bund.net

**URL:** http://www.bund-mecklenburg-vorpommern.de/themen_und_projekte/alleenschutz/

Tree-lined roads (avenues) in European countries represent shared European landscape. They are witness of regional history and are of especially great importance for biodiversity. They are an important green infrastructure that should serve Europeans for centuries to come. Yet the future of avenues is in severe danger. To sustain avenues it needs both, protecting existing avenues and developing new ones! Yet new or changed requirements and demands on roads and traffic safety, as well as new or modified views to the environment, have an impact on the development of avenues. There has to be a way to meet both challenges, to increase road safety and to develop regulations and measures to protect tree-lined roads as important living landscapes within the transport infrastructure. An example is shown in Mecklenburg-Western Pomerania. In some states of Germany avenues are highly legal protected, (particularly) so in Mecklenburg-Western Pomerania with approximately 5.200 km out of the estimated 30.000 km of existing avenues along main roads nationwide. An avenue, by our definition, is two 100 m long rows of trees, which lie opposite each other and each side has at least 3 trees. How can this high protection be carried into effect?1. An "Avenue Edict" valid since 1998, specifies the proportion of trees which must be replaced, quality and distances from the road kerb. Because of new nationwide regulations it had to be revised. A new edict is in force since January 2016.2. An "Alleenfonds "is established in case there is no space to plant trees. Alternatively money can be paid into the Alleenfonds (€400.00 per tree). The idea is to cover the costs of larger-scale avenue–planting projects. This element is unique within Germany.3. An Avenue development and protection program for the federal- and state roads with targets for the next 20 years was announced 2006 (AEP). This allows to plan the necessary steps well in advance for example for acquisition of land. This goes together with a comprehensive inventory of street trees which was completed for federal and state roads in April 2016 and is kept up to date. An "Avenue Map" shows all avenues, the age of the trees, the density of the avenue and the tree species. Thus further potential roads selected for avenue development can be examined more closely as to their suitability. The detailed avenues map can be viewed by everyone in the Internet.4. A Planning Guide for avenues will be written for Nature Conservation authorities and Landscape Management until 2017. These measures worked well and explain the increase of young avenues to approximately 40% (2160 km) of all avenues from 1990 until 2014.However, the statistics also show that so many more trees were planted in the years until 2010. Since then there is an annual deficit. This is due to the fact that the roles for plantings have changed especially regarding the demanded distances between road and trees. Our aim is no less than to preserve the heritage to its full glory for the future.

## Talk- 1.8

### Wildlife monitoring and field studies - Part 1/3

# Wireless camera systems and web-informatics for environmental monitoring of transportation corridors

**Author(s):** Fraser M Shilling, David P Waetjen

**Contact:** Fraser Shilling, Road Ecology Center, University of California Davis

**E-mail:** fmshilling@ucdavis.edu

**URL:** http://roadecology.ucdavis.edu

Environmental monitoring of transportation infrastructure is a critical activity for transportation organizations (TOs). Understanding wildlife connectivity (the ability for wildlife to move freely) improves highway planning where wildlife occurs. Many TOs use camera traps to study wildlife use of purpose-built wildlife crossing structures, or opportunistic use of other structures and associated right-of-way fencing. By recording wildlife use of mitigation structures under or over roads, TOs can measure: 1) effectiveness of structures and structure types in maintaining movement of protected animals, 2) connection of wildlife populations, 3) animal activity levels, and 4) natural behaviors. Camera trap measurements are a cost-effective way to capture information about the occurrence of multiple species. Despite advances in wireless instruments and computing capabilities, environmental monitoring technology for highways (e.g., for wildlife occurrence) lags behind those used for traffic. We describe the creation of an online system (hereafter Cam-WON; http://wildlifeobserver.net) for ingesting and organizing camera trap data (image files with their associated annotations) as individual or bulk file uploads. This system is open to anyone in the world and is free of charge. We used a GNU/Linux operating system, a web server, a relational database management system, and "middleware" tools utilizing several programming languages, including Javascript, Java, Python, and PHP. The web-system described here uses Ubuntu Linux Server running Apache2, PostgreSQL with the PostGIS extension, Geoserver with Apache Tomcat 7, GeoWebCache, Drupal 7, and various other community contributed libraries and tools. We describe automated methods for web-system processing of photographic monitoring data from cell/WiFi-communicating camera systems at purpose-built and opportunistic wildlife crossing structures. The work flow culminates in a common strategy for taking image files from the camera supply chain and automatically creating records in a web-database. The primary human involvement is in animal species identification, animal activity/behavior description, and noting demographics. In order to integrate the physical camera system into transportation decision-making, environmental monitoring, and stewardship activities, the project was conducted with state TO technical staff. The combined web-camera systems were tested in US states: California, Utah, Wyoming, South Dakota, Maine, Colorado, and Washington. In each case, manually-maintained and cell-communicating cameras were used in tandem. The combined cell/wireless camera and web-systems represent an advance over traditional remote cameras with desktop databases in that their output is viewable almost instantly on the web via a wireless data transportation service. Although streaming wildlife web-cameras are not new, "wildlife traffic cameras" have not been previously used before in this way. We developed a model system that any TO could adopt for use in areas with wired, wireless, or cell system connectivity, including using existing infrastructure to add wildlife monitoring to the data input stream. We are also developing automated image analysis approaches to further simplify the workflow. Systematic collection of wildlife movement information at the roadway not only benefits long-term and project related stewardship needs, but it also provides an opportunity to share wildlife data and imagery directly with the public. This combination of science and public relations is increasingly important as public knowledge and awareness contributes towards safer wildlife interactions with highways and traffic.

## Talk- 1.8

### Tree avenues and biodiversity

# A new biodiversity impact assessment tool for road network planning

**Author(s):** Richard Bischof, Ola-Mattis Drageset, Markus A. K. Sydenham, Katrine Eldegard

**Contact:** Richard Bischof, Norwegian University of Life Sciences Department of Ecology and Natural Resource Management

**E-mail:** richard.bischof@nmbu.no

Transportation networks cover entire landscapes, and their impacts extend from the scale of individual plants and animals and their habitat to ecosystems. The issue of scale is particularly important to consider when planning new projects meant to expand or improve existing road networks. Yet, assessment of ecological impacts across the range of scales at which road effects are manifested remains a major challenge to road planners and ecologists alike. Environmental impact assessments, although an integral part of road projects, typically remain limited to localized effect, i.e. effects at the site of construction and immediate surrounding area. There is a particular need for better tools and methods for assessing ecological impacts at large scales, e.g. in connection with strategic planning and concept evaluations. At the network-level, roads fragment the landscape, essentially creating a mosaic of more or less isolated habitat tiles. These tiles ("road islands") and their interactions are intuitive units for analysis and prediction of future impacts, as they capture local effects and at the same time are themselves constituents of the larger network. We develop a spatially-explicit predictive model that allows the user to evaluate and compare the environmental impacts of alternative road projects prior to implementation, with a primary focus on biodiversity effects. The underlying rational for our approach is that biodiversity within a tile in the road network is related to known or remotely measurable attributes of that tile, such as habitat composition, tile size and shape, surrounding road type and traffic volume, and other human disturbance factors. Road construction and other changes to the network alter the configuration of one or more tiles in the mosaic, potentially leading to predictable effects on biodiversity and ecosystem services. We demonstrate the functionality of the approach by applying it to Norwegian road network and biodiversity data and estimating the effect of real and simulated network manipulations. Finally, we discuss the potential of the model as a national planning tool that enables assessment and comparison of the environmental cost of of infrastructure development at all relevant spatial scales.

## Talk- 1.8

### Wildlife monitoring and field studies - Part 1/3

# Road ecology researchers should pay more attention to the spatiotemporal dependence of the roadkills' aggregation.

**Author(s):** Almir Picanço de Figueiredo, Ludmilla Moura de Souza Aguiar

**Contact:** Almir Figueiredo, University of Brasilia - UnB

**E-mail:** almir.ibram@gmail.com

A collision between wildlife and vehicle (WVC) is a phenomenon comparable to others with points patterns, like traffic accidents, crimes, cases of epidemic diseases or extreme climate events. Knowing the aggregation patterns of these events is one of the main challenges of those areas researchers (Miller & Han, 2009, Liu et. al. 2015). Aggregation can be based on a proximity of events in space, time or, simultaneously, in space and time (Miller & Han, 2009). Determine the sites with non-random spatial aggregation of WVC (hotspot) is essential for the design of mitigation measures (e.g. Beaudry et. al., 2008, Malo et. al., 2004). Some studies indicate that hotspots are spatially stable in generation (Clevenger et. al., 2003, Carvalho & Mira, 2010) while others state that their persistence may vary over time. Permanence is due to the biological characteristics of the studied group (Langen et. al. 2006, Costa et. al., 2015) or insufficient sampling frequency (Santos et. al., 2015). The realization of hotspots temporal variations, as well as the explanations for the occurrence of those variations, do not elucidate in which sites measures to prevent WVC should be installed. Identify places where the high probability of collision persists in time increases the feasibility of mitigation measures installation and their efficiency on wildlife conservation. It is important though to know the spatial and temporal patterns of WVC simultaneously. Since the middle of last century there are studies on spatiotemporal clustering patterns in punctual events, particularly in epidemiology and criminology, and more recently in traffic engineering (Eckley & Curtin, 2013). Despite this knowledge availability, space-time interaction has not been emphasized in Road Ecology literature. We reviewed 56 articles published between 2001 and 2015 to assess the importance given in Road Ecology to studies approaching the space-time interaction in the analysis of aggregate WVC. Thirty-two of these articles evaluated only spatial patterns, 9 tested only temporal patterns, and 15 considered the spatial and temporal patterns. However, regarding this third group, only Mountrakis & Gunson (2009) attempted to estimate the association linking the temporal and spatial scales simultaneously. The other authors considered both scales, but in different analyzes. Those authors used an adapted Ripley's K statistic (Diggle et al., 1995) to assess which spatiotemporal scales indicate aggregation of Moose-Vehicle collision on roads of Vermont, USA. Albeit they have not shown the places where such points of aggregation occurred, they demonstrated that the use of space-time interaction generates more robust results because it can recognize aggregation or dispersion caused by sporadic events. Notwithstanding indicating the relevance of this approach, neither the articles that cited this study applied a spatiotemporal dependence analysis of WVC aggregation. Road ecology researchers should pay more attention to the spatiotemporal relationship of the roadkills' aggregation, to diminishing the effect of spatially or temporally stochastic events in the hotspots' identification. The analysis of spatiotemporal interaction on punctual events can support the identification of sampling sufficiency to ensure the spatial persistence of hotspots in the appropriate spatial scales regarding the subjects of conservation.

## Talk- 1.8

### Wildlife monitoring and field studies - Part 1/3

# Roads and bats: use of existing gantries for the restoration of ecological connectivity.

**Author(s):** Fabien Claireau, Sébastien Puechmaille, Benjamin Allegrini, Cédric Heurtebise, Nathalie Machon, Christian Kerbiriou

**Contact:** Fabien Claireau, Naturalia environnement, National Museum of Natural History of Paris ; Zoological Institute and Museum of the Ernst-Moritz-Arndt-University of Greifswald

**E-mail:** fclaireau@mnhn.fr

**URL:** http://cesco.mnhn.fr/users/fabienclaireau

Linear transport infrastructures, including roads and highways, are known to have negative impacts on wildlife. In addition to direct impact (animal mortality) roads have an important impact on habitat loss and fragmentation. For bats, the construction of a highway can lead to destruction of bat roosts and loss of foraging areas. Such infrastructures also induce fragmentation and loss of connectivity between roosts or between roosts and foraging areas. In some cases, it may impact reproduction of bats and thus the viability of the populations. However, highways are strong economic drivers, new ones are created and others are modernized. Therefore, it is necessary for stakeholders to be able to reconcile economic development and biodiversity conservation. As part of mitigation measures such as the restoration of ecological connectivity, several studies suggest that underground passages are quite effective for the passage of bats, and their most convenient conformation is known. But in some situations, technical constraints only allow the installation of crossings over the highway. Depending on the characteristics of certain sites, it is possible to adapt the designs of these overpasses (e.g. material, shape) to increase their use by bats. Indeed, in Europe, they are multiple, complex and often represent a significant cost hardly acceptable by civil society. Among the experiments already carried out, gantries with fences, ropes installed on two floors with carved polystyrene balls, large metal walkways with shaped holes honeycombs, etc. have been tested. In France, the likely number of wildlife crossings is 2000 (12 000 km of highway with 1 wildlife crossing about every 6 kilometers), while among these overpasses only 4 are designed for bats including 1 temporary, since 2012. For bats, the monitoring is often concentrated at the overpasses and the methods used are trajectography with thermal camera and/or acoustic monitoring. In this talk, we will (i) propose an overview of experiments already carried out in Europe, (ii) based on experiment feedbacks, we will discuss why these experiments failed to evaluated the effectiveness of the overpasses (lack of methodology, lack of initial state or control, metrics used…etc), (iii) present an alternative innovative device: the installation of a standard gantry on a motorway in service. This will allow to define what are the factors that determine the success of overpasses for bats. This standard gantry (type «signaling gantry») will be installed at an interruption of ecological corridor for bats. The goal is to evaluate its effectiveness compared to other more complex and more expensive structures. If the result is positive, we would have found a simple, cheap, and discreet way, to restore flight routes for bats. This experience will be carried out and tested by a stakeholder: «Autoroutes du Sud de France» (Vinci) associated with a technical research department: «Naturalia environnement» in collaboration with two research laboratories: the National Museum of Natural History of Paris (France) and the Institute of Zoology and museum of Greifswald (Germany).

## Talk- 1.8

### Wildlife monitoring and field studies - Part 1/3

# Video analysis of animal-train encounters in Sweden

**Author(s):** Andreas Seiler, Mattias Olsson, Pär Söderström, Anders Forsberg, Anders Sjölund

**Contact:** Andreas Seiler, Swedish University of Agricultural Sciences, Dep. of Ecology, Grimsö Wildlife Research Station

**E-mail:** andreas.seiler@slu.se

**URL**: http://www.slu.se

Ungulate-train collisions (UTC) are of increasing concern to railway traffic in Sweden. Train drivers report thousands of incidents per year and the actual number is probably substantially larger as not all collisions are detected or reported. High corporative expenses for train repairs and the socio-economic costs of train delays suggest that the problem has previously been grossly underestimated. Thus, the Swedish Transport Administration (STA) in cooperation with Swedish Railway Company (SJ), the Swedish University of Agricultural Sciences (SLU) and Enviroplanning AB initiated a project to develop new and adapted measures to prevent UTC. As one of the first steps in this endeavor, we studied the behavior of animals towards approaching trains. This is done by means of video recordings made by 20 train drivers since April 2015. Train drivers are equipped with so called dash cams that continuously record driving situations but save only those sequences where drivers had detected wildlife near or on the railway tracks. All saved video recordings are processed for further analysis of the animal' responses to trains and warning signals produced by the train drivers. At present, 122 recordings of ungulate-train interactions have been saved, including 5 collisions. Preliminary analysis indicates that many animals recognize approaching trains too late and/or try to avoid colliding by running away in front of the train. This maladapted behavior is also known to occur on roads. As the monitoring continues, more observations will be made, especially during the current winter season. We will present analyses of the animals' behavior (flight, freeze, ignorance, pause) and discuss what implications these behaviors may have for mitigation. Note: As this study is still on-going, we intend to update this abstract during spring with more empirical data.

## Talk- 1.9

### New prevention technologies

# Acclimation of drivers to a Roadside Animal Detection System

**Author(s):** Molly Kathryn Grace, Daniel Joseph Smith, Reed Frederick Noss

**Contact:** Molly Grace, University of Central Florida

**E-mail:** mkgrace@knights.ucf.edu

**URL:** http://mkgrace14.wix.com/mollykgraceconbio

Roadside Animal Detection Systems (RADS) attempt to reduce the frequency of wildlife-vehicle collisions by sensing animals near the road and warning drivers with flashing signs. We evaluated a RADS built on U.S. Highway 41 in Florida, U.S.A. Objective: Our previous study using a driving simulator showed that a virtual RADS reduced driver speed, so we wanted to assess how effective the system is in real life. We also wanted to test the effects of potential driver acclimation to the RADS. Methods: To assess driver response to the RADS, we measured the speed of individual cars on U.S. Highway 41 when the RADS was active (flashing) and inactive (not flashing) during four periods over the course of a year. This allowed us to test for differences in driver behavior between the tourist season (mostly non-local traffic) and the off-season (mostly local traffic). We expected that locals may have become acclimated to the RADS. Results: In the tourist season, but not in the off-season, the activation of the RADS caused a significant reduction in vehicle speed (3.81 km/h). There was also a significant interaction between season and time of day. During the tourist season, drivers drove faster (5.54 km/h) at twilight than at night. The same effect was observed in the off-season, though the difference was not as large (3.15 km/h). The overwhelming factor influencing speed was time of day. Conclusions: Despite the fact that drivers in the tourist season generally drove faster than those in the off-season, tourist-season drivers responded to the RADS by reducing their speed, while off-season drivers did not. We suggest that this result is from acclimation by local drivers to the RADS, especially because it often malfunctioned and gave warnings when no animal was present. If the system functioned properly, this acclimation may not have occurred. Contributions to Practice: Our study is one of the longest field studies of a RADS and the first to test the responses of potentially acclimated drivers (locals) against those of non-acclimated drivers (tourists).

## Talk- 1.9

### New prevention technologies

# Dynamic Wildlife Warning System

**Author(s):** Gert Hamberg

**Contact:** Gert Hamberg, Manufacturer and contractor for Prowild wildlife mitigation equipment.

**E-mail:** info@prowild.net

**URL:** http://www.prowild.net

Problems with wildlife mitigations are known all over the world. Traffic is increasing and also populations of wildlife are growing. This results in a growing number of Wildlife Vehicle Collisions (WVC) Many solutions have been tested and the outcome is often not clear. We believe that the only effective measure is to take action towards the drivers. Drivers have the cognitive power to make considered decisions whereas animals do only act on instinctive stimulus and habits. After a certain period animals will get used to the altered situation and return to their common way of living. Therefore we believe that warning animals does not provide a long term solution. Warning drivers about animals crossing the road however has proven to be a very effective measure over a long period. The first system in the Netherlands was built in 1998 and it is still running with excellent results. Providing a warning system for drivers can be done by placing sensors in the field along the roadsides where a large number of animals have a fixed habit to cross the road. Triggered sensors will activate LED warning signs alongside the road to warn oncoming traffic. The locations involved are in general classified as WVC hotspots. We can define several classes of hotspots and from >10 WVC per year the earn back time of a warning system is approximately 4 to 5 years. Sometimes wildlife is crossing the road at different locations over a long stretch of the road and do not have fixed crossing sections. In these cases another option is to install fences over longer distances to guide wildlife to a predetermined opening where they can cross the road. These openings will be secured by the wildlife warning system to provide a safe crossing for all kind of animals. The species that can be effectively detected from badger up to large animals like deer and moose. Since 1998 we have developed and improved the Prowild Dynamic Wildlife Warning System (DWWS). The latest generation DWWS has proven that WVC can be reduced with >90%. At one location during the past 4 years the number of WVC has been reduced from 120+ to only 6. Another location has performed even better by reducing the WVC in 4 years from approximately 100 to 0, so no accidents at all over a period of 4 years. Installed systems at other locations show similar results. This cannot be achieved just by simply installing a few sensors and signs. Numerous factors need to be considered. A few are terrain, false triggering, type of detection like passive infrared (PIR) or active infrared(AIR),reliability and backup systems. Another very important factor is that a good protocol for system and terrain maintenance needs to be implemented. With regards to this contractor and client need to work out a proper maintenance plan. During the past 15 years we have carefully looked at these factors and created a DWWS that has proven very reliable. Next to this we can provide downloadable statistics.

## Talk- 1.9

### New prevention technologies

# The reliability and effectiveness of a radar based animal detection system and road crossing behaviour of large ungulates

**Author(s):** Marcel Huijser, Brice Sloan

**Contact:** Marcel Huijser, Western Transportation Institute - Montana State University

**E-mail:** mhuijser@montana.edu

In many parts of the world the number of collisions with large ungulates is high and increasing. These collisions not only lead to substantial property damage, but also cause human fatalities, human injuries, the death of individual animals and the loss of associated economic values. In addition, some species are also affected on the population level. Over 40 different mitigation measures have been implemented or described to reduce animal-vehicle collisions. However, only wildlife fencing, with or without safe crossing opportunities for wildlife, and animal detection systems have shown that they can substantially reduce collisions with large mammals. Animal detection systems are designed to detect large animals (e.g., deer (Odocoileus sp.), elk (Cervus canadensis) and moose (Alces spp.)) as they approach the road. When an animal is detected, signs are activated to warn drivers that large animals may be on or near the road at that time. Drivers may then reduce vehicle speed, become more attentive, or both, which puts them in a better position to avoid hitting the animals. Starting in 1993, animal detection systems have been installed at dozens of locations throughout Europe and North America. Some of these systems were found to be reliable in detecting large mammals and effective in reducing collisions. However, animal detection systems should still be considered experimental and more research and development is needed before they can be considered reliable and effective without requiring much attention or maintenance. In late 2013 a radar based animal detection system (Sloan Security Technologies, Inc.) was installed along US Hwy 95 in Boundary County, Idaho, USA. In this paper we report on the reliability and effectiveness of this animal detection system as well as the behaviour of large mammals on and near the road. We conducted reliability and effectiveness tests in each season (autumn, winter, spring, and summer in 2015-2016). Each test lasted 10 consecutive days. We investigated the detection logs and matched the detections with images of a thermal camera. This allowed for the identification of correct detections (i.e. a detection occurred and a large mammal was present) and false positives (i.e. a detection occurred but no large mammal was present). In addition, we continuously recorded video images with a thermal camera for 3 randomly selected hours for each test day. We investigated these video images and matched them with the detection log to identify correct detections, false positives and false negatives (i.e. a large mammal was present but it was not detected). Furthermore, we investigated the effectiveness of the system in reducing vehicle speed by forcing the warning signs on for 1 randomly selected hour for each test day. We then investigated whether vehicle speed was lower than during periods when no detections occurred and when the warning signs were not activated. Finally, we used the video images from the thermal camera to investigate road crossing behaviour of large ungulates. The latter is important as it shows how long the warning signs should be activated for after a detection has occurred.

## Talk- 1.9

### New prevention technologies

# Is it possible to relocate a cormorant roost affected by new transport infrastructures?

**Author(s):** Ferran Navàs, Ramon Griell, Miguel Ángel Pindado, Rosell Carme

**Contact:** Ferran Navàs, MINUARTIA

**E-mail:** fnavas@minuartia.com

The largest great cormorant (Phalacrocorax carbo) wintering roost in the Llobregat Delta (Barcelona) is located in a group of trees in the old riverbed of the Llobregat River, which was diverted as a consequence of the works to enlarge Barcelona's port. In the last 10 years, an average of over 250 individuals used this roost, i.e. 59% of all individuals in the Llobregat Delta. The future railway and road accesses to the port will be located in the old riverbed, and the roost will disappear. To reduce the impact for this bird species, Barcelona Port Authority is developing an innovative project to provide alternative artificial roosts, and to prevent uncontrolled dispersion of cormorants searching for new places to stay. This could be a hazard for aviation safety, as Barcelona international airport is located in the vicinity of the port. This long-term project started in 2006, when several designs of artificial structures were tested. The most effective was a structure that simulates a tree. It is 10 m high, with a mast and up to 10 horizontal branches. In a second step, suitable locations for alternative roosts – the previous selection was based on knowledge of cormorants' ecological requirements – were equipped with groups of this kind of artificial structures, and a monitoring plan was started. For each wintering period (October–April) from 2006/2007 onwards, monthly censuses were conducted in the different roosts in the Llobregat Delta. The censuses consisted of two hours of observation around dusk, when individuals were counted as they reached the roost to spend the night. In roosts where artificial structures were placed, it was recorded whether or not the cormorants rested in these structures or in trees. The use of artificial structures has increased steadily over the years. In 2006/2007, the percentage of cormorants wintering in the Llobregat Delta that roosted in artificial structures was about 5%, while in the 2014/2015 winter, a maximum of 79% of individuals roosted in artificial structures was achieved. During the last winter, 73% of cormorants roosting in the old riverbed preferred to use the artificial structures, although no trees had been removed. In 2016, new structures are going to be placed in a restored wetland area, and Barcelona Port Authority is launching a communication campaign that includes an informative video, leaflets and other materials. This experience shows that providing artificial resting structures in suitable places – even where no previous roost was established – can reduce disturbances to birds caused by the construction of new infrastructure. This successful, innovative approach to a human wildlife conflict has been the result of strong cooperation between engineers and experts on wildlife and ecology. Although measures must be adapted to every species and scenario, this experience is intended to be an example for future situations involving infrastructures and other bird species.

## Talk- 1.9

### New prevention technologies

# Utilising telemetry and remote sensing technology to evaluate the effectiveness and use of the KA45 highway underpasses by brown bears (Ursus arctos) in the region of Kastoria, W. Macedonia, Greece

**Author(s):** Maria Konstantinos Psaralexi, Yorgos Mertzanis, Ioannis Athanasiadis,Elias Aravidis, Georgina Examilioti, Alexios Giannakopoulos, Yorgos Iliopoulos, Eli Katsiri, Paris Kouris, Yorgos Lazarou, Nikolaos Patsinakidis, Maria Petridou, Sussane Riegler, Armin

**Contact:** Maria Psaralexi, Department of Ecology, School of Biology, Aristotle University of Thessaloniki, Greece

**E-mail:** mpsarale@gmail.com

Avoidance behaviour of otherwise suitable habitats in close proximity to roads has been recorded for brown bears across the globe. In Greece, the current 55km operational part of the newly constructed KA45 highway (attached to the Egnatia Motorway part of the TENT), cuts through bear habitat in Kastoria region in an open valley framed by Gramos and Vitsi-Askio mountains, where a bear population of 150-220 ind. minimum is present. Despite the presence of 134 mitigation structures (mostly culvert underpasses) incremented at an average distance of 400m over the total length of the highway, since 2009 and up to 2014, 21 bear traffic fatalities occurred along this highway segment mainly due to poor fencing. We used telemetry and remote sensing technology in order to investigate and evaluate the oriented use of these mitigation structures by bears after the installation of a bear-proof fence in 2013-14 which dramatically decreased the number of traffic fatalities. The purpose of this double approach was also to investigate whether the bear-proof fence started functioning as an artificial barrier or as a triggering factor for more systematic use of the mitigation structures by bears. Nineteen adult and sub-adult bears (6 M and 13 F) were fitted with GPS/GSM radiocollars over three different periods: 2011-2012 (before bear proof fence installation) and 2014, 2015 (after bear proof fence installation) yielding 58,373 radiolocations. We analysed the spatial patterns of telemetry data to investigate the use of mitigation structures by radio-tagged bears, given the 30min radiolocation interval of the pre-programmed radio-collars. A simple model where straight lines connect consecutive radiolocations was used to describe the animals' movement.Mitigation structure expected attractiveness/suitability was classified according to the Openness Index (OI) and a correlated buffer zone was attributed to each structure, relative to the logarithmic ranked value of the OI. We examined the structure use with the assumption that all highway crossings and fixes (before or after a crossing) of tagged bears which fall in the buffer zone were successful use of the structure. In order to cross validate the effective use of mitigation structures by tagged and non-tagged bears, a two folded methodology was developed. For tagged bears: their interactions with the mitigating structures were detected using appropriate RFID reader technology attached to mitigation infrastructure, while VHF collars functioned as tags. For non-tagged animals, that are currently the majority of the population, a sensor network based on the prototype EcoPrismaMultiSense and EcoTinySkylog nodes has been deployed on selected mitigating structures. Data from a multitude of analog and digital sensors such as (infrared, weight sensors, cameras) are fused together in order to detect bear presence and distinguish it from the presence of other species. The overall approach aims at investigating whether this is currently a transitional adaptive phase for bears before they start using mitigation structures regularly or if this is a case of a highway starting functioning as a critical landscape barrier. The results of this study will essentially contribute in further adjustment of mitigation structures to ensure their effectiveness.

# Workshop - 1.10

## Policy and Strategic planning: infrastructure bundling

# Minimizing road effects through the bundling of infrastructures: Current state of practice, guidelines, and research needs

**Author(s):** Jan Olof Helldin, Jochen Jaeger

**Contact:** Jan Olof Helldin, Calluna AB, Gothenburg

**E-mail:** j-o.helldin@calluna.se

One of the most fundamental measures to minimize the detrimental effects from transport infrastructures on nature and wildlife is considerate siting. The siting of a road or a railroad often determines both the magnitude and character of the final effects, and sets the stage for all further mitigation and remedial efforts. New infrastructures should be avoided in the most valuable or sensitive habitats and landscapes, and fitted into the existing infrastructure network to cause a minimal increase in the total impact. A measure assumed to keep the effects of the road network at a minimum is to bundle infrastructures, i.e. to locate them close together. Bundling has the goal to keep as large areas as possible free from roads and traffic, and it also creates synergies in the construction of technical mitigation structures such as wildlife passages, fencing, and audio-visual screening. It may, however, be argued that bundling results in stronger barriers and higher disturbances that are above critical thresholds, and if these impacts are not well mitigated the end-result may be worse than if the impacts were distributed more evenly among several roads across the landscape. Moreover, interaction between bundled infrastructures may bring about special circumstances for wildlife mitigation, such as complex road crossings and fencing, and isolation of habitat strips. The bundling of transport infrastructure is a planning principle in several countries in Europe, but it is not clear to what extent this principle actually affects decisions about road siting. Previous modelling results suggest that, in most cases, concentrating traffic onto fewer infrastructure corridors minimizes the overall isolation and mortality effects. Yet, the potential importance of bundling of transport infrastructures has generally received little attention in research. Therefore, we currently have rather weak evidence for guiding decisions in the planning of road networks to reduce impacts on wildlife in real landscapes. Road ecology needs further development of network theory and underpinning by empirical studies. There may also be a need for development of technical mitigation structures that can handle bundled infrastructures, and their effectiveness needs to be monitored. This workshop will highlight the pros and cons of infrastructure bundling, in the light of network theory, technical limitations, and the importance of creating functional movement corridors for wildlife. We aim at reviewing the current state of practice in selected European countries, leading to a cross-country comparison. Theoretical and practical examples are presented that will provide a foundation for a discussion among workshop participants of the research needs and guidelines for planning at the scale of road networks.

# Workshop - 1.10

## Policy and Strategic planning: infrastructure bundling

# The effects of the pairing of heavy transport infrastructure on the territories: what lessons?

**Author(s):**Michel Deshaies

**Contact:** Michel Deshaies, LOTERR

**E-mail:** michel.deshaies@univ-lorraine.fr

**URL:** http://www.univ-lorraine.fr/

This communication reports a research on the effects of pairing of heavy infrastructures such as motorways and high speed lines railways on the functioning and perception of the territory. The ecological impact, effects on the evolution and perception of landscapes as well as governance issues and social acceptability in nearby areas have been specifically studied in three representative of the major types of land pairing observed in France : pairing of the East European LGV with the A4 between Reims and Château-Thierry, the A432 coupled with the LGV Rhône-Alpes to the east of Lyon, and the conventional railway line to the RN 113 to the east of Arles. The first justification of these pairings is to minimize fragmentation and reduce disturbance to biodiversity and impact on agriculture. The comparison of the different elements from the research shows in reality an apparent contradiction on scales of analysis of the appropriateness of the pairing. If it offers an overall benefit for land management with space saving and limiting fragmentation, it also causes a consumption of land with the creation of interstitial spaces, and a strong polarization of space. Regarding biodiversity, “pairing” shows benefits for 2 of the 3 investigated fields. Interstitial spaces can provide with development habitat opportunities as far as common habitat background are concerned. The richness and the abundance of some species (eg. For plants, reptiles, butterflies) in those spaces are equivalent to the quality of the external edge areas. Moreover, the habitat fragmentation increase caused by the 2nd infrastructure is also reduced due to “pairing”. For some species of open areas, a longitudinal corridor effect could even be highlighted. Nevertheless, incoherent location and design of ecological connectivity structures of both infrastructures leads to deep physical filters for some species spatial scattering. Landscape and Land use analysis on the studied sites show much less changes induced by the implementation of the second infrastructure than from the first: land redevelopment is indeed much more limited. Paired infrastructures integration into landscape and final layout more or less depend on important technical obligations (relief, curvature radii). Those involve distance variations between infrastructures which determine contrasted situations for the use of the interstitial spaces and the emergence of a new landscape through the development of semi-natural habitats (fallow, hedges, copses). These significant direct effects of infrastructures contrast with the very low indirect influence of infrastructure on the social-demographic developments of the studied territories. From the societal perspective, the advantages and disadvantages of the pairing are also related on scales thinking and posture of the actors interviewed vis-à-vis spatial or organizational cuts, or perception of nuisances. Pairing is therefore more a process than a technical solution. Directed downstream, it does not allow for synergies with the territory, but only responds to some isolated subjects like space consumption. The need to improve consistency between infrastructures, the appropriate management for interstitial spaces, global space fragmentation, better adaptation of pairing for each territory, pros and cons for “pairing” depending on territorial scales and local actors.

# Workshop - 1.11

## Side Event - renaturation under High voltage line

## Developing natural forest edges in electrical corridors to ensure electrical safety and to enhance biodiversity in wooded areas

**Author(s):** Simon de Voghel, Jean-François Godeau

**Contact:** Simon de Voghel, LIFE Elia-RTE project

**E-mail:** devoghel.simon@gmail.com

Vegetation management is a key issue when dealing with electrical safety of high-tension lines crossing forest areas. In order to avoid any problem, most Transmission System Operators (TSO) proceed to regular vegetation cuttings. These operations are costly and they impact landscape and biodiversity. As an alternative to the regular vegetation destruction, the LIFE Elia-RTE project implemented 7 different methods to manage vegetation in a more biodiversity-friendly way. During 6,5 years, this project is implemented in Belgium (along 155 km of lines) and France (7 sites) to combine electrical safety and biodiversity. The project is financed by the European Commission, Elia (Belgian TSO), RTE (French TSO), and the Walloon Region. The most important method concerned structured forest edges on both sides of the forest corridor created by the high-tension line, shifting from a U-shaped corridor to a V-shaped corridor. The methodology followed depended on the presence of indigenous species in the surrounding forests. If they were present, the LIFE Elia-RTE project proceeded by selective felling into spontaneous vegetation : removing problematic trees (those with height at adult age that will threaten electrical conductors : oak, beech, birch, poplar…), and keeping low-height bushes and small trees (those with final height at adult age that will not threaten electrical conductors : hawthorn, hazel tree, cranberry bush, cornelian cherry dogwood) in favor of biodiversity. If there were no indigenous species in the surrounding forests, which happen sometimes in production forests, forest edges were planted. Plantation scheme was the following one : plantation every 1,5 m in a row, and having 2 m between each row. A soil preparation was carried out before plantation to make it easier. Indigenous species used were selected on several criteria : final height at adult age (below electrical conductors), potential for biodiversity and resistance to wild game grazing. In total, 171 ha of structured edges have already been either restored or planted during the project, while the objective to reach is 210 ha. These edges are contributing to the ecological network by offering a biodiversity corridor for plants, insects, birds, bats… Their great interest lies in the fact that they are a transition between the forest and the grassland in the center of the electrical corridor. For the Transmission System Operator, implementation of edges means less work in corridor, and therefore less costs. Long-term management of these edges is undertaken by selective felling of problematic trees, while indigenous low-eight bushes are promoted. The foliar surface of these bushes will end up covering the soil and making it very difficult for a problematic tree to develop in these shadow conditions. But these edges also benefit to local stakeholders such as forest managers, landowners or hunters. Surrounding forests are more protected to strong winds, wild game find food in edges and the boarder trees have a better commercial quality. Compared to the bare land left after regular felling, edges offer a better impact on the landscape by softening the transition between forest and corridor, and by showing colors during flowering period. Feedbacks on technical solutions to install and manage these edges will be developed, as well as their interests for all stakeholders.

## Workshop - 1.11

### Side Event - renaturation under High voltage line

# Using electrical grid to increase the connectivity of protected natural areas

**Author(s):** Simon de Voghel, Jean-François Godeau

**Contact:** Simon de Voghel, LIFE Elia-RTE project

**E-mail:** devoghel.simon@gmail.com

When high-tension lines are crossing wooded areas, vegetation management is a key issue for Transmission System Operators (TSO) when aiming at a safe and steady electrical supply. Most TSO proceed to regular vegetation cuttings so that trees are never high enough to touch or to get too close to the conductor. This vegetation management is costly and does not promote biodiversity since in some cases heavy machines are disturbing plant and animal species. The main idea of the LIFE Elia-RTE project is to test 7 alternative methods to manage vegetation, which can both promote biodiversity and ensure electrical safety. These methods are : planting structured forest edges, planting conservatory orchards, restoring natural habitats, digging ponds, fighting against invasive plants, mowing or pasturing, or sowing flowering meadows. During 6,5 years, this project is implemented in Belgium (along 155 km of lines) and France (7 sites) to combine electrical safety and biodiversity. The project is financed by the European Commission, Elia (Belgian Transmission System Operator), RTE (French Transmission System Operator), and the Walloon Region.The methodology developed in the LIFE Elia-RTE encompasses the following steps : initial mapping to identify potentialities, agreements with local stakeholders, works achieved by subcontractors (planting, cutting, soil scrapping…), and writing of a long-term management plan. Besides, biological and economical indicators are also monitored. Results obtained within the ongoing project are encouraging : planting structured forest edges (171 ha), planting conservatory orchards (16,5 ha), restoring natural habitats (37 ha), digging ponds (118 ponds), fighting against invasive plants (29 ha), mowing or pasturing (40 ha), or sowing flowering meadows (24 ha). By implementing actions that are enhancing biodiversity, constraints related to linear infrastructures management are turned into opportunities for nature protection. In a stable ecological network, connections between biodiversity core areas are of upmost importance, like in the Natura 2000 network. The LIFE Elia-RTE crosses 31 Natura 2000 sites in Belgium and 4 in France. Forest corridors created for high-tension lines can play this role for a wide variety of species by connecting areas where they can mate, feed and develop. Connectivity is ensured either by linear corridors or by stepping-stones.

## Workshop - 1.11

### Side Event - renaturation under High voltage line

# Restoring Natura 2000 habitats under overhead high-tension lines : example of peatlands, heathlands and calcareous grasslands restoration in Belgium and France

**Author(s):** Simon de Voghel

**Contact:** Simon de Voghel, LIFE Elia-RTE project

**E-mail:** devoghel.simon@gmail.com

Through the Habitats Directive, the European Union has listed natural habitats that require special attention. Their protection is partly ensured by the implementation of Natura 2000. But major private linear companies can also have a positive impact on these natural habitats. In the LIFE Elia-RTE project, two Transmission System Operators are carrying out restoration actions along the electrical grid to restore highly valuable and threatened habitats: peatlands, heatlands, calcareous grassland and other Natura 2000 priority habitats. Feedbacks on methods used to restore 40 ha of such habitats under high-tension lines in Belgium and France.

# Workshop - 1.11

## Side Event - renaturation under High voltage line

# Application of urban metabolism theory in energy landscape making: designing with flows

**Author(s):** Roberta Pistoni

**Contact:** Roberta Pistoni, école nationale supérieure de paysage de Versailles

**E-mail:** r.pistoni@ecole-paysage.fr

The proposal relates to the ongoing discourse on energy transition, starting from the consideration that the energy transition generates a landscape transition too, thanks to the long-lasting relationship between energy and spatial organization. In this context the research aims to study energy landscape from the analytical framework of the urban metabolism approach. Urban metabolism defines the total sum of processes for which cities mobilize, consume and transform natural resources needed to make them work and develop, provoking consequences in terms of energy and material used and waste generated (Barles, 2008). Most urban metabolism studies applied quantitative methods accounting for the total energy and materials fluxes of cities. Nevertheless at present an increasing urbanization, combined with a progressive resources limitation, leads to consider urban metabolism as an approach to find new ways how cities and territories can be made more sustainable (Broto et al, 2012). At the same time, landscape designers and urban planners begin to embrace urban metabolism theory: when they incorporate metabolic thinking while design forms and processes, resources management and so the infrastructures that carry these flows are integrated in urban design. The resulting landscape can so be read as a «Landscape infrastructure», referring to his ability to act as a supporting structure for processes of modernization (Perrotti, 2014). The intervention wants to explore the urban metabolism approach of designing with and through flows (energy, materials, water, waste etc.) in urban planning, by focusing on his spatial and landscape configuration. The advanced hypothesis is that landscape medium has the potential to connect the inhabitants' scale with the urban project. In order to do that, case studies at metropolitan and district scale that apply urban metabolism strategies to improve material circulation (dematerialization) and transit from fossil fuels, towards renewable and carbon-free sources are analyzed and compared. The examples are chosen from the Netherlands, that since long time is thinking about energy transition with ambitious objectives for the future, linked also to landscape and spatial planning. The first example analyzed is the project developed during the 2014 International Architecture Biennale in Rotterdam, «IABR-Urban by nature», that has studied the urban metabolism of the city and mapped its flows of energy, water and goods through their infrastructure, to provide insight in what are key locations, to zoom in and propose interventions for. Different spatial projects have been designed to improve flows within the city. At the district scale the case study is Buiksloterham, a brown fields area in Amsterdam, that on the basis of a quantification of an «urban metabolism in project» has settled guidelines for a sustainable planning and design for the 2034. At the moment two small neighborhoods within the district are realized: De Ceuvel (achieved) and City-Plot (in progress). The comparison between case studies and the different resulted landscapes can put in perspective the processes and the issues faced during the application of urban metabolism theory in the planning and design of sustainable energy transition, highlighting the importance of landscape in this process.

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## Workshop - 1.11

### Side Event - renaturation under High voltage line

# The high-voltage network as an opportunity for nature conservation?

**Author(s):** Viviane Degret, Elodie Russier, Simon de Voghel

**Contact:** Viviane Degret, RTE

**E-mail:** viviane.degret@rte-france.com

How to improve the integration of a high-voltage network in its environment? Could the easement strips for high-voltage power lines encourage preservation or restoration of natural habitats and its connectivity? If so, under which conditions? Within the French Electricity Transmission Network – RTE –, the Environmental Research and development Program was launched to increase knowledge and know-how on these issues. Linear infrastructure operators are facing similar challenges. One of them is to take biodiversity into account in its field of activity, from existing infrastructures to new projects. This shared issue, and the parallels between the solutions put forward to deal with it, brought to light the advantages of a joint work within the Linear Infrastructure and Biodiversity Club (CILB). The CILB and the French Committee of IUCN (International Union for Conservation of Nature) organized in 2014 the seminar «Infrastructure corridors, ecological connectivity?". This event was a call to the stakeholders of ecology and land management on a complex and controversial issue in order to confirm, contradict or specify the potential value for ecological connectivity of the verges along the linear transport infrastructures. Concluding this common work, the IUCN French Committee recommended linear infrastructure operators to enhance: - governance and involvement of stakeholders;- infrastructures design;- restoration of natural areas;- biodiversity in the management of existing infrastructure;- knowledge. The work carried out through the RTE Environmental Research and development Program with researcher, naturalists and nature management experts follows these guidelines. Two Action research programs that will help RTE to fit into IUCN's recommendations will be presented: - contribution to the Chair of Landscape and Energy led by the National School of Landscape Architecture. It was within this framework that a studio - led until March 2016, has proposed landscape recommendations to manage planning and biodiversity of easements of power lines in two Paris area places; - contribution to the LIFE Elia-RTE Project that aims to create green corridors under overhead power lines in wooded areas in Belgium and France thanks to various innovative actions. Those achievements show that it is now possible to work together along the grid - in order to preserve or restore actual biodiversity that could shrink if we do not carry on an appropriate management.

## Workshop - 1.12

# SIDE EVENT - Tree avenues - Award

**Author(s):** Chantal Pradines, Alexandre GADY

**Contact:** Chantal Pradines, Cabinet All(i)ée

**E-mail:** chantal.pradines@wanadoo.fr

La Société pour la Protection des Paysages et de l'Esthétique de la France (SPPEF) est une ONG plus que centenaire de protection des paysages et de l'environnement, reconnue d'utilité publique. Depuis près de 30 ans, elle organise chaque année un concours récompensant les meilleures actions de sauvegarde du patrimoine. A l'occasion de la Journée européenne des allées de 2015, elle a choisi d'orienter une partie de ce concours vers le patrimoine des allées d'arbres. Le prix concerne les propriétaires et gestionnaires d'allées, publics ou privés, les experts, les ONG. Le concours fait référence au rapport « Infrastructures routières : les allées d'arbres dans le paysage » publié par le Conseil de l'Europe dans le cadre des travaux de la Convention européenne du paysage. Les actions récompensées sont celles qui contribuent, au sens large, à la pérennisation des allées et à leur valorisation. La conférence internationale IENE abordera la thématique des allées au cours d'une session spécifique, avec des contributions allemandes, françaises, suédoises, tchèques. On y montrera leur intérêt pour la biodiversité et on présentera des exemples de gestion destinés à assurer le maintien du patrimoine. La remise du prix proposée en marge de la conférence vient avantageusement compléter cette session : elle fait le lien entre la Convention de Berne et la Convention de Florence, l'écologie et le paysage, et permet la rencontre entre les scientifiques et les « praticiens », qu'ils soient gestionnaires ou défenseurs du patrimoine. Ces croisements sont essentiels à une bonne préservation des allées et sont le reflet de leur richesse.

France's officially-recognized Société pour la Protection des Paysages et de l'Esthétique de la France (SPPEF), a more than one hundred-year-old NGO, is committed to the protection of the landscape and the environment. For over 30 years, SPPEF has been organizing a yearly contest rewarding the best actions for the preservation of France's heritage. In 2015, as part of the European Avenue Day initiative, SPPEF chose to devote part of its contest to a specific asset: tree avenues. Prizewinners can be public or private owners and managers of tree avenues, experts or NGOs whose actions contribute to their image and/or preservation. The contest refers to the report published by the Council of Europe within the framework of the European Landscape Convention: "Road infrastructures: tree avenues in the landscape". Avenues will be addressed during a specific session of the international IENE-Conference, with contributors from the Czech Republic, France, Germany and Sweden who will highlight the importance of avenues for biodiversity and show examples of good practices and management for the preservation of this asset. The award ceremony proposed as a side event to the conference advantageously complements this session: it establishes a link between the Bern Convention and the Florence Convention, between ecology and landscape; it is an opportunity for scientists and stakeholders, be they heritage advocates or managers, to meet. These interchanges, which reflect the richness of avenues, are essential for their effective safeguard.

# Workshop - 1.13

## Wildlife detectors to reduce animal-vehicle collisions: sharing experience

## Wildlife detectors to reduce animal-vehicle collisions : sharing experience

**Author(s):** Sylvie Vanpeene, Anne-Sophie Croyal

**Contact:** Sylvie Vanpeene, Irstea, centre Aix en Provence 3275 route de Cézanne CS 40061 13182 Aix-en-Provence cedex 5

**E-mail:** sylvie.vanpeene@irstea.fr

Hitting an animal like wildboar, reindeer, moose, with a car can be a fatal encounter. Reduce the collision is more than a safety measure because these crashes are costly in health care, vehicle repair and emergency services costs. In terms of biodiversity, some species could be in danger with roadkill (badgers for example). For example, in France 40 000 collisions occurred in 2008 between cars and wild animals and caused around 30 human deaths. Fence is a partial solution but it creates strong barriers to animal movements. So, when it's not possible to restore or create safe fauna crossings over or under roads, some ILT managers have installed wildlife detectors and alert systems for detecting wildlife along roads and warn drivers in real time to reduce the speed of cars. Some countries have installed different types of systems to detect animals (sensors and infrared cameras, laser tripwires, radar …). The workshop propose sharing experiences on wildlife detector use: about method and material used, positioning of the detection system, sensitivity adjustment, monitoring, effect on driver comportment, effect on collision …

# Workshop - 1.14

## Towards global guidelines for infrastructure development - a project proposal

## Towards global guidelines for infrastructure development - a project proposal

**Author(s):** Rodney van der Ree, Kate Newman, Anders Sjolund, Lazaros Georgiadis, Elke Hahn, Andreas Seiler

**Contact:** Rodney van der Ree, Australian Research Centre for Urban Ecology

**E-mail:** rvdr@unimelb.edu.au

Roads and other linear infrastructure, such as rail and pipelines, are essential for sustainable development but often have deleterious impacts on species, communities and ecosystems, including human and wildlife injury and mortality, deforestation, barrier effects, carbon emissions, wildlife poaching, and land-clearing. Impacts can extend for kilometres from the road itself and continue to develop for years, thereby affecting ecosystems and their services across the landscape. On the other hand, maintaining healthy ecosystems, particularly with our changing climate, can both protect 'grey' infrastructure by reducing potential damage from hazards such as landslides, flooding and erosion - and provide 'green' or natural infrastructure that can protect communities from harm. There are 64 million km of roads on earth – enough for 83 round-trips to the moon. An additional 25 million km will be constructed by 2050; 90% of which will be in non-OECD countries.  Much of this infrastructure will occur within and around areas currently managed for biodiversity and ecosystem service values, thereby undermining past, current and future conservation investments. The provision of linear infrastructure is central to achieving the 9th United Nations Sustainable Development Goal. In this workshop, we will introduce a proposal to develop globally-relevant best-practise guidelines to ensure the linear infrastructure we build today is as ecologically sensitive as possible. This workshop is relevant to anyone involved in planning, designing, constructing, funding, approving, and managing linear infrastructure from government, private industry, international development banks and other investors, conservation groups, aid and development organisations and research institutions. We seek feedback on what would make the guidelines realistic and practical in a local context, thereby ensuring that the guidelines will ultimately meet their needs. We also present opportunities for collaborations from partner organisations and sponsors.

# Workshop- 1.15

## Side Event - renaturation under High voltage line

## SIDE EVENT - Roadkill reporting systems around the world - experience sharing

**Author(s):** Fraser Shilling

**Contact:** Fraser Schilling

**E-mail:** fmshilling@ucdavis.edu

Reporting systems for animal carcasses and crashes involving wildlife are rapidly emerging throughout the world. Some of these are intensive efforts on a single roadway and some cover an entire country. A group of people and organizations involved in supporting roadkill reporting systems will be meeting in Lyon. If you have such a system (or similar system), or want to develop such a system, please join us virtually (email fmshilling@ucdavis.edu) and in person (IENE 2016, 17:15 Wednesday 08/31). Thanks for all of your great work, Fraser Shilling; Co-Director, Road Ecology Center; University of California, Davis

# Poster Session 1

## Poster

## Your Steps Towards Ecological Connectivity - The GreenAlps Project

**Author(s):** Filippo Favilli, Isidoro De Bortoli

**Contact:** Filippo Favilli, EURAC Research

**E-mail:** filippo.favilli@eurac.edu

**URL**: http://www.greenalps-project.eu/

The Alpine environment provides for fundamental and high-quality ecosystem services, which bring enormous benefits to the human society, only if the connections between the different habitats are established and maintained.The Work Package 4 of the GreenAlps project investigated what local stakeholder, experts and people know about ecological connectivity and ecosystem services and their involvement in past European projects. Workshop participants' experts pointed at ecological connectivity as a solution for the main threats of local development: landscape fragmentation, the loss of local identity, the promotion of local economy and tourism. Yet non-experts and the large public poorly understand the concept of connectivity and the concrete application of this vision in the real world; it would mean to find a way to manage all the environmental, social and economic conflicts that move around this issue. In an attempt to simplify the connectivity concept, GreenAlps developed an infographic poster showing symbolically how connectivity is at the heart of the interactions between humans and the rest of nature in a territory. The poster wants to use a touching approach, painting a "human-nature-being" to bring the spectator into a journey in the possible feelings experienced by wildlife species when facing any kind of barrier that impedes their free movements. Life is movement and without this freedom, it undergoes the process of decaying. Only through the stimulation of empathy of humans towards the environment and the wildlife populations, taking personal responsibility for the sake of nature and of human health itself, we may understand the damages humans are causing to nature and therefore, to themselves. Starting from the head, the poster invites the reader to open the mind to a new contact with nature, seeing ecological connectivity as a new opportunity, especially for humans. From the neck, down to the legs, how would you feel if something, out of your control, would impede your will to move freely? We are used to have no barriers in our environment and rarely think that wildlife species have the same right as we have to live on this planet. The best way to reach this goal is to stimulate the audience to the feeling of stagnation in an environment transformed by someone else for their own selfish needs. Giving some information on the European Green Belt initiative and on the potentials of Green Infrastructures, the audience is driven to a simple, but still ununderstood, truth: humans and wildlife share the same need – free movement for a working brain and a healthy life.The project GreenAlps has proved that ecological connectivity is still unknown to the most and that it is actually a new opportunity to see the world around us, because it holds a vision capable of joining nature protection with regional development, but only if experts, local people and stakeholder work together in a public participation process. Is it possible to imagine a world where humans and wildlife species live in harmony? If you also wish for that, what can YOU do for ecological connectivity?

# Poster Session 1

## Poster

# Implementing a collision survey protocol over the national road network. Review and prospects after two years of monitoring

**Author(s):** Jean-Francois Bretaud

**Contact:** Jean-Francois Bretaud, Cerema Dter Ouest Centre for studies and expertise on risks, environment, mobility, and urban and country planning - Territorial division for the western regions

**E-mail:** jean-francois.bretaud@cerema.fr

The Western France Interdepartmental Road Department (DIRO) manages a 1500 km road network, of which 1200 km is dual carriageways. Mainly located in Brittany, these infrastructures are old and require an upgrade to address today's environmental concerns, especially to integrate the issue of ecological continuums. In order to improve its knowledge in terms of the movement of animals and the major accident spots, DIRO has decided to implement a register of collisions between wildlife and vehicles throughout its network. Since January 2014, each patrol has had to list collisions noticeable from their vehicle, at least in waterproofed areas, without actively looking for road kill on each part of the road. Priority is of course given to the safety of the patrol officers, who need to survey while fully respecting the rules of the road. In case of identification difficulties, it is considered that even if only the species group is known, this already provides an interesting indication (e.g. amphibians, mustelids). However, a particular protocol is followed if there is a doubt about the identity of the otter. In this case, the patrol officer is asked to take a picture and keep the animal until formal identification of the species and the removal of tissue for subsequent analysis. Each animal seen is recorded very precisely (date, track, road position + x-axis), and the data is then centralized monthly for layout, mapping and georeferencing of the data. The involvement of 28 service and intervention centres, assigned to cover the entire network, is complete with almost 100% returns. In 2014 (the only full year available during the writing of this summary), there were well over 5,000 listed collisions (3.3 collisions / km / year) which represent (using an average weight per species) 34 tonnes of biomass ... Foxes and birds pay the highest price (20% of all collisions) followed by rabbits (11%), badgers (8%), and roe deer (6%). Despite the lack of historical data, trends have emerged including an annual breakdown of the most impacted species corresponding to periods of high activity (reproduction, rearing young, swarming, migration). With the accumulation of data over the years the trends will become clearer and explanations for disparities in observed results between service and intervention centres will emerge. CEREMA (Centre for studies and expertise on risks, environment, mobility, and urban and country planning) is assisting the DIRO in the implementation of this action, from the writing of the collision survey protocol to participation in interpreting the results. In 2016, it will be commissioned by the Directorate General of Transport and Infrastructure and the Sea (DGITM), on the DIRO network, to assess the representativeness of the collision survey methods used daily by DIRO agents by carrying out monthly reviews of two homogeneous areas of 50 km. The aim is to work on the overall method, in particular as regards to the detection of major conflict spots using the data collected by each method.A partnership agreement between the Natural History Museum and road network managers may be signed.

# Poster Session 1

## Poster

## Citizen's perceptions of ecosystem services in managed space on road interchanges in Abidjan (Côte d'Ivoire)

**Author(s):** Bi Tra Aimé VROH

**Contact:** Bi Tra Aimé VROH, University Félix Houphouët-Boigny, Abidjan, Côte d'Ivoire

**E-mail:** vrohbitra@gmail.com

Urban green infrastructure is closely related to human wellbeing and biodiversity in urban areas and plays an important part in urban ecology. The Autoroute du Nord in Abidjan is an example of green infrastructure. It has many road interchanges for facilitation of urban transportation. During the building of these road interchanges, many spaces with 0.2 to 1.5 ha were managed with trees woody. This study assessed some ecosystem services related to the presence of plants in 10 of these road interchanges containing a total of 28 blocks, covering an area of 18 hectares in three municipalities: Yopougon, Adjamé and Cocody. 132 visitors were interviewed about reasons for their presence in these areas. Also, we surveyed their perceptions about the presence of trees and services related in these spaces. Results show that 83.3% of visitors are male. The majority of respondents (62%) have secondary academic level. In Adjamé municipality, those with elementary academic level (75%) work in the informal sector. Among them, 50% attend these spaces every day. In Cocody and Yopougon municipalities, 60% of visitors have secondary academic level and students. They attend these spaces at least three times by week. Only provisioning and cultural services such as food provisioning, raw materials, medicinal plants, esthetic and recreation are more accessible and well known by citizens. Main reasons for visits are the rest (40% of visitors) and appointment (20% of visitors). Others reasons vary according to municipalities. In Adjamé, blocks are used for workplace (35% of visitors). In Yopougon, these spaces are used for religious rite (18% of visitors) and study (17% of visitors). In Cocody, visitors aspire to the freshness of these woodlands. Reasons of presence vary also according to academic level. Those with elementary level exercise activities in these spaces. Those with secondary academic level prefer esthetic value and use them also to study. From 50 to 75% of these visitors know uses of plant species in African pharmacopoeia. Other uses are: fodder, firewood, construction, food, and timber. However 91% don't know tree species names present in these areas. The best known species are: Orgueil de Chine (Caesalpinia pulcherrima), Flamboyant (Delonix regia), Teak (Tectona grandis), Mango (Mangifera indica) and Terminalia catappa locally called «Cocoman». Responses about proposals species for enrichment of these areas vary according to municipalities. Users (40%) in Adjamé want more species providing shade they enjoy to work. In Yopougon visitors (38%) prefer eating fruit species. Few visitors wished enrichment with ornamental species. If all users find these spaces very important, they also highlight problems associated with plant species: dirty condition (48.8% of responses), attraction of mosquitoes, insects and birds (39, 8% of responses), falling branches and destruction of roads (11.7% of responses). This study shows that spaces arranged at road interchanges in Abidjan city are ecosystems where plants, animals and citizens find shelter and resources for their development. These areas respond to social, economic and environmental challenges. But some non-market services such as climate regulation, water purification, carbon sequestration, and flood control are unknown by citizens, this can constitute a threat for these spaces.

# Poster Session 1

## Poster

## LIFE+ OZON - defragmentation of the Sonian Forest

**Author(s):** Steven Vanonckelen

**Contact:** Steven Vanonckelen, Agency of Nature and Forests (ANB), Belgium

**E-mail:** steven.vanonckelen@lne.vlaanderen.be

**URL:** http://www.sonianforest.be/

Project The LIFE+ OZON project tackles the fragmentation of the Sonian Forest. Different roads fragment the forest into isolated patches and prevent animals from travelling between different areas. The 'Dead provides Life' project revealed that about fifty animals were killed each year. Along these roads, 25 wildlife crossings are being constructed or renovated. These structures are designed to reconnect parts of the forest, so as to recreate a larger habitat for numerous animals. This is good news for endangered species, such as the Daubenton's bat, European pine marten, Dendrocopos medius, Triturus cristatus, etc. Objectives Defragmention of the Sonian forest The LIFE+ project reconnects ecological hotspots by constructing or renovating 25 wildlife crossings by 2017. The most spectacular is the wildlife bridge, but also different tunnels and bridges have been constructed. Moreover, wildlife fences and warning reflectors are being installed. Reduction of roadkills The number of roadkills among migrating forest animals will decline. The idea is to protect existing populations, as well as to reduce human damage. Nature-friendly forest edges Forest edges and ponds are made nature-friendly with additional open areas and shrub vegetation. Moreover, the project examines how recreation in the forest can be steered to less sensitive areas so that animals can use the wildlife crossings. UNEP and N2000 recognition Recently, the project received international support of the United Nations Environment Programma (UNEP). Moreover, the Sonian Forest was nominated as a finalist for the Natura 2000 Award in 2014 and 2015! Methods Concrete protection measures - Restoring 15 existing tunnels and culverts; - Constructing a wildlife bridge, 3 wildlife tunnels and 4 tree bridges; - Defragmentation measures on secondary roads; - Installing wildlife fences and warning reflectors; - Creating additional open areas and forest edges; - Steering and clearly demarcating recreational flows. Monitoring and communication - Monitoring the use of wildlife passages between 2014-2017; - Mapping animal species and their evolution; - Communication through website, information panels, magazines, etc.; - Laymans report and technical publications. Results Putting an end to fragmentation In 2015, 18 tunnels have already been renovated or built, the wildlife crossing and fence will be built in 2016-2017. These measures allow isolated animal populations to migrate across the forest. A boost for protected animal species By defragmenting and restoring the habitats in the Sonian Forest, animal species are provided a chance to survive. Roadkills reduced by 90% The number of roadkills among migrating forest animals declines by 90%. Long term investment Closely involving the public in the Sonian Forest and subsequently increasing the respect for this beautiful city forest with European valuable habitats and species. Finally, the success story of this project sends an important message to the society: inter-regional cooperation between different partners is possible and improves nature conservation. Thanks to the collaboration for a common long-term goal, we reach beyond our individual goals.

# Poster Session 1

## Poster

# Primary monitoring to small bridges and culverts used by wildlife along Qinghai-Tibet railway

**Author(s):** Yun Wang

**Contact:** Yun Wang, China Academy of Transportation Sciences

**E-mail:** wangyun80314@163.com

The Tibetan plateau is the highest plateau in the world and home to a variety of endemic endangered species. One species of particular concern is the Tibetan antelope (Pantholops hodgsonii). Its seasonal migration results in bi-annual railway and highway crossings on the plateau. Large bridges along the railway (width>100m, including kekexili bridges) have been previously studied and found to be effective passages for antelope movement. However, numerous small bridges and culverts located along railway have not been examined. The Qinghai-Tibet expressway, planned for construction in the near future, will likely parallel the existing highway (G109) and Qinghai-Tibet railway. Consequently, knowledge gained from studying the use of existing small bridges and culverts by wildlife will contribute to improvements in the design of wildlife crossing structures for the expressway. Twenty infra-red cameras were located inside 11 small bridges and 5 culverts along Qinghai-Tibet railway from August to December in 2014 to determine their effectiveness for wildlife passage. Factors related to usage of structures were recorded, including structural characteristics (length, width, height, openness, type), landscape features (water size, distance to highway, distance to the nearest structure) and human disturbance. Highway traffic volume data was collected from the local transportation management agency. At least 10 mammal species were found to cross the railway by means of small bridges and culverts. Over a period of 1312 trap-days, the total number of wildlife crossings observed was 1597.The total average crossing rate for all structures combined was 1.22 per day, or 0.076 crossings per structure per day. Three species were listed Chinese National First-class Protective species (Tibetan antelope, Kiang (Equus kiang) and Wild Yak (Bos mutus Przewalski) and two species were listed Chinese National Second-class Protective species (Tibetan gazelle (Procapra picticaudata Hodgson) and Eurasian Lynx (Lynx lynx)). Crossing frequency of all species were: Tibetan gazelle: 381, Kiang: 361, Gray-tailed hare (Lepus oiostolus): 287, fox (Tibetan fox (Vulpes ferrilata) and Corsac fox (Vulpes corsac): 211, Tibetan antelope: 199, Common wolf (Canis lupus): 143, Mountain weasel (Mustela altaica): 10, Badger (Meles meles): 2, Wild Yak: 2, Eurasian lynx: 1. Common wolf, fox, Tibetan gazelle and Kiang all used more than 10 structures. In general, most species were found to prefer to large crossing structures with a high openness ratio. The frequency of use of small bridges was significantly higher than culvert use. However, Tibetan antelope and kiang were never observed to use culverts. We found a negative relationship between hourly traffic volume and frequency of fox and kiang use of crossing structures. The results demonstrate that crossing structures for the planned expressway should be tall, wide, and short in length, with high openness ratios. To protect Tibetan antelope, the openness ratios should exceed 4.2. Presently only 5 structures were found to be used by Tibetan antelope. More extensive and comprehensive long-term studies and monitoring are required.

# Poster Session 1

## Poster

# Evaluation of effects of the pairing between road and rail infrastructures on the functionning and the perception of the crossed territories

**Author(s):** Angelique Godart, Charlotte Le bris, Jean Carsignol, Sophie Noiret, Depigny Bertrand, Agnès Rossot Darmet

**Contact:** Angelique Godart, Cerema / Dter Centre Est

**E-mail:** angelique.godart@cerema.fr

The research project deals with the effects of “pairing” between road and rail infrastructures on the functioning and the perception of the crossed territories. Questioning “pairing” goes beyond the raw juxtaposition of two infrastructures to reach a net benefit for crossed territories. The assumption aims at finding less impacts, synergetic functions between infrastructures and global benefits for population in that case. Three themes have been particularly focused on: the ecological impact on biodiversity, the effects on the evolution and the perception of landscapes and land use as well as governance issues and social acceptability in nearby areas. Three areas have been selected in rural and suburban zones to represent the major types of pairing observed in France: a railway built after a motorway in a rural field near Reims; a motorway built after a railway in suburban field near Lyon; a motorway built after an historical railway and a main road close to Arles. For each theme, methodology crossed bibliographic reviews about the main impacts of infrastructures, feedbacks from experts and former experiences, and field analysis. From the beginning, a cross-thematic approach linked all those elements. As for the results, benefits were shown for 2 of the 3 investigated fields depending on species. The habitat fragmentation, caused by the 2nd infrastructure, is reduced thanks to pairing. Nevertheless, needs for consistency with location and design of ecological connectivity structures of each infrastructure are highlighted. Regarding landscape and land use analysis, less changes are induced by the implementation of the second infrastructure than from the first when pairing is created. However, paired infrastructures integration into landscape and final layout more or less depend on important technical obligations. From the societal perspective, the lack of spontaneous and specific view of pairing is significant for the different actors of the crossed territories. This notion is globally misunderstood or is not associated with infrastructures. No special link between crossed territories and paired infrastructures was noticed. Moreover, actors mobilizations don’t seem to be as much dependent on the pairing characteristics as on the territorial context (social, economic, politic) or more precisely their view of their territory. Disparities in the perception and the feeling of the nuisances by local residents were observed to be dependent on personal characteristics and scale analysis (different benefits at national, regional or local level). However, a certain acceptation of paired infrastructures was shown on the medium and on the long term. Thanks to a cross-thematic approach, comparison between different contributions and pros/cons analysis highlight the complexity of “pairing” implementation. Some observations are shared beyond each specific conclusion : the need to improve consistency between infrastructures, the appropriate management for interstitial spaces, global space fragmentation, better adaptation of pairing for each territory, pros/cons for “pairing” depending on territorial scales and local actors. Thus, this complex and multi-focal notion goes beyond technical approach for an infrastructure project manager. The only impact assessment doesn’t make it possible to reach beneficial “pairing” for crossed territories due to the decisive relations between scales, stakeholders and inhabitants.

# Poster Session 1

## Poster

# How to attenuate the barrier effect of linear infrastructures? A method for prioritizing existing crossings to improve wildlife regional connectivity

**Author(s):** Céline Clauzel, Anne Mimet, Jean-Christophe Foltête

**Contact:** Céline Clauzel, Université Paris DiderotLADYSS UMR 7533 CNRS

**E-mail:** celine.clauzel@univ-paris-diderot.fr

Linear transportation infrastructures traverse and separate wildlife populations, potentially leading to their decline at local and regional scales. Wildlife crossings are built to mitigate this barrier effect. Their location should be considered before road building begins so as to limit the impact on connectivity. But in practice, biodiversity seldom takes precedence over economics and wildlife crossings are often developed as an afterthought for already existing infrastructures. In such cases, re-designing existing crossings to improve their permeability to wildlife is often the cheaper and preferred option. Limiting the economic costs also necessitate to find the best crossing location optimizing the connectivity for the larger number of species. We propose to set up a standardized protocol using graph theory for prioritizing these existing crossings so as to improve the connectivity of a set of species with varying degrees of mobility and living in different habitats. The study area is located in the Gresivaudan valley in the French Alps. The method was based on five successive steps: (1) defining the virtual-species groups, (2) land-cover mapping, (3) constructing graphs to model the ecological networks of virtual species, (4) prioritizing wildlife crossing locations depending on the connectivity gains they provide, and (5) combining the results in a multispecies diagnosis. To integrate the nesting of ecological processes and explore connectivity at regional scale and over decades, we proposed to construct graphs based exclusively on habitat areas that were sufficiently large and/or interconnected to support a viable population over time. The prioritization method consists in computing a global index quantifying the initial connectivity of the network and then evaluating the potential contribution of a crossing along the highway corridor by quantifying the increase in the connectivity index provided by this crossing. The results show that the connectivity gain varied greatly among the eight virtual species. Two species groups can be distinguished: the forest species that had most of the habitat area in the study region and the mountain and open habitat species. The connectivity of the first group increased from 4 to 10% with the re-designing of the best crossing. By contrast, the connectivity gain for the second group was small, under 1%. A set of several crossing locations on the eastern branch of the highway optimized the connectivity of the five forest virtual species. This area also held several locations improving connectivity for mountain species. Three crossing locations can be identified in this area as an interesting compromise for these two groups. The locations of the best crossings for the open habitat species were too different from the locations for the other species to reach a compromise. This method could guide planners in identifying crossing locations to increase the connectivity of different species at regional scales over the long term.

# Poster Session 1

## Poster

# Landscape analysis in the East Link projekt an important tool for sustainable ecology

**Author(s):** Cecilia Kjellander, Kajsa Nilsson

**Contact:** Cecilia Kjellander,

**E-mail:** cecilia.kjellander@trafikverket.se

Landscape analysis in East Link projektThe Swedish Transport Administration uses landscape analysis as a tool for project planning in order to accomplish sustainable ecology. In the East Link project, which comprises 150 kilometer high-speed railroad between Stockholm and Linkoping, the use of landscape analysis is playing and important part in the planning process. A Landscape analysis can be made in various ways. In the East Link project the landscape is analyzed systematically in three steps, integrating a wide variety of specialists early in the process. Specialists studies the landscape, based on their expertise (1). This includes for example several GIS analysis analyzing wildlife movements, habitats and connectivity, multifunctional landscapes etc. supplemented with results from field inventory. Noted values in the landscape is presented in a three-graded scale (2). All different values are then analyzed together, and a priority of the values are made (3). Different types of maps is used to illustrate the result. The main purpose of the landscape analysis is to produce sufficient knowledge to enable sustainably solutions in the project, including avoidance, adaption and mitigation measures. When adapting to the values presented in the landscape analysis it is possible to avoid and minimize barrier effects and fragmentation. The knowledge can also be used to reinforce ecosystems and habitats; creating values when restoring areas along the railroad (embankment) and when handling safety zones without trees etc. The landscape analysis is also providing for a traceability, as a cause for where (and how) the railroad is located. The process with an early involvement of different specialists working together, clarifies different obstacles for ecological sustainability in the project and extracts the prioritization of different aspects in the landscape.  Furthermore, specialists are working closely with engineers designing the railway, which integrates ecological sustainability in the construction. This strategy enhances a more efficient way of preserving natural habitats, functional ecosystems etc., as well as prevent retakes and unnecessary costs later on in the project.

# Poster Session 1

## Poster

# Use of the non-specialised structures as a wildlife passages, Lyulin Motorway, Bulgaria

**Author(s):** Maria Nikolaeva Kachamakova, Diana Peneva Zlatanova

**Contact:** Maria Kachamakova, Sofia University «St. Kliment Ohridski»

**E-mail:** maria_kachamakova@abv.bg

Most of the motorways in Bulgaria were built before the implementation of EC regulations related to the ecological corridors' preservation. As consequence a lot of them are barriers for the wildlife movements, moreover when they lie in important natural areas, connecting distant populations. One such an example is the Lyulin Motorway. Because of the rough mountain terrain the road pass through numerous infrastructure facilities (26 viaducts, 3 tunnels, culverts), which occupy 30% of its entire length. The potential use of the structures by the wildlife has not been investigated yet but their existence means that the motorway is not a continuous impenetrable physical barrier. However none of these structures is specially designed as a wildlife passage; a lot of them are not suitable due to their dimensions, position, technical implementation and cover or because of an enhanced human presence and hunting nearby. Three-months camera trap monitoring and snow and mud tracking were carried in order to evaluate the use of the passing structures by the middle-sized and big mammals and to estimate what the issues are. Two tunnels (Lmean=400m), 6 viaducts (Hmax=10m, Lmax=476m, Lmin=81m) and 4 culverts were investigated in the segment where the motorway runs through habitats with high quality, part of the big carnivores' biocorridors on national level. We found that the middle-sized mammals – stone marten (Martes foina), red fox (Vulpes vulpes), wild cat (Felis silvestris) – use all types of structures. In all cases the passes were one-way; a sign that the animals use several structures or cross the roadbed. Hares (Lepus europaeus) and roe deer (Capreolus capreolus) were registered predominantly on the tunnels (Fisher Exact Test, p=0.045) which serve as "green bridges". We did not found any evidences for big animals crossing like red deer (Cervus elaphus), wolf (Canis lupus) or bear (Ursus arctos) although their presence in the vicinity. It could be due to the short period of the investigation or because of the human presence. During field visits we found also that the fence (the only fragmentation mitigation measure present) was in a poor condition and hardly promote the use of the passing structures. On the other hand the structures by them self are not well integrated in the surrounding landscape, miss vegetation and natural cover, the human presence is considerable, there are roads, serious erosion and illegal landfills. All these factors stultify the great permeability of the segment – between 27,5% and 43,4% for the different animals groups, while it vary between 3,1% and 12,1% for Hemus and Trakiya motorways (Zlatanova, 2010). The study could be used as a model evaluation for the old motorways permeability in Bulgaria and contribute for the mitigation of the habitat fragmentation in the cases when potential passing structures exist but are lacking the appropriate design and landscape integration.

## Poster Session 1

### Poster

# Safeguarding wild animals and vehicles on the main roads of Lithuania: an assessment of the effectiveness of measures

**Author(s):** Linas Balčiauskas, Laima Balčiauskienė

**Contact:** Linas Balčiauskas, Nature Research Centre

**E-mail:** linasbal@ekoi.lt

Over the last five years, an average of 2–3 wild mammal individuals have been killed daily for every 100 km of main road in Lithuania. In total, 30 accidents involving wild mammals have resulted in injury or death to people. Forecasts indicate that the number of serious wildlife-vehicle accidents in the country will reach 2500 in 2016. Of particular concern is the fact that the number of WVA involving large mammals, such as moose, is increasing by the fastest rate. In response to this, we assessed the effectiveness of WVA prevention measures (wildlife fencing, underpasses, deer guards and jumpouts) from March 2014 till March 2015. This was first such case study for the country. We used data from wildlife cameras and animal footprint registration, roadkill registration and statistical data from the Register of administrative law offenses and traffic accidents. Seasonal and temporal dynamics of wildlife-vehicle accidents were re-evaluated, identifying the highest activity periods for the main game species. We confirmed that wildlife fencing significantly reduced the number of wildlife-vehicle accidents and our calculation reviewed that the presence of wildlife fencing prevented 300 wildlife-vehicle accidents on the main roads of Lithuania in the course of 2009–2014. The most successful preventive impact was that of the wildlife fencing along the E85 main road, a 311 km long section Vilnius–Kaunas–Klaipėda (the number of accidents was reduced by 160) and the E272, a 136 km long section Vilnius–Panevėžys (the number of accidents was reduced by 112). The effectiveness of the wildlife fences was reduced by insufficient maintenance (gaps in the fence, open gates, etc). Short-span and fragmented wildlife fences were not effective (ungulates accessed the roads through gaps in the wildlife fences and/or around their ends). Deer guards were effective in stopping ungulates (roe deer and wild boar), but their effectiveness in the case of smaller wild mammals, such as carnivores and hares, was insufficient. We were unable to confirm if jumpouts were utilized. In the course of one year, 372 individuals of 15 mammal species were registered successfully using underground passages. It was found that ungulate mammals (including moose and red deer) mostly used recently-built underground passages with large cross-sectional areas. Underground passages with multiple use were less suitable for wildlife and the effectiveness of underground passages was reduced by insufficient maintenance. Recommendations for increasing the effectiveness of measures to reduce WVA were prepared, including physical means to promote safer road crossings for mammals along the main roads and for increasing public awareness with the view to again reduce the number of wildlife-vehicle accidents.

# Poster Session 1

## Poster

# Development of landscape fragmentation in the Czech Republic

**Author(s):** Dusan Romportl, Vladimír Zýka

**Contact:** Dusan Romportl, researcher

**E-mail:** dusan.romportl@vukoz.cz

Landscape fragmentation represents one of the most important issues of current landscape protection. Roads and highways with heavy traffic volume (and moreover often fenced) create long impermeable barriers, which cause enormous negative impact on dispersing or even migrating animal species. Total length of such structures as well as the traffic volume is rapidly increasing within last decades. Poster presents outputs of analysis of the fragmentation development since 1926 till nowadays including prognosis until 2020. The level of fragmentation was quantified by using Effective Mesh Size method (Jaeger et al. 2000) within square fields of regular grid 1x1km overlapping the area of the Czech Republic. Roads of all levels and urban areas larger than 25 ha were used as fragmentation geometry. Database of historical road system developed by team of Department of Cartography and Geoinformatics of Faculty of Science (Hudeček et al. 2012) was used for analysis of roads development and historical topographical maps and CORINE Land Cover database for definition of urban areas. Finally, assessment of landscape quality was provided by analysis of level of providing ecosystem services (Burkhard et al. 2012). Outputs show significant increase of landscape fragmentation with several enormous changing steps caused by construction of highways of urban sprawl. Assessment of quality of non-fragmented landscape brings interesting outputs from the conservation point of view. Gap analysis of spatial distributions of protected landscape areas (NP, PLA, NATURA 2000 sites) and non-fragmented landscape patches shows important facts for current landscape and transport policies.

# Poster Session 1

## Poster

# Do roads select their prey? A comparison of bird roadkill data with local availability

**Author(s):** Sara Maria Santos, António Mira, Pedro Alexandre Salgueiro, Pedro Costa, Denis Medinas, Pedro Beja

**Contact:** Sara Santos, CIBIO/UE - Research Center in Biodiversity and Genetic Resources, Pólo de Évora, Universidade de Évora, Departamento de Biologia, Mitra, 7002-554 Évora, Portugal UBC – Conservation Biology Unit, Universidade de Évo

**E-mail:** saramsantos@hotmail.com

Road traffic collisions are an important mortality source in bird populations. While it is known that some species are more susceptible to road-killing than others, the underlying reasons remain largely unknown. We test the hypothesis that bird vulnerability to vehicle collisions is strongly influenced by morphological, ecological and behavioural traits, thus providing a general basis to predict the species potentially most at risk from road-killing. Bird roadkills were collected from daily surveys conducted during the breeding seasons of 2009-2011, along 50 km of roads, while bird abundances were estimated from point counts conducted around roads during the same periods. Selective mortality was tested in relation to species identity and several species traits. We detected 2,225 bird roadkills belonging to at least 73 species. Most birds showed roadkill rates proportional to their abundance. However, nine species were road-killed more (or less) often than expected from their abundances, with a strong positive selection found for Blue tit Parus caeruleus, Blackcap Sylvia atricapilla and Goldfinch Carduelis carduelis. We provide evidence that birds most vulnerable to road-killing seem to be small passerines that often forage in shrubs and small trees. Efforts should thus be directed towards reducing road-related mortality for this type of species, particularly where roads cross habitats occupied by species of conservation concern meeting these traits.

# Poster Session 1

## Poster

# The promise and reality of using genetic techniques to quantify the impacts of linear infrastructure and evaluate the effectiveness of mitigation

**Author(s):** Kylie Soanes

**Contact:** Kylie Soanes, Australian Research Centre for Urban Ecology

**E-mail:** ksoanes@unimelb.edu.au

Roads, railways and other linear infrastructure can affect the movement and survival of wildlife, with negative consequences for gene flow and genetic diversity. Several reviews highlight the importance of these issues, yet genetic approaches are relatively underutilised in road ecology. Further, many researchers seem unaware of the power of genetic techniques to address 'non-genetic' road ecology questions. Here, we revisit the importance of conservation genetic approaches in road ecology research, discuss the latest advances in 'molecular road ecology', and introduce studies that apply these techniques to common road ecology questions. Individual-based approaches, simulation modelling, next generation sequencing and non-invasive genetic sampling have the potential to provide great insights to genetic and ecological road effects. For example, genetic approaches can be used to quantify barrier effect, identify 'unidentifiable' roadkill carcasses and estimate demographic parameters. Genetic approaches are particularly valuable when investigating the impacts of roads and wildlife crossing structures on animal movement and functional connectivity. We also discuss some of the perceived hurdles to using genetic approaches (e.g. cost, expertise, time constraints, scale) and suggest ways that they can be overcome. Finally, it is important to remember that while genetic techniques are powerful, they are not a cure-all. They are most informative when applied in the context of question-driven science, a robust study design (e.g. BACI) and sufficient replication. Further, combining genetic and non-genetic approaches will provide a more comprehensive understanding of the effects of linear infrastructure and mitigation on population viability. Our goal is to provide a realistic overview of the opportunities, challenges and requirements of genetic approaches in the hope that people will feel better prepared to include them in road ecology research.

# Poster Session 1

## Poster

# Over or under the road? – Effectiveness of some bat road crossing mitigation measures

**Author(s):** Morten Christensen, Esben Terp Fjederholt, Julie Dahl Møller, Hans J. Baagøe, Morten Elmeros

**Contact:** Morten Christensen, Sweco A/S, Granskoven 8, DK-2600 Glostrup, Denmark

**E-mail:** morten.christensen2@sweco.dk

Roads have been shown to impact bats negatively. To explore the effectiveness of different road mitigation measures we studied bat activity at two existing underpasses for watercourses at a highway, and at four experiential hop-over sites by the uses of screens, and at a control site in Denmark. The study used synchronized ultrasound recordings, in combination with night vision video and manual observation to describe the flight behaviour of the bats. More than 2500 bat passes were analysed at seven sites. The study mainly focused on small low flying bats, Myotis daubentonii and Pipistrellus pygmeus. Low-flying bats have the highest risk of fatal road crossing and are most vulnerable to road construction near forest edges, hedges and river crossing are high-risk sites. Underpasses were only found to be efficient for M. daubentonii and were not used by other bat species. Hop-overs and screens were only efficient in cases where alternatives did not exist. The bats' behaviour at the hop-over sites was very variable and they may adapt to the new obstacle by change their flight routes. Screens and hop-overs may be used to reduce the risk of fatal road crossing in cases where underpasses are not possible to construct. For both M. daubentonii and P. pygmaeus correct positioning of the screens is of crucial importance and screens placed in the wrong position can be without any effect or even, in worst cases cause negative impact because they forces the bats to cross the road at more risky places or catch the bats between the screens. The studies emphasises the importance of proper planning of mitigation measures and the need for detailed understanding of the bat commuting routes and behaviour.

# Poster Session 1

## Poster

# Study of behavior of sika deer nearby railroad tracks and effect of alarm call

**Author(s):** Minoru Shimura

**Contact:** Minoru Shimura, Railway Technical Research Institute

**E-mail:** mino@rtri.or.jp

It has become a serious problem that deer-train collision on tracks in Japan. It is estimated that there are more than 5,000 cases happened in a year. According to the report published by Hokkaido local government, there were 2,493 deer-train collisions happed in Hokkaido in 2014 fy. (from 2014/4/1 to 2015/3/31). Although there are 19 commuter train lines, around an half of the collision was occurred in 3 lines. In the most abundant line, there were 530 collisions occurred and it was about 20 % of the total collision. In the line, which is 135.4km long and 21 trains run daily, most of the collision was occurred from evening to early morning in winter. There are 3 hot spots on the line and the hot spot no. 1 is in mountainous region and no. 2 & no. 3 are in flat land where forests are flourished near the track. There are few reports which describe about train-deer collision and less information available to consider about mitigation measure. We observed and took a video of deer around the track through the front window of trains to see how deer react to approaching trains. Deer were recorded with high sensitive CCD cameras settled on the front window of train and it was 158 times which deer were appeared around the track during 48 hours of the observation period. Although 55% of deer was standing at place where train operation would not be interfered by them, rest of them was on the track or closing it. It was 8 times that deer-train collisions were observed. Analysis of video showed that mainly three types of deer behavior (preceding on the track, standing, and crossing) resulted in the collision. We also investigated deer response to an alarm call and a train horn. It was revealed that, whatever the deer are domestic or wild, they were on alert when they heard those sounds. Blowing the sound makes deer being on the alert, therefore, that may be a useful method to prevent deer-train collision. Key words : railway, deer, collision, alarm call

# Poster Session 1

## Poster

# Green Infrastructure Networks in Austria

**Author(s):** Daniel Leissing, Horst Leitner, Roland Grillmayer, Gebhard Banko

**Contact:** Daniel Leissing, Büro für Wildökologie und Forstwirtschaft

**E-mail:** daniel.leissing@wildoekologie.at

**URL:** http://www.wildoekologie.at/

In Austria efforts towards Green Infrastructure Networks have been made by a number of federal states individually, while other federal states do not yet explicitly deal with the topic of habitat fragmentation and habitat corridors. So far, no coordinated, holistic approach has been made by the country as a whole although the EU Biodiversity Strategy to 2020 as well as the national Austrian Biodiversity Strategy 2020+ (amongst a variety of other national and international conventions and laws) demand action. Austrian federal states that engage in creating Green Infrastructure Networks often proceed methodically different from their neighbouring states and their outcomes vary due to the method used. The concepts generally work with habitat corridors (green corridors) or the like and aim on protecting green space from urban sprawl and soil sealing. However, differences exist in the use of focal species and in the level of relevance, ranging from local to regional, supra-regional and international significance. Also the legal status of identified Green Infrastructure Networks differs from federal state to federal state. In Styria, for example, Green Zones are decreed by the authorities and are therefore legally binding, whereas in Carinthia Wildlife Corridors still only serve as a technical concept. In the federal state of Salzburg Green Corridors were lined out, and Pinzgau – one out of five major regions within Salzburg – has already protected its supra-regional corridors by decree. Most important however, is the mere existence of Green Infrastructure Networks concepts and the visibility of these, as well as their accessibility by stakeholders and parties concerned. One of the main objectives of the underlying project of the poster presented was thus to gain a clear and complete overview of all concepts and projects in Austria concerning Green Infrastructure Networks and habitat defragmentation and to make them accessible for users and the public. By methods of literature review, stakeholder workshops and structured telephone interviews the required information and data was collected and all current projects and concepts on Green Infrastructure Networks are being made visible on the webpage www.lebensraumvernetzung.at, where information and spatial data will also be available for download. The poster shows all existing and provided large-scale concepts on Green Infrastructure Networks in Austria. Equally important, the poster shows all parts of the country where no such concepts are provided yet. Objective of the project and of the poster is to graphically demonstrate gaps in a nationwide Green Infrastructure Network and to indicate the need for action.

# Poster Session 1

## Poster

# Assessing the importance of intersections between linear transportation infrastructures and fluvial corridors on plant diversity: first results on road bridges

**Author(s):** Eric Tabacchi, Quentin Fernandez, Anne-Marie Planty-Tabacchi, Didier Alard, Blaise Touzard

**Contact:** Eric Tabacchi, ECOLAB, Laboratoire d'Ecologie fonctionnelle et Environnement, CNRS, Université de Toulouse, Institut National Polytechnique

**E-mail:** eric.tabacchi@univ-tlse3.fr

**URL:** http://www.ittecop.fr/index.php/recherches-cat/47-recherches-ittecop/recherches-2014/128-t

The TGB (ITTECOP program) project aims to identify the role of intersections between linear transportation infrastructures and fluvial corridors for regional and local plant diversities. As a first step, we studied 19 sites distributed along the Adour River (335 km long) and along the Garonne River (650 km long) in SW France. On each site, plant community composition and abundance was assessed from 240 0.5x1 m plots distributed among 3 zones (from inner to outer corridor side) at proximity (test) and far from (reference) the bridges, in both fluvial and road corridors. The purposes of the study were to: 1) understand how each corridor generates or integrates the regional biodiversity gradient; 2) assess possible differences between bridge and reference subsites; 3) identify, from plant traits, the mechanisms involved in a possible disruption or reinforcement of the biological connectivity along the river corridor gradient. About 1800 plant species were identified at the total, with a maximum species density of 73 sp/m² along rivers and 49 sp/m² along roads. Unexpectedly, the total number of species found on roadsides was similar to the number observed along riversides, and the Garonne River system, more heavily impacted by human activities for several centuries, showed similar total species richness than the more natural Adour River system. These results are analyzed and discussed on the basis of biological trait distributions and on landscape patterns, with recommendations for integrated management of roads and rivers.

# Poster Session 1

## Poster

## Detecting existing crossing structures with optimization potential for wildlife by calculating a Structure-Permeability-Index

**Author(s):** Kim Krause

**Contact:** Kim Krause, Kaden ; Partner AG, Bahnhofstrasse 43, CH-8500 Frauenfeld

**E-mail:** kim.krause@kadenpartner.ch

**URL:** http://www.kadenpartner.ch

Existing crossing structures are becoming increasingly important to reduce the barrier effect of fenced highways as they can help to increase the permeability at little additional cost. Nevertheless, not every existing crossing structure is suitable for optimization because of inappropriate structure related attributes such as its dimensions, road-related attributes, surrounding habitat characteristics, and human disturbance levels. The detection of suitable structures along a highway section is labour-intensive as each structure has to be inspected on site. Furthermore, the assessment of the suitability relies on the personal opinion of the consultant, because no standard methodology is available to date. We present a user-friendly method to calculate a Structure-Permeability-Index (SPI) for crossing structures of fenced highways for the identification of structures which are worthwhile for wildlife optimization. The SPI considers structure type and its dimensions, the land-use in the surrounding of the structure (forest, agriculture, settlement, water surface), noise emissions by traffic in the surrounding and the usage of the structure by motorised traffic. Since the SPI has a value between 0 and 1, the permeability of crossing structures can be compared one with another and thus, the overall permeability of a highway section can be classified. The quality of the SPI was tested using linear regression analyses. Therefore, we tested the relationship between the SPI and the number of measured animal crossings (camera survey) of 98 crossing structures (own data). Results show a strong statistical relationship between SPI and number of animal crossings ($R2=0.45$, $p<0.001$). This method allows reducing the cost of the identification of crossing structures which are suitable for wildlife optimization.

# Poster Session 1

## Poster

## Evidence of usage of Estonia`s first ecoduct by mammals

**Author(s):** Maris Kruuse

**Contact:** Maris Kruuse, University of Tartu / Estonian Naturalists` Society

**E-mail:** maris_kruuse@yahoo.com

E263 Tallinn-Tartu-Võru-Luhamaa road is one of the most important national routes in Estonia, connecting capital Tallinn to university town Tartu and South Estonian region. The road separates Estonia`s mainland into two halfs and cuts several important habitats of wild mammals, including large carnivores like gray wolf, brown bear and Eurasian lynx and ungulates like moose, wild boar and roe deer. Estonia`s first wildlife overpass was built in 2013 on a well-known moose migration corridor during road construction of Aruvalla-Kose road segment on E263. The average annual daily traffic volume on Aruvalla-Kose section was 11 000 vehicles per day in 2015 which makes road-crossing very difficult or even impossible for many species. Road section was upgraded from a regular two-line road to a four-lane partly fenced first class road and several wildlife passages (four small/ medium mammal tunnels, three amphibian tunnels, bridge underpass and an ecoduct) were constructed. Three more overpasses and three same-level crossings (fence-breaks) for large mammals are being planned to the next road section. While planning and building such massive and expensive mitigation measures it is important to determine, which species and how often use the passages. Estonian Road Administration retained Estonian Naturalists` Society to conduct effectiveness monitoring of the wildlife passages on Aruvalla-Kose road section from February 2015 to December 2016. Two infrared-triggered trail cameras Uovision UM565-SMS (GPRS) 12MP were placed on the ecoduct. Additionally, 4 m wide track-pad was checked and raked smooth weekly. Data presented in this study was received by analysing trail camera photos from period 1 April 2015 –31 March 2016. Cases of two or more individuals crossing together were counted as multiple crossings. Additional data received by checking track-pads was not included. The first year of monitoring has shown that the most active overpass users are domestic cats (35,8% of total 1006 camera-registered crossings) and red fox (25,9%), followed by wild boar (11,5%) and roe deer (9,6%), domestic dogs (4,8%), humans (4,7%), raccoon dogs (3,6%), gray wolf and European hare (both 0,9%). Also odd crossings by European pine marten and European hedgehog were registered. In 1,9% of the cases the animal species remained unidentified. Further monitoring is necessary to determine if number of wildlife crossings increases in time and if the target species moose starts using the ecoduct.

# Poster Session 1

## Poster

# Current state of road ecology in Japan

**Author(s):** Yushin Asari, Takane Shikano, Miyuki Tanizaki, Misako Noro, Yoshiki Yamada, Hisashi Yanagawa

**Contact:** Yushin Asari, Chodai co., ltd.

**E-mail:** ushin@pop17.odn.ne.jp

ObjectivesRecently, «Roadd ecology» has become widespread worldwide. However its term and concept are not well known in Japan despite there are many conservative constructions and road business operators have given carefull considerations for wildlife. For future development of road ecology in Japan, it is necessary to clearly grasp the information concerning road and wildlife. Our aim of this research is to understand current state and suggest future problems of road ecology in Japan.MethodsThe data base «CiNii» operated by National Institute of Informatics was used for searching domestic research papers relating to road ecology. In 2013, we selected following six keywords concerning wildlife and traffic (excluding traffics by ship and plane): «Road kill», «Eco-road» which was term coined to denote the road giving consideration for environment, «Habitat + Conservation measures», «Train + Wildlife», and «Rail kill». We retrieved papers with above keywords and identified the tendency of subject matter, issue year, target species, and study site.ResultsWe found a total of 136 papers published from 1981 to 2012. There were 62 papers hits for « Eco-road», 31 for «Road kill», 28 for «Road + Conservation measures», 15 for «Train + Wildlife», three for «Habitat fragmentation», and no hits for «Rail kill».The number of issued papers has tended to rise in recent years. Only eight papers were published in second decade; 1992-2002 and in the third decade; 2003-2012. As for target species of research, all papers were distributed into eleven items. There were most hits for large-sized mammal (19), and plant (15) and insect (7) follow it. Studies were mostly conducted in Hokkaido (25 papers) and limited in several regions.ConclusionIt was thought that the reason why «Eco-road» had most hits was the word used widely in road construction and conservation without relation to target species. Keywords concerning train had few papers however study of train and wildlife will be increased because many collisions with large-sized mammal have been found on newspaper in recently. The number of paper published has increased 10 times in several decades. We considered that enhancement of environmental preservation consideration of road business not only newly built road but also road widening affected increasing of number of study and paper published. As for the target species of the study, it might be a reason that countermeasures for road kills have been improved since magnitude of the damage by collision with large-sized mammals as deer has been well known. For the study area, the Hokkaido Development Engeneering Center holds workshop on the theme «wildlife and traffic» every year in Hokkaido and provide a platform for researchers of unique countermeasures (conservation for flying squirrels, bats, and crayfish). In conclusion, it is needed that more information about wildlife and traffic/road will be published and collected through various region for popularization of road ecology and maintaining a good relationship between human and wildlife in Japan.

# Poster Session 1

## Poster

## Effects of habitats fragmentation in a human-dominated landscape (France) and mitigation measures to limit lynx (Lynx lynx) vehicle collisions

**Author(s):** Alain Morand, Jean Carsignol

**Contact:** Alain Morand, Cerema - Dt Est 1, boulevard Solidarité - BP 85230 - 57076 Metz Cedex 03

**E-mail:** alain.morand@cerema.fr

In the human-dominated landscape, land transport infrastructures can impact potentially large carnivore species, and in particular the Eurasian lynx (Lynx lynx), either with direct effects (habitats loss, increased accessibility of quiet areas and facilitation of poaching, vehicle collisions) or indirect effects (noise disturbance or human activity, habitats fragmentation, reduced and more isolated populations, loss of genetic diversity, etc.). Our study investigated, firstly, the previous results of the most recent works in the field studies and modelling approaches of lynx and road infrastructures : habitat suitability model ; model to distinguish fragmentation and forest continuity, corridors and barriers ; local metapopulation viability and the dispersal model with assessment of management scenarios ; predicting model of the risk of collisions. We also used other single analyses and maps on the data set by the French National Game And Wildlife Agency completed and re visited (n=107 collision data between 1974-2014). Within the Lynx range in France, including the Vosges, the Jura and the Alps, the lynx sub-populations and the factors fragmenting suitable habitats are quite well identified. The land transport infrastructures also cut the home range. They are barriers to dayly and seasonal movements that increase risk collisions. With poaching, they are the main causes of lynx mortality in France. In this analysis, we investigate the three aim questions related to collision risk (1) Where ? When ? How do the mortality events occur ? (2) Do age and sex (juvenile, subadult, adult ; male or female) make a difference ? (3) Are there factors increasing the collision risk ? If yes, which are they ? Finally, in a last part, we discuss some mitigation measures to limit the effects of fragmentation and road mortality. We analyse the main reasons of difficulties or unsuitability of the crossings and suggest some recommendations (subject to availability of complementary data and field experiments). Such scientific and practical results will improve the effectiveness of passages and related infrastructures (fences). It will be possible only by strongly encouraging a dialogue and future projects between all the stakeholders linked to this species and partners (managers, experts, scientists) either in road ecology and engineering or lynx studies.

# Poster Session 1

## Poster

## How do we Positively Change Public Perception of the Importance of Infra Eco Solutions?

**Author(s):** Camiel Meijneken

**Contact:** Camiel Meijneken, ProRail

**E-mail:** camiel.meijneken@prorail.nl

**URL:** http://www.prorail.nl/omwonenden/vernieuwen-van-het-spoor/natuurgebieden-verbinden

A Longterm Biodiversity Communications strategy using Infra Eco projects in the Dutch Railways Defragmentation Programme.When building ecological structures, both big wildlife bridges or small eco-culverts, public opinion is that it is an expensive solution for a minor problem, mostly imposed by regulation. The general feeling is: spent our money on more important projects. The belief that these projects are very important links in for example increasing biodiversity is not shared. How can we turn this mindset so that people themselves embrace the idea?At ProRail, the Dutch organization responsible for the management of the Dutch railway system, we initiated a long term communication strategy within the ProRail part of the national defragmentation programme. Communication in a project organization is mostly based on reached milestones and it stops afterwards. Together with organizing projects in a longterm programme, the strategy is to force ourselves in putting out messages in a continuous stream.Every month a small or more or less related news item is put on the ProRail website. Together comes the use of social media. It is important because it directs people to the website. The content of the news item is limited but it can contain a link to more detailed information and it always highlights the same underlying message:»Nature is important and by connecting natural areas we create a larger habitat and thereby strengthen nature.»Another important thing in the strategy is how to create that stream of news items. You will need content. We have experience with te following selection:Project milestones.Picking up news items. A lot is happening on -for example- social media.Join existing happenings or items like «Animal Day», national Sustainability Day. But also for example Halloween.Highlighting specific work within projects. Smaller milestones.Share photos. Promoting the use of social media by the contractor and project members: make pictures or movies and post them. It's easy to link to.Participating in educational projects like Green Future Hero's.Place a bee hostel or other small fauna shelters.Initiating educational projects.Make attractive visuals.We believe we can raise people's consciousness in order to convince thema that it's important to help increase biodiversity. These contributions to more living space for flora and fauna can also be seen as a part of corporate social responsibility or sustainability programs. It can change the public perception of an organization.

# Poster Session 1

## Poster

## Compensatory measures for Smooth Snakes during road construction in Sweden

**Author(s):** Tim Hipkiss, Petter Bohman, Mats Lindqvist

**Contact:** Tim Hipkiss, EnviroPlanning AB

**E-mail:** tim.hipkiss@enviroplanning.se

In 2014 a major road was constructed in Bohuslän, western Sweden, through land used for foraging and hibernation by Smooth Snakes (Coronella austriaca), an endangered and legally protected species. Several mitigatory and compensatory measures were carried out during construction for the benefit of this species as well as other reptiles. A new 0.5-ha foraging site, approximately equivalent to the area lost to road construction, was established by clearing shrub vegetation and creating ponds. In addition, six new hibernation sites were constructed, to replace two known natural hibernation sites that were removed during road construction. Snakes were located and collected prior to the onset of the hibernation season and placed in the new hibernation sites. Snakes that were found during the careful demolition of the natural hibernation sites in late winter were also placed in the new hibernation sites. Foraging and hibernation sites will be managed for the next ten years, for example, by clearing encroaching shrubs , to maintain their suitability for Smooth Snakes and other reptiles. A two year monitoring programme has been established to evaluate the effectiveness of these measures. Preliminary results show that hibernation sites were functional, but only infrequently used by hibernating Smooth Snakes during the first two winters post-construction. Preliminary spring survey results show that numbers of Smooth Snakes located pre- and post construction were more or less equal.

# Poster Session 1

## Poster

# Latest technologies to assess utilization of fauna underpasses by wildlife

**Author(s):** Jonathan Jumeau, Yves Handrich

**Contact:** Jonathan Jumeau, Université de Strasbourg, IPHC, 23 rue Becquerel, 67087 Strasbourg, France CNRS, UMR 7178, 23 rue Becquerel, 67087 Strasbourg, France Conseil Départemental du Bas-Rhin, place du Quartier Blanc, 67964 Strasbourg, France

**E-mail**: jumeau.jonathan@gmail.com

Monitoring wildlife passages allow scientists to improve effectiveness of these structures by adapting their conception, location and planning. To perform the surveys, infrared triggered cameras are probably the most used technique. Indeed, these small photographic cameras with an invisible flash are well adapted to capture a wide variety of species, even when used inside the narrowest underpass. However, few studies have investigated the efficiency of these devices to systematically and automatically capture a majority of the passage events (PE), or their impact on wildlife passages frequentation. How many animals are missed by the device? Is the reliability dependent on type of species ? What are the best sensors' parameters? Is there an impact of the devices on animals' behavior? How many days are needed to make a sufficient survey of an underpass? These are the questions we asked to improve the knowledge in triggered camera utilization.From April 2012 to June 2013, we monitored 12 underpasses located in Alsace (East France) with both triggered photographic cameras (Reconyx HC600) and video cameras. Video cameras recorded 24 hours a day and 7 days per week in order to observe all PE of all species and identify every event missed by triggered cameras configured in 5 different motion/thermal ratios. The behavior of carnivores was recorded in order to assess possible disturbance by the devices on the animals. Finally, we performed a correlation between the number of monitoring days and the diversity of species observed.We found that in small box culverts, 47% of small mammals (voles, mice, shrews) PE and 17% of medium-sized mammals PE (foxes, badgers and other mustelids) are missed by triggered cameras. Moreover, we demonstrated that whatever the season, motion/thermal ratios favoring the motion sensor missed less events than ratios favoring the thermal sensor. Despite every species likely to use our culverts are detected, we found that a minimum of five months were needed to detect 90% of the overall specific diversity over the study period, 3 months more than the duration recommended in previous studies. Monitoring devices disrupted medium-sized mammals during the first five weeks after their installation. There were also fewer carnivores the night after our presence on the field to replace batteries and memory cards. Even by using the latest technologies, our results point out a significant underestimation of wildlife passage utilization which can introduce an important bias to conclusions about effectiveness of faunal passage structures.

# Poster Session 1

## Poster

# Road bund landscapes as habitat: a main asset for rodents in an intensive farming landscape

**Author(s):** Jonathan Jumeau, Yves Handrich

**Contact:** Jonathan Jumeau, Université de Strasbourg, IPHC, 23 rue Becquerel, 67087 Strasbourg, France CNRS, UMR 7178, 23 rue Becquerel, 67087 Strasbourg, France Conseil Départemental du Bas-Rhin, place du Quartier Blanc, 67964 Strasbourg, France.

**E-mail:** jumeau.jonathan@gmail.com

Since the 1970's the intensive farming has led to shape new landscapes of huge single-crops fields, often to the detriment of natural refuges for small mammals and birds, like hedgerows or groves. This type of landscape is frequent in Alsace (France) where hectares are only covered by corn and wheat without interruption leading us to speak about biological desert or unstable ecosystem. Indeed, about the few species living there like rodents, wheat fields are mown during the breeding season in July and corn fields cannot be considered as habitat for these species. They therefore have to survive from July to April without refuges, but few survive more than a few weeks.When a road is built, potential substitution environments (named road bound landscape elements or RBLE) appear like (1) road verges, (2) storm-water basins, (3) excavation slopes or even (4) middle of roundabouts. Indeed, road verges are for example well known to be habitats for some butterflies, orchids or rodents and storm-water basins are frequently occupied by amphibians or birds. However, the habitat potentiality of all RBLE is not known and even if they could be beneficial for the environment, such hypothesis is not considered during current road environmental studies. Thus, to study the ability of RBLE to be suitable habitats, we have compared these 4 RBLE to two different usual crops fields of corn and wheat. Four replicates of these 6 different habitats were selected in an intensive farming landscape.To characterize differences in habitat quality, indexes of rodents populations abundance (capture-mark-recapture) and qualities (body condition and survival based on Huggin's Robust Design model) have been investigated. The study was conducted from May 2015 to August 2015 with 4 captures sessions of 4 consecutive days.We captured 3166 micromammals with an average of 66 individuals per day. These individuals were distributed in four different species: wood mouse (Apodemus sylvaticus), bank vole (Myodes glareolus), commun vole (Microtus arvalis) and Greater white-toothed shrew (Crocidura russula). Following results concern Microtus arvalis only. We found a greater abundance of individuals in every RBLE than in controls (7.5 times more in average), with almost no individuals in corn crops (< 2 per studied crop). This effect is even stronger in July when wheat crops are mown (0,2 individuals/m² in RLBE vs 0,006 individuals/m² in controls). There is also no significant difference in terms of survival and body condition index between sites with sufficient captured individuals (RLBE and wheat corn only).These results lead us to consider all road bund landscapes elements (not only road verges) as sustainable habitats which can favor both rodents (and probably shrews too) and predators communities. However, the respective advantages (rodent vs predators) may be difficult to consider in the light of the Predation Release Hypothesis: i.e. a small number of predators will profit of these RBL habitats.We recommend taking account damages these rodents can cause to nearest crops (financial compensations to farmers), road hedgerows (plants protections, fences) and structures like basins during roads environmental impact studies and road conception, particularly in years of great rodent abundance. Finally, if the rodents' abundances in RBLE have to be decreased, the employed methods need to be considered in the light of other RBLE taxa such as butterflies and orchids.

# Poster Session 1

## Poster

## Integrating biodiversity into an intermodal transport hub project thanks to Eco-design

**Author(s):** Pouchelle Hippolyte

**Contact:** Pouchelle Hippolyte, Egis Structures et Environnement

**E-mail:** hippolyte.pouchelle@egis.fr

LOGIPARC is a logistics hub (road/ rail) covering 184 hectares used mainly for industrial activities, logistics and the service sector located in the Allier Department (Center of France). The environmental assessment has identified that the area was rich with respect to its natural heritage (flora and fauna). Due to the uniqueness of the project, the development was undertaken while taking into account economic performance as well as ensuring the sustainability of natural habitats with a rich biodiversity. These habitats have been preserved thanks to eco-design concepts implemented at the very early stage of the project. At a local level, the project generated value thanks to the development of economic activity and the natural capital that was preserved or redeveloped on-site. The ecological improvements were conceived in such a way as to conserve and improve the existing ecological connectivity. These environmental management prescriptions were monitored during the construction phase and included: The conservation of two wildlife corridors covering one quarter of the total site area, within which the European pond turtle is present (maintained ecological pathways with culverts).Creation of a network of 4600 meters of viable hedges which replaced 3800 meters destroyed: a net gain.Re-creation of a 2ha wet-grassland floodplain on a receptor site of “improved grassland” made use of an existing water reservoir off site and contributed to the compensatory measures required by the regulations. Re-grading the underwater profile of an existing pond. The short-time operation resulted in a variety of profiles, different bank exposures and was left to recolonize naturally by existing plants.Creation of a network of 7 small ponds. The design was such that they maximised their ecological capacity by having different depths, profiles and exposures. The ponds also provided a role for the European pond turtle, by being a habitat suitable for juvenile hatchlings before they reach the pond. Creation of 5 hibernacula.Creation of 3 artificial egg-laying sites for the European pond turtle. The design, management and efficiency of the mitigation measures were followed up by a series of inventories. In particular the monitoring of turtles, that were tracked with a GPS device (a technique developed by Egis).At a local scale, wetlands, hedges and meadows contributed towards the maintenance of the wildlife connectivity and conservation of biodiversity. In relation with these eco-engineering measures, an awareness campaign was prepared for the personnel of the local companies through an educational tour as well as a management plan to ensure the sustainability of the measures that have been put in place.

# Poster Session 1

## Poster

## Assess Ecosytem Services provided by Green Spaces along Linear Transport infrastructure: Exploratory approach

**Author(s):** Labarraque dorothee

**Contact:** Labarraque dorothee, Egis Structures et Environnement

**E-mail:** dorothee.labarraque@egis.fr

Green Spaces along Linear Transport Infrastructures can provide services to the human society. It occurs through ecological processes that are taking place within these spaces. What are these services? Is it possible and is there an interest in modifying these services? The study offers a preliminary assessment of ecological services produced by natural habitats of these infrastructures green spaces.The study is based on a concrete example. The site study is a short section of a highway (around 3 km), in the south of Tours, a city in the center of France. This road is going through different kind of landscapes: woods, open farmland and peri-urban area.Due to the inaccessibility of infrastructures green spaces (especially for security reason), we didn't take cultural and provision services into account. Therefore, we considered that only regulation types of ecological services are likely to be present along Road and Rail Infrastructures. The study concerned the following ecosystem services: air quality regulation, local climate regulation, erosion prevention, pollination, biological control.The second stage was the quantitative assessment in biophysical and economic terms. We selected values per biome based on accepted valuation method. We also used the InVEST Tool for pollination and erosion prevention services.Values provide a rough estimate of the services produced by the green dependences of the infrastructure. Considering the uncertainties which surround their determination, they can only be used for information purpose. So, the study shows that there is a spatial variability of these services within these Green Spaces. It is highly dependent upon the landuse and to a lesser extent upon the surrounding environment. In economic terms, the total value is estimated around 600 €/year/ha (value which is probably underestimated since only few services were evaluated). Even if this value is low, it would represent nearly 200 million Euros per year in France (for 340.000 ha of green dependences –source Union Routière de France, 2007). Therefore, even as an indicative value, it illustrates the stakes associated to green dependences, which are often forgotten.Furthermore, the study highlights the need for research to quantify the services produced at a local scale.The study then explores factors that could modify the production of ecological services. Factors can vary based on management and maintenance, but also landscaping practices.It shows that new skills can be developed for a landscape design of ecosystem services. The anthropocentric approach of ecosystem services also considers that project managers can rely on actions promoting certain services for an eco-design of their infrastructure, better social acceptability and possibly an economic optimization of their project.

# Poster Session 1

## Poster

# Viability of linking bridges in the area of environmental corridors in Germany

**Author(s):** Udo Tegethof

**Contact:** Udo Tegethof, Federal Highway Research Institute (BASt)

**E-mail:** tegethof@bast.de

**URL:** http://www.bast.de

Green bridges, wildlife and small animal tunnels serve the linking of animal habitats over or under roads and at the same time prevent accidents involving collisions with wild animals. Underpasses for flowing water bodies and such for service roads also have a significant potential for the ecological linking of landscapes. The German Nature Conservation Act (BNatSchG) demands a biotope network system, which has already been implemented in the federal re-linking program. In this context, the question of ecological penetrability of the existing federal highway network arises. Crossing aids specially built for wildlife are lacking in the sections where roads meet corridors of the biotope network. To estimate the value of existing structures a method was developed for the assessment of any bridge structure on federal highways with regard to their suitability to facilitate animal crossings. The findings of the project are available as "Fauna Value" assessment form. With this form the entire range of types of underpasses, from simple pipe passages to large viaducts, can be assessed uniformly based on 27 criteria with ecological importance. The best suitable large viaduct in a natural environment may achieve 5550 points, while the worst pipe may get only 10 points. The form is held simply and clear to make it ready for the application by members of road authorities, conservation administration or nature conservation organisations. Comparable results must be achieved, regardless of any previous training the operators may have. With the plotted "Fauna Values" of road structures in a map, together with wildlife corridors it is easy to discuss where additional structures or upgrades are needed to successfully link wildlife habitats across roads.

# Poster Session 1

## Poster

# Implementing local actions for biodiversity and extend them at European level : a feedback from LIFE Elia-RTE project

**Author(s):** Simon de Voghel

**Contact:** Simon de Voghel, LIFE Elia-RTE project

**E-mail:** devoghel.simon@gmail.com

**URL:** http://www.life-elia.eu/en/

Innovative "biodiversity-friendly" actions related to vegetation management under overhead high tension lines in forest areas are carried out by the LIFE Elia-RTE project. These actions are implemented along 155 km of electrical forest corridors in Belgium and on 7 different sites in France. These actions are solutions to major challenges faced by linear infrastructure companies in Europe (Electricity Transmission System Operators) : extend the grid and take biodiversity into account. The project strives at adapting methods in several EU countries, towards a large network for biodiversity. We provide concrete examples in Belgium and France, and future implementations in Portugal and Germany.

# Poster Session 1

## Poster

# Working for biodiversity on linear infrastructures : need of appropriate and efficient tools such as mapping system and stakeholder involvement

**Author(s):** Simon de Voghel

**Contact:** Simon de Voghel, LIFE Elia-RTE project

**E-mail:** devoghel.simon@gmail.com

**URL:** http://www.life-elia.eu/en/

The LIFE Elia-RTE project implements 7 innovative actions in Belgium (155 km) and France (7 sites) to combine electrical safety and biodiversity in corridors created by high-tension lines in forest. The first steps to plan these actions are the vegetation description, mapping and analysis of potentialities. These steps require the choice of appropriate technical tools (hardware & software) from field data collection to database management and reporting. To ensure a long-term success, action plans must also match with local stakeholders interest by finding win-win agreements. We address pro's and con's of some IT solutions developed in our project based on feedback after 4 years about two main features : mapping and stakeholders involvement.

# Poster Session 1

## Poster

## Development of microsatellite marker for identifying Japanese squirrels-Noninvasive genetic sampling on the road

**Author(s):** Yoichi Sonoda, Masatoshi Nakamura, Yusuke Ueno, Masahiko Matsue, Masao Kurihara

**Contact:** Yoichi Sonoda, Regional Environmental Planning inc.

**E-mail:** sonogonia0210@gmail.com

The arboreal mammals are potentially highly vulnerable to discontinuities in habitat created by road. There is a scarcity of research and survey methods regarding arboreal mammals in road ecology. In this study, we carried out the selection of microsatellite markers to identify individuals from trace DNA in order to apply to the pre- and post-assessment on road of arboreal mammals. We developed an effective method for collecting trace DNA from food marks samples of wild individuals in the field. We extracted trace DNA from the collected food marks samples and verified the possibility of identifying individuals in the field. Using 52 DNA samples of Japanese squirrels, we evaluated the polymorphism of total 63 microsatellite markers of squirrel genus. From a set of 37 microsatellite markers, we selected 10 individual discrimination markers for Japanese squirrels i.e. Lis-09, Scv-15, Scv-04, Scv-16, FO-33, FO-35, FO-36, FO-39, FO-4 and FO-48 based on the lowest possibility of identity values (PI-sibs). DNA was extracted from non-invasive samples such as feces or saliva can be of low quantity, low molecular weight and often contaminated with PCR inhibitors. Taking this into consideration, we used feces samples and food trace samples expected to contain saliva of Japanese squirrels, and carried out this study in three parts: 1) sample storage method; 2) DNA extraction method; and 3) Efficient PCR reaction conditions. Optimal analysis conditions for individual identification method of Japanese squirrels with non-invasive samples were determined. We collected a total of 45 of feces and food traces samples (apples and sweet potatoes) from Japanese squirrels bred in Inokashira natural culture park and analyzed individual identification using the selected 10 microsatellite markers. Individual identification was successful in 28 out of 45 samples, and the success rate was 62.2%. The success rate by sample type, fecal samples were 89.5% (successful in 19 samples out of 17 samples), food samples (apple) were 12.5% (success in one sample out of 8 samples), and food samples (sweet potato) were 55.6% (18 samples in success in 10 samples). Fecal samples showed the highest success rate. We analyzed a total of 29 food traces (pine cone) of Japanese squirrels collected at Kashi road (about 1.0km × 1.5km around Fukushima Prefecture's Minamiaizu-gun Shimogo-machi) for identification using the 10 microsatellite markers. Individual identification was successful in 5 samples out of 29 samples, and the success rate was Identification success rate was low from food traces (Pine cone) in the field. The success rate of fecal samples is the highest. But we could sufficiently identified individuals in the field using DNA extracted from saliva. In order to capture saliva easily, we suggested that we set up bait traps and capture food trace with saliva.

# Poster Session 1

## Poster

## A test of wildlife warning reflectors as a way to reduce risk of wildlife-train collisions

**Author(s):** Karolina Jasińska, Joanna Werka, Dagny Krauze-Gryz

**Contact:** Karolina Jasińska, Warsaw University of Life Sciences - SGGW Faculty of Forestry Department of Forest Zoology and Wildlife Management

**E-mail:** sep.wedrowny@gmail.com

Looking for an effective method to reduce risk of animal-train collisions we tested the system of wildlife warning reflectors, usually used on roads. The research was conducted in central Poland along the E 65 line between Warszawa Wschodnia and Legionowo in the years 2010 – 2011. Digital cameras were used to register animal activity 24h a day in two periods: when the reflectors reflected light from approaching trains and when the reflectors were covered (they were deactivated). We registered 700 observations of 6 mammal species near railway track – roe deer, wild boar, red fox, brown here, domestic dog and cat. We described three types of animal reaction to an approaching train: (1) escape, (2) moving away from rail track, (3) no reaction. In situations when the reflectors were covered animals reacted similarly like in situations when reflectors reflected light from an approaching train: (1) 64% and 46%, (2) 3% and 7%, (3) 33% and 47%) ($\chi 2=5{,}04$, $p>0{,}05$). Because this type of warning devices have to reflect light from approaching train, they can work only at night. That is why we compared reactions of animals to an approaching train at day and night. During the day animals escaped more often than at night, when warning devices were supposed to work – respectively: 69% and 46% ($\chi 2=26{,}85$, $p<0{,}01$). The results indicate that wildlife warning reflectors are not effective method to reduce risk of animal-train collisions.

Information about the conference
Tuesday August 30th
Wednesday August 31st
Thursday September 1st
Friday September 2nd
Index of authors

# Poster Session 1

## Poster

## The use of crowd sourcing to conduct research and create support for wildlife crossings

**Author(s):** Mark Van Heukelum, Anne Martine Kruidering

**Contact:** Mark Van Heukelum, Ecology Consultant at the company Arcadis. Specialized in the design, inspection and monitoring of wildlife crossings and road safety

**E-mail:** mark.vanheukelum@arcadis.com

To ensure the sustainable functionality of wildlife crossings it is essential that these structures are being monitored and/or maintained regularly. However, in performing these activities we noticed that there is a lack of attention, priority and budget for monitoring and maintainance. Also, examples of failed wildlife crossing functionalities in the media lead to a lack of suport by the general public. Efforts to increase support are very limited. What is needed is more monitoring of wildlife crossings, more communication on wildlife migration and to generate more support and attention for wildlife crossings.

Arcadis has developed a solution that combines these needs. Together with the Province of Overijssel (Dutch government) we developed a webtool based on the principle of crowd sourcing, called wildspotter.nl ('wildlife viewer.nl'). Images of camera traps used in monitoring wildlife crossings are shared on this webtool with the general public. Visitors are asked to determine the images by clicking on the right species. The image will be determined by the species with the most number of votes. Images can be shared on social media and visitors get a user status based on the rate of correct answers. So basically, the analysis of data is being outsourced to the general public. Crowd sourcing has proven to be a reliable source of information. The webtool generates standard lists and graphs as input for a report. Outsourcing and automating the analysis makes monitoring projects less expensive and more attractive to perform.

The purpose of the tool is to:

- Perform a proper monitoring research based on crowd sourcing, thereby reducing costs and improving the data quality;
- Sharing the functionality of wildlife crossings;
- Creating attention, involvement and support for wildlife crossings, but also for wildlife migration and the potential hazards on the road.

This spring the webtool will go live. In our presentation we would like to demonstrate the tool and talk about:

- the first results
- the strenght of the technique
- the advantages of public involvement

**Uniqueness:**

The concept of crowd monitoring to learn about fauna passages and communicate about this passages via website is something new. Crowd monitoring is a common activity yet using the public for animal monitoring at fauna passages is unique at least in the Netherlands. There is some experience in other countries, per example in Tanzania *1. This way the general public learns about the functioning of these passages which animals cross it and spread the word that most of these passages are really functional.

Lessons learnt:

- > 98 percent of the answers is correct;
- How to use (social) media to familiarize people with the concept of crowd monitoring ofwildlife passages

# Poster Session 1

## Poster

# Assessing the potential of linear infrastructure verges for conservation and dispersal of wild pollinators in landscapes - The PolLinéaire approach

**Author(s):** Denis François, Violette Le Feon, Jean-François Bretaud, Eric Guinard, Mickaël Henry, Christophe Pineau, Bernard Vaissiere

**Contact:** Denis François, IFSTTAR

**E-mail:** denis.francois@ifsttar.fr

Pollinators are declining worldwide, leading to question whether a global pollination crisis is underway. This would result in severe consequences for man and nature as most crop and wild plant species depend on animal pollination. This decline is due to multiple interacting factors, mostly bound to agriculture and urbanization, but the transportation sector has its share of responsibility as linear transport infrastructures (LTI) are notably responsible for habitat loss, fragmentation and pollutant release. In practice, such impacts are considered by Environmental Impact Assessment studies, which regard mainly the conception of LTI projects and the construction stage. Nevertheless, LTI in operation keep important surfaces of green verges which, under suitable management, might serve to improve their overall environmental balance sheet. Yet, the potential benefits of LTI verges for pollinators and the potential pollination service they provide to the surrounding landscape mosaic have scarcely been assessed. Their proper management could result in a better environmental integration of LTI into landscapes (contribution to green networks, support to agro-ecology). The PolLinéaire project (2014-2016) aims at assessing, explaining - and making operational proposals to develop - the potential of green verges as habitat and source of pollinators (Hymenoptera, Apoidea and Lepidoptera, Rhopalocera). Typical site configurations were defined in order to study the habitat (nesting resources, food availability) and the source (displacements) functions. Western France was investigated for study sites bound to national roads, railways, waterways and powerline networks. In order to assess lateral displacements, entomophilous crops adjacent to LTI were searched. The habitat function was more extensively studied thanks to LTI implanted into forest cuts in the most forested part of the investigation area (Limoges region, 45°51'N, 1°15'E). The preliminary search for relevant areas was carried out by means of the BD Topo database (2014) for LTI networks, the RPG database (2012) for crops, and the BD Forêt database (2014) for afforestation. When necessary, network operators were consulted for information and to access sites for check-up (e.g. crop rotation). An oilseed rape (OSR; Brassica napus) production area was selected with crops adjacent to a set of national road sections (north-west). Field work was carried out during OSR flowering on 6 sites. Insects were identified on-site (butterflies) or collected (sweep netting) for identification by experts (wild bees) along a 1-km long section of green verge, and within the OSR field. A set of 31 power line rights-of-way (ROW) sections was selected as study sites in the forest area. Insects were also identified/collected in 25 grassland sites located less than 1 km away from the ROW sections for comparison purpose. LTI networks irrigate all areas under man's influence. At a regional/country scale, green verges constitute a very large surface. PolLinéaire is a first step to improve knowledge on their potential benefits for pollinators. In order to gather more information and to answer faster the worldwide concern about pollinators and insect pollination, this methodology could be applied to many kinds of LTI networks in different biogeographic areas in the world.

# Poster Session 1

## Poster

## Using Citizen Science in French National Road Departments to collect data on wildlife roadkills.

**Author(s):** Lucille Billon, Elisabeth Wattebled, Perrine Vermeersch, Romain Sordello, Julien Touroult

**Contact:** Lucille Billon, National Museum of Natural History of Paris

**E-mail:** lbillon@mnhn.fr

The Green and Blue Infrastructure is a French policy which aims at preserving and restoring functional ecological networks, to reduce habitat fragmentation. Roads have various effects on the environment and they participate to the loss of habitat and to their fragmentation. Mortality caused by collisions between animals and vehicles is a negative consequence of roads on wildlife. To reduce this effect, we have to quantify it by enhancing knowledge and data collection. Some studies have shown that roadkills are aggregated along roads. Identifying these areas can allow implementing appropriate mitigation measures. In France, the study of wildlife collisions is growing. Many initiatives exist but few have a standardized protocol. Using a standardized protocol would allow providing reliable data and identifying roadkill aggregation areas. In 2009, a partnership with a national road department, the “Direction Interdépartementale des Routes de l’Est” (DIR Est), and the National Museum of Natural History of Paris (MNHN) was set up. A protocol for collecting roadkill data has been developed and tested for five years. This protocol is based on the participation of the road maintainers. During their daily maintenance survey, they have to remove animal carcasses for the security of road users. It is an opportunity to collect roadkill information. The maintainers complete a survey sheet that provides information on the species, the date and the location of the collision. Mobilizing road maintainers has several advantages. It raises awareness of biodiversity conservation issues among them. Moreover, data are more reliable, due to the high frequency of surveys, and the cost of data collection is low. Each year, data are analysed with the Ripley’s K function, in order to detect hotspots of collisions along roads. Aggregation areas are then mapped. Analyses are done with SIRIEMA software, developed by Brazilian searchers. This protocol is currently being extended to other structures in order to standardize methods and to limit biases. Since 2015, six new partnerships between the MNHN and national road departments (DIR) have been set up, with the participation of the CEREMA. More than a thousand data have been collected a year with the “DIR Centre-Est”. The first results are being analysed and will be available in spring 2016.

# Poster Session 1

## Poster

# Roadkill Data Collection using Citizen Science in Austria

**Author(s):** Florian Heigl, Wolfgang Steiner, Carina Stretz, Kathrin Horvath, Franz Suppan, Thomas Bauer, Gregor Laaha, Johann G. Zaller

**Contact:** Florian Heigl, Citizen Science Working Group, Institute of Zoology, University of Natural Resources and Life Sciences, Vienna

**E-mail:** florian.heigl@boku.ac.at

**URL:** http://www.roadkill.at/en

The most direct impact of roads on vertebrate species is roadkill – particularly for those with high mobility or seasonal migration behaviour, such as mammals or amphibians. In Austria, official data of roadkilled animals are only available for huntable wildlife (e.g. deer, fox, badger). In the year 2015, amongst others 22602 European hare, 37412 Roe deer, 1193 European badger were killed on Austrian roads. However, there are no data available on the effects of roads on non-huntable wildlife or red list species such as European hedgehog (Erinaceus europaeus) or European green toad (Bufo viridis). The overall goal of the project is to get an overview of the number, species and location of roadkilled vertebrates in Austria and at the same time raise public awareness for roadkill. In two subprojects we hypothesized that (I) data from citizens and hunters regarding the influence of landscape structure on European hare (Lepus europaeus) are complementary and (II) that traffic intensity is a major factor for roadkilled amphibians and reptiles. Therefore we launched the citizen science project Roadkill (www.roadkill.at/en). In citizen science projects volunteers are collecting and/or process data. To minimize the expenditure of time and the associated costs in such a multifaceted project, we conducted a testing phase with students in an obligatory course of the Bachelor programme of Environment and Bio-Resources Management at the University of Natural Resources and Life Sciences Vienna, Austria. We engaged about 200 students in reporting roadkills during their daily routine. Data collection was carried out via an open source mobile app (EpiCollect) that ran on students' private devices. After three months students provided feedback on the project. Based on this feedback, we developed a new simple online platform together with a student extending the project for all citizens to participate. Because of a major spam attack on our database we were forced to shut down the project and relaunch it in cooperation with a professional web design company in the following season. At www.roadkill.at you can now enter your data directly or download an App for Android or iOS systems and upload your data via mobile phone. Our project flow showed in the testing phase that the advantage for students in participating in a pre citizen science project is that they can apply their acquired theoretical knowledge and learn in an active way how a scientific project is carried out. They can collect and interpret data by themselves and learn how to evaluate projects. The advantage for teachers is that citizen science project ideas can be tested before they are presented to the public. Preliminary results in our sub-projects suggest that (I) data from citizens and hunters are complementary and that (II) amphibians and reptiles are not necessary killed were traffic intensity is highest.

# Poster Session 1

## Poster

## Can linear infrastructure elements contribute to conservation of grassland biodiversity?

**Author(s):** Erik Öckinger

**Contact**: Erik Öckinger, Swedish University of Agricultural Sciences

**E-mail:** erik.ockinger@slu.se

With decreasing areas of natural and semi-natural habitats, the importance of anthropogenic habitats for biodiversity is increasing. Infrastructure rights-of-way, such as road verges and electrical transmission line corridors cover large areas of land. In Sweden their total area exceeds that of semi-natural grasslands, and hence they have a great potential for conservation of especially species associated with grasslands. As linear habitats they also have the potential to act as dispersal corridors and increase landscape connectivity. We compared species richness and community composition of butterflies along small forest roads and in power-line corridors in comparison with semi-natural grasslands, and tested how this was influenced by landscape configuration and local management. Power-line corridors had higher species richness than semi-natural pastures, but contained a partially different set of species, whereas forest roads had similar number of species as semi-natural pastures. Butterfly communities in power-line corridors were not affected by the amount of grasslands in the landscape, but instead the community composition in semi-natural grasslands and road verges are influenced by the vicinity of a power-line corridor. Studies of dispersal behavior indicate that the power-line corridors and road verges act mainly as habitat for grassland butterflies, and do not direct dispersal movements. We conclude that power-line corridors and other rights-of way habitats to some extent can be managed to act as a substitute for rapidly declining semi-natural habitats in anthropogenic landscapes. Further studies underway will show to what extent these infrastructure habitats contribute to biodiversity and ecosystem services at landscape scales (i.e. not only locally) depending on landscape context.

# Poster Session 1

## Poster

## Impacts on Wildlife Genetic Diversity in Road-Effect Zones

**Author(s):** Karl Jamison Jarvis, Samuel A. Cushman, Paul Beier, Brett G. Dickson, Jason A. Wilder, Erin L. Landguth

**Contact**: Karl Jarvis, Northern Arizona University

**E-mail:** karljarvis@gmail.com

**URL:** https://karljarvis.wordpress.com

When roads divide wildlife populations, it prevents road crossing, leading to genetic consequences. The most studied of these consequences is genetic differentiation, but an additional effect can be a drop in genetic diversity. This can occur in areas nearest to roads, which we term a "genetic road-effect zone." This can occur because individuals near roads have less accessible habitat and mates, essentially shrinking their gene pool. Therefore, the closer an individual is to the barrier, the more its gene pool is limited. Empirical studies have suggested that subpopulations nearer to roads have lower genetic diversity than clusters farther from roads. However, studies have yet to address the question of how roads affect genetic diversity across continuously distributed populations across heterogeneous landscapes, because they have focused on clumped populations or clumped sampling of continuous populations. We tested the hypothesis that roads drive a decrease in genetic diversity using datasets on two kangaroo rat species, alpine newts, pronghorn antelope, roe deer, and simulations to assess the effect of roads on genetic diversity across landscapes with heterogeneous habitat quality. We analysed populations in which individuals were sampled continuously across their habitats, and we developed simple resistance surfaces for them, largely focused on road impacts. We used Mantel tests to select resistance surfaces with cost distance matrices that model genetic distances. We then used a spatial genetic diversity (sGD) approach to assess genetic diversity in Wright's neighbourhoods across these resistant landscapes. Our simulation results indicate that a drop in genetic diversity develops near roads when road avoidance or roadkill prevents crossing in > 50% of attempted migrants. Some empirical results fit this result, but others suggested that roads could have more complicated effects on genetic diversity; roads may even increase genetic diversity when road avoidance and roadkill are low. We describe the range of characteristics of species that may be most affected by roads, and mention road characteristics that are most likely to cause decreases in genetic diversity for wildlife populations. We suggest that the impacts of roads on genetic diversity could be significant in some taxa.

# Poster Session 1

## Poster

# The Dawei Road project: An international cooperation of IENE on sustainable planning of large linear infrastructure trans-boundary project in a Biodiversity Hotspot of Southeast Asia.

**Author(s):** Lazaros Georgiadis

**Contact:** Lazaros Georgiadis, IENE

**E-mail:** lazgeo36@gmail.com

**URL:** http://www.iene.info/

At the IENE 2014 International Conference in Malmö, Sweden, a team of government officials of Myanmar and Thailand and staff of WWF Myanmar and WWF Thailand learned about road ecology, understood the challenges that both countries face in their different stages of infrastructure development and network with various green infrastructure experts. After a meeting with the IENE Steering Committee a project was set up by WWF, IENE and the Austrian Ministry of Transport, Innovation and Technology with two purposes: a) To organize a systematic exchange of knowledge and experiences on Green Linear Transport Infrastructure in national-ministerial, regional and local-social level. b) To evaluate the environmental impact on habitat fragmentation of the alignment of the trans-boundary high speed motorway between Bangkok in Thailand and Dawei in Myanmar and to propose a framework of recommendations for an appropriate design of the alignment. An IENE team visited the two countries in February 2015 and participated in the international GEGG Forum in Myanmar, meetings and special technical workshops as well as in special field visits on the planned motorway alignment spots as well as in important protected areas and National Parks in Thailand. Aiming to exchange knowledge and experiences from Europe, the IENE team, in cooperation with WWF, established a framework of presentations which covered the demands of important topics on sustainable linear infrastructure development as: The environmental strategy and policy in the European Union.The legal framework with the appropriate legal tools implemented in Europe. Introduction of the negative impacts on the environment in case of inappropriate design and construction of a road.Introduction of the basic principles in appropriate design and how to avoid, mitigate or compensate the environmental impacts.Sharing best practices ranged from trans-boundary agreements to environmentally friendly road designing. Sharing best practices from green transport infrastructure development. Introduction of basic principles of ecosystem services and the values of roadless and low traffic areas. From the experience gained during the trip, eight general recommendations were made for the countries in the Greater Mekong Region that can be evaluated as basic Green Transport Infrastructure Principles for developing countries. Additionally, based on the field trip that took place on Thai side, seventeen specific recommendations were focused on concrete topics adapted to local mitigation needs. The overall project “Planning and Applying Mitigating Measures to Green Transport Infrastructure” in Myanmar and Thailand is a pioneer step for the development of IENE cooperation in an international level and WWF has made that achievement possible. Estimating the results of the project according to the working team presences in Myanmar and Thailand and the fruitful cooperation with WWF colleagues, IENE is sure that the lessons that were transferred to the Greater Mekong Region from Europe will be a start for the development of Green Policy in the transport infrastructure sector in Asia. The overall results can be evaluated and used as a first step toward the development of a framework of Global Green Transport Infrastructure Principles

# Abstracts

# Thursday September 1st

## Plenary Presentation - P3

# Traffic verges and biological diversity: Realized possibilities, realities and prospects

**Author(s):** Heinrich Reck

**Contact:** Heinrich Reck, Institute for Natural Resource Conservation, Dept. of Landscape Ecology at Kiel University, Germany

**E-mail:** hreck@ecology.uni-kiel.de

Is the expanse of roadside habitats larger than that of nature reserves? Which European target species are already dependent on verges? Are there more native shrub and tree species at roadsides than in working forests? Are road networks already the best part of existing ecological corridors? How could the vast amount of verges play part in the mitigation of barrier effects or as element of the European green infrastructure? What could be the benefits for plants, insects, reptiles, mammals and even people? Such questions arise when looking at modern European landscapes and their future development. The working groups around Klaus Richter and Heinrich Reck will present answers from a Central European viewpoint and provide clues to draw practical conclusions by e.g. analyzing species composition at common and experimentally designed roadsides and reference habitats or regarding roadside behaviour and roadkill of threatened species.

## Plenary Presentation- P4

# Interaction and adjustment: essential concepts in biodiversity evolution processes for landscapes fragmented by infrastructure

**Author(s):** Yves Luginbühl

**Contact:** Yves Luginbühl, CNRS - Université Paris 1

**E-mail**: Yves.Luginbuhl@univ-paris1.fr

The effects of infrastructure on biodiversity are now analysed in terms of the infrastructural fragmentation of ecosystems. To study these effects, the term most often used is “impact”. This term comes from ballistics, and indicates that the damage is in one direction only. However, these effects also have consequences for the infrastructure itself and how the actors concerned manage its environment. For these reasons, a preferable term is “interaction”, because it implies a feedback effect, reflecting the complexity of anthropo-ecological processes. Meanwhile, the term “adaptation” is most often used in research on biodiversity. We prefer the more relevant term “adjustment”, which expresses the ways in which the organisation of social actors changes in the most significant ecosystem evolutions. Using the term “adaptation” implies that social activities adapt to nature, which is constantly evolving and lays down its law for humanity. Which law is meant here? When an agreement must be discussed for an issue of damaged biodiversity, nature will not be at the negotiating table to sign the agreement (Michel Serres). This presentation will discuss the implications of these ideas, using the example of interactions between infrastructure, agriculture and landscapes, and focusing on several complex situations in France and abroad. It will explain the many different interrelations between agricultural activities, infrastructure and the actors involved, drawing conclusions that make it possible to rethink the relationship between societies and nature.

## Talk- 2.1

### Wildlife crossing structures - Part 2/3

# Analysing ecological network for identifying, reducing, mitigating impacts of infrastructures

**Author(s):** Sylvie Vanpeene

**Contact:** Sylvie Vanpeene, Irstea, centre Aix en Provence 3275 route de Cézanne CS 40061 13182 Aix-en-Provence cedex 5

**E-mail:** sylvie.vanpeene@irstea.fr

Since decade, attention has been paid to common landscapes and to connections between significant reservoirs of biodiversity. This context has highlighted landscape connectivity and ecological network. To promote a safe and ecologically sustainable transport infrastructure, transport systeme will have to minimize impacts on the environment and of course on connectivity. But ecological networks are spatial patterns that do not necessarily correspond to spatially explicit elements in the landscape. Consequently, reducing impact on connectivity involves a methodological approach specifically designed for modelling ecological networks and functional connectivity. Various methods to quantify landscape connectivity can be used for mitigation of transport infrastructure impacts: individual-based movement models, least-cost analysis, circuit theory, centrality analyses, landscape graphs … This scientific session will gather scientific presentation concerning identifying, reducing, mitigating impacts of infrastructures.

# Talk- 2.1

## Wildlife crossing structures - Part 2/3

# Making a change in the life of riverine species - removal of 300 barriers in northern Sweden

**Author(s):** Ida Schönfeldt, Torbjörn Nilsson

**Contact:** Ida Schönfeldt, Swedish Transport Administration

**E-mail:** ida.schonfeldt@trafikverket.se

**URL:** http://www.trafikverket.se/remibar_en

Many animals and plants that live in streams are dependent on migration during certain stages of their lives, to spread and to reproduce. For fish, migration is vital in order to move between spawning grounds, nursery grounds and feeding grounds. The project Remibar has removed migratory barriers in five larger water systems in the northern part of Sweden. The work was conducted within the network of Natura 2000, and the goal was to improve the conditions for the target species salmon, freshwater pearl mussel, bullhead and otter, along with their habitats. The project represents one of the largest freshwater initiative in Sweden. A total of 300 migratory barriers, both culverts and dams, have been removed. In Sweden there is a road crossing approximately every second kilometer of a stream and of these at least 30% are barriers to fish and other aquatic species. There are also dams, remaining from the log-driving period, which are no longer in use but still makes barriers. Through removing barriers we have created connectivity within the streams and thereby improved and secured the conditions for the targeted species as well as for other species that thrive in or along the streams. What are the problems? Culverts can cause different kinds of migration barriers. Some of the most significant are: Water velocity is high. Lack of resting sites for fish. Low water level within the culvert. Perched crossings – that is, the culverts level is above the river bed at the outlet. Bridges or culverts lacks natural shores, and is thereby a barrier to terrestrial animals. The solutions! There are several solutions to the problems: Replacing the existing culvert with a bridge or an arch so that a natural riverbed can be remediated. The water velocity will decrease and resting places for fish is created. Replacing the existing culvert with a larger dimension lower the water velocity. Lowering the existing culvert, this is only possible if the dimension of the existing culvert is correct. Step-pools downstream the culvert will raise the water level and lower the water velocity. Constructed shores, shelves or marking stones will lead small animals like otters to pass under the road. Dissemination and information has been an important part of the project. Through information on our website, in brochures, signs etc. we increased awareness of problems and solutions to barriers in streams. We have had excursions and education to targeted groups such as entrepreneurs, consultants, authorities, foresters, land owners and children. During the project time (2011-2016) 300 barriers has been removed in the Northern part of Sweden. The project budget is € 8 million and EU's LIFE nature-fund contributes with half the sum. Remibar is a cooperation project between the Swedish Transport Administration, The County Administrative Board of Norrbotten and Västerbotten, the Swedish Forestry Agency, The Swedish Agency for Marine and Water Management, the forest companies Sveaskog, Holmen and SCA.

## Talk- 2.1

### Wildlife crossing structures - Part 2/3

# Use of wildlife crossing structures by ungulates in relation to human activity and migration periods

**Author(s):** Ole Roer, Karianne Thoger-Andresen
**Contact:** Ole Roer, Faun Naturforvaltning AS
**E-mail:** ole.roer@fnat.no

The transportation infrastructure is rapidly expanding and are being upgraded to move goods and people in and out of populated areas. The impacts of roads and traffic are globally recognized as threats to the functioning of healthy ecosystems, and mitigation strategies are increasingly being adopted around the world. However, not all impacts can be fully mitigated, and not all mitigation measures are equally effective. Wildlife crossing structures encompass a broad range of natural (e.g. tunnel roofs) or artificial (e.g. grey and green bridges, culverts, underpasses) structures designed to provide habitat connectivity and reducing animal-vehicle collisions (AVCs). The objective of our study was to contribute with knowledge that can be used to develop best practice guides for designing and placement of wildlife crossing structures under Scandinavian conditions. More specifically we first aimed to analyze if increasing intensity of human use of crossing structures affected the use by our target species, moose (Alces alces) and roe deer (Capreolus capreolus). Secondly, our aim was to identify which crossing structures that were important during moose migration and small-scale daily movements. Our analysis was based on 20 crossing structures monitored by motion triggered wildlife cameras located on fenced roads and railways in a study area surrounding Oslo Airport Gardermoen, in Norway. During the monitoring period March 2012 – June 2013 (15 months) we got pictures of 2354 moose, 4628 roe deer and 33508 humans (walking, skiing or bicycling). We examined the temporal (daily and monthly) patterns between moose and roe deer crossing frequency, and related this to the intensity of human use. We used data from GPS-marked moose (n = 55) to support our discussion regarding the frequency and direction moose used different passages during migration periods. We discuss how our results can inform management about best practice guides for planning and building of crossing structures to counteract the barrier effect of wildlife fences.

# Talk- 2.1

## Wildlife crossing structures - Part 2/3

# Wildlife surveys following the construction of modified culverts – Developing and providing a vibration-trap

**Author(s):** Fagart Sylvain, Heurtebise Cédric

**Contact:** Fagart Sylvain, Ligue pour la Protection des Oiseaux

**E-mail:** sylvain.fagart@lpo.fr

In Charente-Maritime (France), since 2012, nine modified culverts have been set up under two of the Autoroutes du Sud de la France motorway network to restore ecological continuity. To assess whether animals use these crossing structures, wildlife surveys have been conducted by the Ligue pour la Protection des Oiseaux since the construction of the modified culverts using infrared camera traps. First results have shown that infrared camera traps might often fail to catch semi-aquatic mustelids, such as European otter, whose isolated fur have a low surface temperature, sometimes undetectable with infrared technology. However during these monitorings, crossing clues were found several times without video recorded. Some monitorings have also demonstrated an increase in detectability of otter in winter when the temperature of the ambient air decreases. In the nine modified culverts surveyed in March 2012 to late 2015, 8 structures are located along the river course, and 34 Otter crossings have been recorded with infrared camera traps in 5 of these structures. Other detection problems have been observed: the moving speed of small mustelids (e.g. Weasel), the small size combined with a rapid movement for micro-mammal fauna, and reptiles and amphibians ectothermy.Further to these findings, and inspired by the work of Lerone who used pressure sensors to detect the Otter, we developed a vibration-trap in collaboration with the company JAMA. It consists of a semi-rigid canvas aluminum of about 1 m², to which is attached a pressure sensor connected to a camera trap. Low mechanical pressure applied to the canvas (animal weight for example) allows the instantaneous triggering of the camera trap. In order to assess efficiency of this device, it has been tested in modified culvert 1.2 meters in diameter, in parallel with an infrared camera trap already installed for 30 months. The simultaneously monitoring took place over 12 months, divided into several phases of testing and optimization of the device. The results of the two devices were compared (results are given without reference to real crossing). The first results show a greater efficiency of the vibration-trap compared to infrared trap, both in species diversity (16 species detected against 8), and number of detections (+ 35%). The vibration-trap detected 94% of all recorded crossings against 59% for the infrared trap. Otters, European polecats, reptiles, amphibians and micro-mammal fauna are among the species detected only by the vibration-trap, thus explaining the bias found with infrared detection. For other species, a significant gain in the number of detection is observed, in particular for the Stone/Pine marten (+ 35%) and Genet (+ 45%). This vibration-trap is already operational and more effective than an infrared system. In the short term, some additional improvements will optimize this new device (long-term use of the aluminum canvas, optimizing the sensitivity, and so on) thus opening up interesting perspectives for improving fauna monitorings of the underpass structures.

# Talk- 2.1

## Wildlife crossing structures - Part 2/3

# Wildlife collision data as an indicator of the effectiveness of mammal mitigation measures across the National Road Network in Ireland

**Author(s):** Sarah-Jane Phelan, Vincent O’Malley, Brendan Kennedy, Eugene Finnerty

**Contact**: Sarah-Jane Phelan, Transport Infrastructure Ireland

**E-mail:** Sarah-Jane.Phelan@tii.ie

Over the past two decades, the national road network in Ireland has increased substantially. Transport Infrastructure Ireland (TII) recognises that together with improved road systems, increased traffic volumes and higher traffic speeds, it is likely that the number of collisions with wildlife across Ireland will increase into the future. Collisions between road traffic and wildlife pose a threat to animal welfare and can also have major safety and cost implications. When constructing national road schemes in Ireland, it is standard best practice to integrate mammal mitigation measures into the early planning stages to ensure impacts on wildlife are limited and that safety is enhanced by reducing collisions between wildlife and vehicles. Over the past 15 years, mammal underpasses and mammal resistant fencing have been built into major roads in Ireland. The suitability/ effectiveness of such mitigation measures has been the subject of a major study over the last five years by recording mammal activity in the underpassess and undertaking species-specific road kill analysis across the major road network. TII are developing standardized protocols for the collection of road kill data on the Irish national road network. Species-specific data collection is supported by the use of roadkill collection apps which are uploaded onto Geographic Information Systems (GIS). TII is in a unique position in that it has operatives out patrolling the major interurban routes on a daily basis. The practice of daily surveying increases the likelihoodof the accurate capture of road mortality data as it minimises the time in which scavengers may remove a carcass as well as reducing the likelihood of a loss of evidence of a wildlife-vehicle collision due to adverse weather conditions or the number of vehicles passing over a carcass. Daily road monitoring and a reduced interval time between surveys also allows for increased sampling frequency which minimizes bias in road mortality estimates thus allowing for a more robust statistical analysis of the data.Species-specific data will be presented here on traffic kills and sightings across the network. This information is vital for producing a standardized protocol for risk assessments and for isolating road kill hotspots across the network. In particular, the road kill hotspots identify sections of the network which allows for a detailed assessment of the suitability and effectiveness of the prescribed mammal mitigation measures. Detailed assessments of such mitigation measures often reveal a range of issues that compromises their functionality, resulting in wildlife collisions on the network. Examples of such issues will be outlined in this presentation.

# Talk- 2.2

## Guidelines and experiences

## New guideline on highway verge design and management

**Author(s):** Marguerite Trocmé
**Contact:** Marguerite Trocmé, Federal Roads Office (FEDRO)
**E-mail:** marguerite.trocme@astra.admin.ch

A new Swiss guideline on highway verge design and management has been published beginning 2016. Its main goal is to better adapt landscaping to maintenance prerogatives, while integrating biodiversity issues. Six main objectives were set for verges: enhance integration of the infrastructure in the landscape, enhance buffer zone function, reeinforce positive corridor effects and linkages, maintain and enhance biodiversity in defined areas, avoid and contain invasive plants and finaly adapt design so as to ensure cost effective maintenance. Maintenance should clearly distingusih between intensive cut areas adjacent the traffic zone (2m wide) and extensive areas. The wildlife fencing should be placed, when possible, between thses two areas. The overall management objective is to set aside 20 % of verges as biodiversity areas. The presentation will focus on how these goals should be met and the many practical obstacles to an ecological verge management that need to be overcome.

# Talk- 2.2

## Guidelines and experiences

# Spatial structure of populations of deer around Paris since 1950: consequences of the development of transport infrastructures

**Author(s):** Vincent Vignon

**Contact:** Vincent Vignon, O.G.E. - Office de Génie Ecologique 5 boulevard de Créteil 94100 Saint-Maur-des-Fossés

**E-mail:** v.vignon@oge.fr

**URL:** http://www.oge.fr/

Populations of deer (Cervus elaphus) have always existed around Paris, in the many forests near the capital. The development of urban areas and the realization of large linear transport infrastructures have completely changed the spatial organization of the deer populations. To assess the impact of this fragmentation of the landscape on the spatial structure of the deer populations, and also the permeability of the transport infrastructures, two complementary approaches were used. The first, through field observations, was to conduct a study of the use of the habitats by the deer over more than 50 years, covering c. 60 000 ha. The second approach being a landscape genetic study, between 2013 - 2015 on a sample of 345 individuals. The study of habitat use shows that new population nuclei appeared in previously unused areas. In parallel, the deer have left the state forests, open to the public, to concentrate in private forests, apparently because of disturbance in their previous forest refuges. In the Paris region, large numbers of people with more free time and more cars have occupied the peri-urban forests since the 1980s. Genetic analyses show that the fragmentation of the landscape was accompanied by differentiation of the deer populations. Further, the results show the beneficial role of wildlife passages over the infrastructures, and reveal the remarkable reactivity of deer in an environment that has completely changed in fifty years. The Paris region provides an exceptional field laboratory for studying the interactions between landscape fragmentation and red deer, and very likely for other species too.

## Talk- 2.2

### Guidelines and experiences

# A management model for maintenance of roadsides with high biodiversity values along public roads in Sweden

**Author(s):** Mats Lindqvist, John Rolander, Maria Pettersson

**Contact:** Mats Lindqvist,

**E-mail:** mats.lindqvist@trafikverket.se

The Swedish Transport Administration has since the mid-1990s run a project focusing on identifying and assessing road verges with particularly high habitat and species richness. During recent years the survey efforts have increased, which has resulted in a greater understanding of the ecological importance of infrastructure. For some areas the public road network has been more thoroughly surveyed regarding the presence and abundance of vascular plants and insects. About 2-5% of the public road network system in southern and central parts of Sweden is considered to present higher levels of species richness and habitat value. The Administration is responsible for the management of all state-owned roads in Sweden. This road system consists of a wide range of road types in terms of size, construction type and traffic volume; from narrow gravel roads with very little traffic to multilane highways. The administration itself has no operational capacity, which means that all road work is procured on the market from contractors. Road verges that have been found to display higher levels of species richness and habitat value are designated as “species rich roadsides”. The maintenance of these stretches is regulated in a system of around 110 maintenance contracts across the country, with each contract being for a term of 4-6 years. These contracts are in turn governed by a steering document (Standard Description of Road Management) specifying which types of works are included in the contracts. The steering document allows road verges designated as “species rich roadsides” to be mowed later in the year relative to ordinary roadsides. At present, four different types of maintenance regimes are in operation for species rich roadsides: 1) late mowing, 2) extra late mowing, 3) late mowing with removal of plant debris and 4) site specific management plans. The general aim of the existing model is to allow plants to complete their flowering season and to provide floral resources for different kinds of pollinating insects. In the surrounding agricultural landscape, certain habitats and species are in continual decline, which makes it even more imperative to conserve the infrastructural habitats. Some of the sites subject to specific management plans provide habitats for endangered species, requiring even more elaborate management efforts. Even though the system does not work perfectly due to a lack of suitable equipment, failure to communicate and provide correct information to the subcontractors, and the impacts of different types of other road management activities – it has given us an opportunity to initiate a process towards more adapted, ecological maintenance of roadsides. The aim going forward is to regularly evaluate the species rich roadsides with respect to their ecological status. This will give a basis for deciding whether the current level of management is sufficient for attaining a favourable conservation status for the designated habitats and species. Maintenance of species rich roadsides is indisputably a field in which harsh infrastructure realities clash with ecological theory and practice.

## Talk- 2.2

### Guidelines and experiences

# Increased understanding of the extent of road kills in central Italy and development of a new prevention technology – results from a 4-year LIFE project

**Author(s):** Annette Mertens, Simone Ricci, Umberto Sergiacomi, Roberta Mazzei

**Contact:** Annette Mertens, Regione Umbria

**E-mail:** mertens.annette@gmail.com

**URL**: http://www.lifestrade.it

In Italy road mortality is a severe problem (Dinetti 2010), which concerns round 1.5 million animals each year (based on Guccione et al. 2008). Especially the collisions that involve large animals represent an economic problem for the authorities in charge of damage compensation, and are also a reason of concern for the safety of drivers, in fact in Italy from 1995 to 2005 over 150 persons have been killed due to an accident caused by wildlife. In this country first single initiatives have started targeting this issue but the problem is still increasing. This is also due to the fact that no coherent regulations exist to support the appropriate management of the road mortality issue. The LIFE STRADE Project "Demonstration of a system for the management and prevention of traffic collisions with wildlife" (2013-2017) (http://www.lifestrade.it) has now entered its last year and during its implementation several different aspects regarding the management of road mortality have been addressed: A first large-scale and standardized monitoring of the road mortality has been made on 250 km, in three Regions in Central Italy. This data, together with the analysis of the official statistics on road mortality, are crucial towards the understanding of the extent of the problem in central Italy. This information has been used to develop risk maps for the roads of the project area (40.000 km2). This will be a fundamental tool for the authorities in future management and prevention decisions. An opinion and knowledge assessment on 1.000 interviewees has revealed that 1. the general public is poorly aware about the road mortality issue and its implications, 2. most people believe that the most effective way to reduce this problem is to improve the road sign system, whereas only few people are aware of the importance of an adequate driving behavior. This result calls for adequate communication activities in this field. An innovative technology for the prevention of road mortality on hot spot road tracks was developed. This system registers the presence of animals near the road, alerts the drivers, and if the car does not reduce speed to an acceptable level it deters the animal with an acoustic scaring device. The advantage of this system is on the one hand that it does not represent a barrier for wildlife, and on the other hand that both drivers and animals are alerted only in specific critical conditions. Therefore the risk of habituation of drivers to the alert signal, and of the animal to the scaring sounds is minimized. The results of this experimentation are very encouraging. The problems in the legal background were identified, and a first official agreement about common necessary monitoring and management provisions has was signed between the involved authorities. All these activities were accompanied by a large-scale public awareness programme. The project has set some very important first knowledge and management steps, and has provided many extremely important lessons. These are now being disseminated to authorities in the rest of the country. References:

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## Talk- 2.2

### Guidelines and experiences

# Tools for a risk-adapted management concept to prevent animal-vehicle collisions along transport routes

**Author(s):** Jens-Ulrich Polster, Sven Herzog

**Contact:** Jens-Ulrich Polster, Technische Universität Dresden

**E-mail:** jens-ulrich.polster@tu-dresden.de

The loss and fragmentation of suitable habitats due to transport infrastructure is one of the key challenges for large wildlife species management. Usual measures for the prevention of animal-vehicle collisions, like fences, often act as an additional barrier and are only appropriate in the case of long intersection-free motorways or railroads. Over- or underpasses are valid measures to reduce fragmentation effects, but these type of buildings is mostly very expensive to build and to maintain over years. In addition, the combination of fences and conventional wildlife-crossings is nearly unable to adapt to a changing habitat use of the target species. The goal of our research is the development of a risk-adapted management concept which makes use of an iterative assessment of the whole transport route to find the best location for secured crossing-structures. This includes the use of different monitoring measures like wildlife track monitoring, camera traps or a survey of local experts. The second part of our research is the development of a new type of secured wildlife crossing, which addresses most of the disadvantages of traditional buildings. It should be usable on medium-class railroads in a landscape where it's not appropriate to build large crossing-structures. For this purpose we developed a system of relatively short fences to guide the animals to narrow gaps which allow a nearly unrestricted crossing. To avoid a funnel-effect and more collisions at these gaps or at the end sections of the fences, we will use acoustic deterrent devices to chase away near standing animals in the case of an approaching train. These devices will act like an automatic boom barrier at level crossings for wildlife. This type of wildlife-crossing is highly adaptable to changes in the environment or habitat use, when noticed in the risk assessment. The main challenge with this approach is the arrangement of sound effects in order to avoid a fast habituation of the target species. An additional requirement in our sample area is the effectiveness of the applied techniques on large herbivores like red and roe deer as well as carnivores like the wolf. Therefore, the creation and application of suitable acoustic repellents is subject of actual investigations in two different wildlife enclosures. Tests in a sample area along a renewed railway section will follow. By the described risk-adapted management concept we expect a significant reduction of animal-vehicle collisions along railway routes or even secondary roads, being not in the condition to be secured by long fences and additional over- or underpasses.

## Talk- 2.3

### Bats and infrastructure crossing

# Artificial night-time lighting reduces the use of wildlife crossing structures by insectivorous bats in southeast Australia

**Author(s):** Manisha Bhardwaj, Kylie Soanes, Jose Lahoz-Monfort, Lindy Lumsden, Rodney van der Ree

**Contact:** Manisha Bhardwaj, Australian Research Centre for Urban Ecology (Royal Botanic Garden Victoria) and the University of Melbourne.

**E-mail:** mbhardwaj@student.unimelb.edu.au

OBJECTIVES Barrier-to-movement impacts of roads on wildlife may be amplified by the presence of artificial night-time lighting, such as street lights. This may be particularly true for nocturnal wildlife such as insectivorous bats that often avoid large gaps in the canopy and areas of high light and noise, such as major highways. Wildlife crossing underpasses (i.e. culverts and bridges) are often used to reduce road impacts. Previously, we studied the use of these structures in southeast Australia by bats and determined that bats are more likely to use bridges than culverts. In this study, we introduced light to these structures to evaluate if the presence of light alters the activity within and above the structures. METHODS We monitored the level of activity of bats (i.e. number of calls, recorded using Anabat bat detectors) under and above two types of crossing structures: wildlife underpass bridges, and wildlife culverts along a major freeway in southeast Australia. We placed four detectors under the structure (two in the middle and one at each entrance, facing towards the middle of the structure), and four detectors on the road above the structure (two in the middle and one on each edge, facing towards the centre of the road). Nightly bat activity was monitored at two bridges and two culverts simultaneously, with one structure of each pair designated control and the other impact. At the impact sites, we lit the structure using LED light strips on 1m x 1.2m sheets of zinc powered by 12V batteries, and monitored activity for 16 days which were divided into three experimental phases: before (lights off for 4 nights), during (light on for 8 nights) and after (lights off for 4 nights). Each structure was lit to an average of 10 lux (the standard light level for residential street lighting). Control sites were monitored for the same 16 nights but without any lighting. We used Poisson regression models, to estimate the change in activity between the phases of light presence and also compared the activity between structure types. RESULTS Bat activity was significantly lower when lights were introduced in crossing structures. Furthermore, lit structures resulted in higher than usual activity above the structure at the road. This suggests that bats actively avoided the lit passageway. CONCLUSIONS Light can have a significant impact on the behaviour and movement of insectivorous bats. Our study showed that some bats will actively avoid lit areas, even if that means potentially accessing "unsafe" habitat such as a roadway. These results suggest that bats will avoid roadways lit by streetlights, further amplifying barrier-to-movement impacts presented by roads. CONTRIBUTIONS TO PRACTICE Where possible, lighting should be avoided around critical bat habitat and crossing structures. Road lighting significantly alters the behaviour of bats and may extend into the habitat surrounding the road. This will ultimately reduce the habitat quality and amount of suitable habitat available for bats to use while foraging, commuting, or reproducing.

# Talk- 2.3

## Bats and infrastructure crossing

# Temporary guidance structure for bats during construction works

**Author(s):** Pouchelle Hippolyte

**Contact:** Pouchelle Hippolyte, Egis Structures et Environnement

**E-mail:** hippolyte.pouchelle@egis.fr

Maintaining ecological connectivity during the construction phase of projects is increasingly requested by administrative bodies in areas where ecological connectivity is considered important. Guidance features already exist for bats (cables, nets…), especially in Great Britain where they are known as “Bat-bridges” but their effectiveness has been contested and is highly dependent upon the local topography and vegetation cover.Within the context of an environmental constrained road bypass project (in the Oise department North of Paris), Egis Structures et Environnement installed a lightweight and low-cost temporary guidance device for bats during the construction phase. It was made up of ropes and “acoustic reflectors”. The reflectors had multiple facets like those of a golf ball. Made out of a light material, the reflectors were placed in staggered rows with a 1.5m interval along two ropes. The multiple reflective surfaces would result in the increase in number of bat echolocation calls being returned. Located along an old flight corridor for bats, interrupted by road construction works, the device was confirmed an efficient success. To test the effectiveness of the device, we surveyed bats at nightfall using two technologies: 3D bat trajectory monitoring system (Bat3Data®)* and a thermal camera. The results showed after forest clearing and setting up the temporary guidance device that the connectivity of the flight paths was partially reestablished. The return flight path at the forest edge by the Common Pipistrelle (observed before installation of the device) was not observed after device installation. Specific bat behavior was shown both by the trajectory monitoring (Bat3Data®) and by the thermal camera:-Pipistrelles bat crossing just above the guidance device;- Greater mouse-eared bat and Long-eared bat flying just under the device;- Common noctule bat flying very high over the device.The installation of the lightweight device (ropes and acoustic reflectors) has therefore allowed the quick reestablishment of the transit flight line functionality for bats.Egis Environnement is continuing with its R&D work to optimize further the acoustic performance of the device. Egis has already received 1st prize at the IDRRIM 2015 awards (a French-based best-practice championship for infrastructure and biodiversity) in the category of “ingenious solutions”. *presented by poster at the IENE in 2015

# Talk- 2.3

## Bats and infrastructure crossing

# Roads and railroads as barriers for bats in Sweden

**Author(s):** Johnny de Jong

**Contact:** Johnny de Jong, Swedish Biodiversity Centre

**E-mail:** johnny.de.jong@slu.se

Bats are affected in different ways by roads and railways. In a forest dominated landscape roads and railways create openings in the landscape, and for species of bats linked to forest habitats these might act as barriers. Roads and railways also influence bats through noise and light. In some cases wildlife crossing (both above and under the road) are used to compensate for the barrier effect, but the function and the design of these are still under evaluation and development. This project is the first time the impact of roads on bats are tested in a north European hemi-boreal landscape. Landscape and species composition, abundance of bats and the light condition differ from previous studies. Bats (all species occurring in the area) were surveyed along a high-way (road number E18 between Västerås and Stockholm, Sweden). In addition, a study was made about the flight behaviour of Brandt's bat (Myotis brandtii) and whiskered bat (Myotis mystacinus) by using radio-tracking, in the vicinity of the highway and the railway. The results from the radio-tracking showed that Brandt's bats and whiskered bats were foraging on both sides of the road, and they frequently used the wildlife crossing, both under and above the road, but in general they did not pass the road. Thus, the road worked as a barrier and wildlife crossings are used for foraging and commuting. However, there are exceptions when bats pass the road, and also forage along the tree-line in the mid part of the highway, as shown in the highway survey. By analysing these cases, it is possible to learn more about where and how wildlife passages should be constructed, and to identify problems early in the planning process.

## Talk- 2.3

### Bats and infrastructure crossing

# Improving the effectiveness of mitigation and monitoring for bats on roads and railways

**Author(s):** Anna Berthinussen, John Altringham

**Contact:** Anna Berthinussen, University of Leeds, UK

**E-mail:** A.berthinussen@leeds.ac.uk

**URL:** http://tinyurl.com/batsandroads

The aims of this UK government-funded project were to develop standardised cost-effective survey methods to assess the effects of linear transport infrastructure on bats and the effectiveness of crossing structures as mitigation. The methods developed (which include broadband acoustic surveys along transects and static observational surveys) are suitable for robust, objective statistical analysis when appropriate, and can be used for pre, during and post-construction monitoring. They can also be used to gather baseline data for Environmental Statements. To assist practitioners detailed protocols for fieldwork and subsequent data analysis and presentation have been published. The effectiveness of many currently used mitigation measures for bats (including underpasses, overpasses, wire bat bridges and a green landscape bridge) was assessed during the development and testing of the methods and many were shown to be failing. We will outline the rationale behind our methods and describe the main findings.

# Talk- 2.3

## Bats and infrastructure crossing

# Vegetated fauna overpass significantly facilitates crossing capacity of forest microbats

**Author(s):** Darryl Noel Jones

**Contact:** Darryl Jones, Griffith university

**E-mail:** D.jones@griffith.edu.au

The road barrier effect on flying vertebrates has been consistently underestimated, presumably because of the assumption that flight confers the capacity to overcome this challenge. Recent studies, however, have demonstrated that many forest dwelling birds and microbats may be reluctant to traverse the space above the road. One effective solution to this impediment is the installation of vegetated fauna overpasses which provide contiguous habitat connections across even large roads. These structures have been shown to be extremely effective for smaller forest birds, including species known to be extremely reluctant to cross even small spaces. Little is known about the use of vegetated overpasses by microbats. We assessed the patterns of activity and species richness of microbat assemblages in relation to the Compton Road fauna overpass near Brisbane in Australia throughout 2015. Bat vocalisations were recorded weekly using Echo Meter recorders along eight 100m transects positioned perpendicular to the road from the roadside into the surrounding forest and along the overpass. A total of nine species and two species groups (species that could not be differentiated) were identified during the study, all of which were recorded on the overpass. Bat activity and richness on the overpass was significantly higher than the adjoining forest, although call activity was not significantly correlated with roadside proximity. Activity patterns based on feeding behaviours suggest that the road effect zone extends far into the forest, impacting forest specialist species especially. The vegetation on the overpass, which was planted to resemble the structure and composition of the surrounding forest, is likely to be the key factor encouraging microbat activity on the overpass. The Compton Road overpass appears to successfully disguise road presence and facilitate microbat movements across a major road. This study is the first to demonstrate that vegetated fauna overpasses can facilitate activity and provide natural habitat continuity for a diverse microbat community.

## Talk- 2.4

### Green infrastructure networks

# Find a second life for old regional railway tracks in France allying transport perspective for the future and protection of the environment

**Author(s):** Xavier Orthlieb

**Contact:** Xavier Orthlieb, Transport Technologie-Consult Karlsruhe GmbH (Transport consultancy)

**E-mail:** xavier.orthlieb@ttk.de

**URL:** http://www.ttk.de/en/

The concentration of jobs and services in urban centres associated with the search of a better quality of life and of housing outside cities generates a lot of transport needs that are not satisfied with an adequate public transport offer outside of the major French metropolitan areas. Car modal split is too high considering that regional railway lines represent nowadays more than the half of the existing French rail network. The huge majority of these tracks goes through rural and suburban areas reaching then vicinity or local towns centres but is unfortunately underused: traffic is very low, if not inexistent, even when there is a local demand. In France, decades of non-investment in maintenance and renewal of the infrastructures have degraded the performances, threatening the existence of those lines, and consequently increasing the use of private car due to the lack of efficient public transport facilities. Impacts on the environment are well known too: traffic jams when approaching cities during peak hours and more CO2 emissions. The concentration of the track property and the right of exploitation in the hands of the SNCF doesn't let enough space for local or private initiative to develop efficient solutions in a small scale and to replace the financial disengagement of the state in local rail infrastructure. Closing lines are in the best case replaced by busses and when a track is dismantled, train services never come again. A regeneration of the track might seem to be too expensive and complex today, but it is interesting to think in a mid-term perspective, considering the implementation of efficient energy-cell powered rolling stock for the years 2030-2050 and a possible regional rail market opening after 2026, which could make these old tracks more competitive and attractive than now. The main priority in absence of traffic is to master the development of the vegetation to assure an optimal drainage and protect the infrastructure, especially bridges and canalizations. This action has a positive impact on the environment too by preventing the emergence of invading vegetal species and reducing the risk of fire in summer. Implementing innovative alternative use of the tracks, for example with touristic purposes like rail-cycle or horse-drawn streetcars, or innovative maintenance methods like weeding by goats and cows, will allow restoring easily and with lower costs the public transportation function of a line in the future. Such positive economic conditions that allowed the emergence of this network in the nineteenth century will probably never reproduce again and the new edification of a similar network couldn't be financed nowadays. Moreover, those infrastructures are even well integrated in the landscape and less aggressive than new roads in terms of rainwater management for example. Enough reasons to preserve this network of lines as a patrimony for next generations, even if is impossible to develop again a public transport offer by train in short time.

## Talk- 2.4

### Green infrastructure networks

# Do we have a proper idea of how much investment for defragmentation is needed? Experiences about financial, spatial and temporal demands for effective connection of ecoducts by designing ecological corridors

**Author(s):** Björn Schulz, Heinrich Reck, Marita Böttcher

**Contact:** Björn Schulz, Schleswig-Holstein State Foundation for Nature Conservation

**E-mail:** schulz@sn-sh.de

The set-up of a green infrastructure – a functioning network of healthy ecosystems – is one of Europe's main strategies to overcome the loss of biodiversity. To achieve this target in densely populated and intensively used European landscapes considerable investment into nature restoration and defragmentation are needed. Especially crossways, where both, green and grey infrastructure meet and where suitable ecoducts must be connected to a surrounding high quality habitat network, play a most crucial role. At such places the installation of integrative and therefore mostly large wildlife under- and overpasses is meanwhile implemented in road planning all over Europe. Design settings for such buildings are developed and costs are known and well calculable. In most cases however an additional set-up of biological connectivity of the ecoducts to the wider landscape or to the "network of healthy ecosystems" respectively is mandatory too. Other than building standards, standards for "hinterland connections" are missing and measures much more difficult to calculate and execute. Substantial experience about practical landscaping, needed supervision and cost management is rare. In Schleswig-Holstein (Northern Germany) a project group is working on the practical implementation of hinterland connections of by now three different but on regional scale cross-linked ecoducts since 2008. Based on that we present the factors that play the most important role for the long-term preparation and safeguarding of a functioning reconnection of habitats in combination with ecoducts: Transfer of land property (how much land and money is needed?) We present different constellations of landscape ownerships and their consequence and discuss, if a high proportion of public land simplifies ecological hinterland connection. We present, how much money we spent for land purchase and the great variety of (European) funds that could be usedNature restoration (what must be done in an intensively used cultural landscape?) Costs depend on the quality, shape and location of existing habitats and target habitats. In wilderness areas, where only minor degradation of ecosystems took place, restoration costs should be low, but in the average Central European landscape, only few and mostly small areas with "healthy ecosystems" are left, so nature restoration for functioning ecological networks is highly demanding and costs tend to be unpredictable. We present, what was needed in our example, how much it was and where the funds were raised.Safeguarding of long-term responsibility Responsibility for the function of ecoducts is regularly with the transport administration, while there is no clear decision about the responsibility for the function of the ecological hinterland connection. There is a need for a precise regulation about long-term responsibility, guidance and funding as well as for adequate development and management plans. Mediation and management The most crucial factor in implementing ecological corridors as hinterland connection however is the availability of a contact person and motivator and the coordination of possible funds and nature protection concerns as well.

## Talk- 2.4

### Green infrastructure networks

# How to save large carnivore populations in Western Carpathians?

**Author(s):** Vaclav Hlavac, Petr Anděl

**Contact:** Vaclav Hlavac, Nature Conservatin Agency of the Czech Republic

**E-mail:** hlavac.vaclav@seznam.cz

Western Carpathians - the Mountains on the border of the Czech Republic, Poland and Slovakia represent an area with a unique natural value. Large forest units and near-natural farming based on sheep herding create conditions for a number of rare species that have already disappeared from other areas. On Czech side of the area, the Beskydy Mountains are protected as a Natura 2000 site, where species of wolf, lynx and bear are the main subjects of protection. However, detailed monitoring carried out in recent years has shown that populations of all three species of large carnivores are declining, and their extinction can be expected in coming years. To clarify this problem, a map of barriers formed by major transport infrastructure and by continuously built-up areas was created. The analysis made in cooperation of experts from all three countries showed that the area of the Beskydy Mountains is almost isolated from populations in the Central Carpathians. The last passages in the northern part of the region are threatened by construction of highways and rapidly advancing further development. The map showed similar problem in other areas of the Western Carpathians as well – this originally continuous area is divided into isolated islands, where the populations are too small for a long-term survival. The Silesian Beskydy Mountains in Poland can be mentioned as an example of such an isolated area. Fragmentation is progressing very quickly, nearly isolated populations can already be found also in the Kysuce Mountains or Mala Fatra National Park in Slovakia. The barriers are made up not only by highways, but very often also by smaller roads in mountain valleys, which are followed by further development. The map identifies key migration corridors and 67 critical points - places where permeability of the corridor for large carnivores is threatened by an expanding barrier. A new project aimed at a spatial definition of biotopes of specially protected species of large mammals such as lynx, wolf, bear and moose was finished in the Czech Republic this year. These biotopes include both places of permanent occurrence of these species and their migration corridors. Although the corridors are not permanently occupied, these species are not able to survive without the corridors in a long term. Identification of corridors was based on actual data regarding the occurrence of target species. Where occurrence data were insufficient, habitat suitability models were used to identify migration corridors. A comprehensive layer of biotopes of target species was produced as the main product of the project. Since the biotopes of protected species are legally protected from destruction, the new layer will be obligatorily implemented in spatial plans of all levels. Thus, the biotope of target species will be protected from both newly built transportation infrastructure and from new development. In this manner, the new layer of biotopes of specially protected species should provide basic ecological connectivity of the entire territory of the Czech Republic, including the Western Carpathians.

## Talk- 2.4

### Green infrastructure networks

# Designing a network of wildlife corridors across heterogeneous mountain landscape – the Carpathian case study

**Author(s):** Dusan Romportl, Vladimír Zýka, Miroslav Kutal

**Contact:** Dusan Romportl, researcher

**E-mail:** dusan.romportl@vukoz.cz

The Carpathian Mountains forming an arc roughly 1.500 km across seven states provide the habitat for some of the largest European populations of brown bears, grey wolves and Eurasian lynx, with the highest concentration in Romania. However, Ukrainian, Romanian and even Slovakian parts of Carpathians suffer from the lack of the functional nature protection and the effective landscape management. Several protected areas including the large number of NATURA 2000 sites have been declared, but their spatial design recalls rather patchwork instead of coherent network. Populations of large carnivores with enormous spatial requirements and extensive dispersal and migratory needs are widely endangered by rapid development of roads and motorways creating long impermeable barriers across the Carpathians. As new traffic projects are planned on supra-national level, the same scale is needed for designing an extensive system of wildlife corridors. Habitat suitability models for brown bear, grey wolf and Eurasian lynx were used to delineate core habitat areas and stepping stones important for dispersal. The Circuit Theory was applied for assessment of landscape connectivity and finally a coherent network of wildlife corridors was designed. Proposal of such green infrastructure was presented to regional authorities and stakeholders, to provide them with relevant information for negotiations with road and motorways planners.

## Talk- 2.4

### Green infrastructure networks

# Innovative methods and organizational approaches to improving biodiversity offsets in France: the example of the new Nimes – Montpellier railway line.

**Author(s):** Fabien Quetier, Grégoire Goettelmann, Thomas Menut, Xavier Rufray, Rénald Boulnois

**Contact:** Fabien Quetier, Biotope 22 Bld Foch 34140 Mèze France

**E-mail:** fquetier@biotope.fr

**URL:** http://www.biotope.fr/

When development projects generate impacts on biodiversity that could not be sufficiently avoided or reduced, offsets must be designed and implemented to effectively and fully compensate for residual losses of biodiversity. International best practice indicates that biodiversity offsets must achieve no net loss of biodiversity, or preferably a net gain. In France, recent guidance on the mitigation hierarchy is also pushing for such an ambitious goal. How to design and implement such offsets remains a considerable technical and organizational challenge. Losses and gains must be assessed and compared to demonstrate that no net loss can be achieved, in-kind, and on the basis of targeted loss-gain metrics for for impacted species, habitats, etc. Offset feasibility must be assessed, to ensure they can be put in place, especially with regards to access to land and long-term management.To address this challenge, a dedicated methodology was developed and applied to a new, 80 km, high-speed railway line in Southern France, between the cities of Nîmes and Montpellier. Losses and gains were measured in “offset units”, calculated as quality-hectares per species, and then integrated into a common framework to determine the amounts of each multi-species habitat that had to be restored (and how) to achieve no net loss.The method was approved by permitting authorities and used to obtain required permits under French and EU law protecting certain species of plants and animals. It wasn’t limited to focusing on these species, however, and generated an offsetting strategy, covering 1800 ha, that integrated other biodiversity components, as well as the concerns of a wide range of stakeholders, and particularly the agricultural sector.The method was successfully applied thanks to early and continuous engagement with stakeholders, and was shown to enable a rigorous, transparent and participatory treatment of biodiversity impacts from development.

## Workshop- 2.5

# How to implement ecological restoration in civil engineering sector? The power of participation

**Author(s):** Adrián Mohmed Sanz

**Contact:** Adrián Mohmed Sanz, Creando Redes (Company). Co-Founder.

**E-mail:** a.mohmed@creandoredes.es

**URL:** http://www.creandoredes.es

Roadside restoration has been historically performed using standard techniques such as hydroseeding and plantings. These conventional techniques oriented to control erosion and boost ecosystem recovery often fail (at least under Mediterranean conditions), leading to unsatisfactory results with que consequent cost for construction companies that must afford the environmental liabilities. However, the field of ecological restoration provide new approaches that can be used in roadside restoration, that allow to integrate infrastructure more efficiently and add value to projects and companies. This practical science has reached a degree of maturity that could guide practitioners in order to significantly improve their activities. Moreover, some companies are aware of the importance to improve restoration actions associated with their activity in order to be more competitive and improve their return of investment, but the truth is that there are some barriers that imped the application of ecological restoration in civil engineering sector. On the one hand, governments and companies implicated in the development of restoration projects related with infrastructures usually have limited knowledge about innovative restoration techniques. On the other hand, all stakeholders that, in some way, are involved in restoration projects linked with civil engineering are disconnected, so the interchange of experiences and needs do not take place. In this sense, to generate multidisciplinary encounters that promote participation of all stakeholders in the identification of barriers and the co-creation of new solutions to implement innovative environmental approaches in civil engineering sector are essential to better integrate infrastructures with the ecosystems and the social environment, with a triple win for nature, society and businesses. In the present communication we introduce our experience with the development of discussion forums and participatory processes to implement environmental innovation in civil engineering sector and main conclusions derived from them.

# Workshop- 2.5

## How to implement ecological restoration in civil engineering sector? The power of participation

# A Tale of two Regions Towards a multi-level approach of decision-making processes concerning transport infrastructure in France

**Author(s):** Cécile Blatrix

**Contact:** Cécile Blatrix, AgroParisTech

**E-mail:** cecileblatrix@gmail.com

In France, the last three years have seen several conflicts among infrastructure projects, reaching high levels of contention. In october 2014, the death of an activist during a demonstration against a dam project, forced the government to launch a reform in order to improve the decison-making process. Yet, various means of public participation in the decision-making process have been set during the last 20 years. Public debates for example, have been settled in 1995 precisely to avoid further conflict. Why do these existing forms of public participation do not seem to prevent processes of escalation, as they were initially supposed to do? Our hypothese is that the French decision-making process does not allow to take seriously environmental concerns into account, and is not designed to do so. Our methodology is based on the assumption that we cannot answer these questions without getting a bird's eye view of land-planning as a whole at a territorial scale. In other words, we need to understand the way projects and existing infrastructure interact and are (or not) part of a global land-planning policy. Two french regions will be compared : Région Rhône-Alpes, which is concerned by three important projects : Lyon-Turin high speed line, Rhin-Rhône High-Speed Line, and the Lyon urban area bypass (Contournement ferroviaire de l'agglomération lyonnaise, CFAL) ; Région Aquitaine with, among others, a High Speed railway project (Large South West Railway Project - Grand Projet Ferroviaire du Sud-Ouest, GPSO). Our data consists in several qualitatives tools (interviews, observation, and document analysis). As we will underline, this regional land-planning policy itself is channelled and framed by national and European orientations and constraints. The place occupied by environmental information in the elaboration of a land-planning policy, as well as the monitoring of the quality of environmental information in France, will be presented and discussed. The communication will show that, while the reform of the decision-making process is still being debated, several concerns are competing. On the one hand, there is a will to improve the way environment in a broad sense is taken into account in large project elaboration and implementation. The necessity to improve the quality of environmental information has been emphasized. But on the other hand, there are actors complaining concerning the burden and delays linked to environmental issues and public participation. This communication will be based on the result of an on-going research project called INEDIT (Integrating Environmental Issues in the Decision-Making Process concerning Transport Infrastructure). INEDIT is part of the ITTECOP Program (Land Transport Infrastructures, Ecosystems and Landscapes, an incentive program led by the French Ministry for Ecology, Sustainable Development and Energy).

# Talk- 2.6

## Infrastructure and biodiversity roadkill in Africa

# HIT AND RUN! Reducing Wildlife-Vehicle-Collisions in Protected Areas

**Author(s):** Wendy Jane Collinson, Lizanne Roxburgh, Harriet Davies-Mostert

**Contact:** Wendy Collinson, The Endangered Wildlife Trust

**E-mail:** wendyc@ewt.org.za

**URL:** https://www.ewt.org.za/

The Endangered Wildlife Trust (EWT) has strived to raise public awareness of the impacts of roads on biodiversity through media campaigns, extensive social media platforms and by engaging with relevant stakeholders. Initially our attention was focused on road impacts on wildlife outside of protected areas, since traffic volume is higher and collisions are often more visible and more threatening to human life. However, reports from various social media platforms have indicated huge public concern for wildlife-vehicle collisions (WVC) inside protected areas. Consequently, in 2014 we initiated an assessment of WVC rates within selected protected areas in South Africa, with an emphasis on using park visitors to provide citizen science data. However, expert data collection remains the most reliable source of information about impacts. For example, 97% of the 143 WVC events we recorded in Pilanesberg National Park in 2014 were obtained from systematic surveys by our project team. This illustrates the critical need to raise public awareness about wildlife on all of our roads.Of almost 700 questionnaire surveys conducted with visitors to protected areas, more than 95% of respondents to the questionnaire survey believed that speed was the main cause of WVCs. However, traffic monitoring devices deployed within the parks showed that 72% of park visitors (n=6,981) complied with park speed limits driving at or below the speed limit. We postulated that WVCs were likely to occur because drivers were either unaware of their surroundings or travelling too fast to avoid collisions. To investigate these factors, we placed two fake animals (a snake and an amphibian) on a 40 m section of road in two National Parks. We used traffic monitoring devices to record the speed at which the vehicles were being driven, and observational techniques to assess the position of the driver's head (looking straight ahead at the road or to the bush at the side) as well as the driver response to the fake animal (a 'hit' or a 'miss'). Of 201 vehicles, 67.7% of the drivers were not looking at the road, but rather scanning the bush for wildlife, and 49.6% of vehicles hit the fake animals. This suggests that WVCs in national parks happen primarily because of the expectation that animals are to be found in the habitat alongside the road, rather than on the road itself and that improving driver observation of the road, rather than the speed of the vehicle, is the key factor in preventing a WVC.

## Workshop- 2.6

### Infrastructure and biodiversity roadkill in Africa

# Low-level fences reduce roadkill at hotspots: a South African example

**Author(s):** Wendy Jane Collinson, Warwick Davies-Mostert, Harriet Davies-Mostert

**Contact:** Wendy Collinson, The Endangered Wildlife Trust

**E-mail:** wendyc@ewt.org.za

**URL:** https://www.ewt.org.za/

A wide variety of mitigation measures are deployed to reduce wildlife mortality on roads, but few of these have been tested in South Africa, where road ecology is still an emerging field. During baseline roadkill surveys conducted in 2009 in the Greater Mapungubwe Transfrontier Conservation Area (GMTFCA), a UNESCO World Heritage Site in Limpopo province South Africa, we identified the presence of a roadkill hotspot. Such hotspots are characterized by higher than average concentrations of roadkill and therefore provide an opportunity to initiate targeted mitigation measures with relatively high potential impact. In early 2015, we investigated the efficacy of roadside barriers in reducing mortality frequency of small terrestrial vertebrates in the hotspot. We erected low-level fencing by the roadside to direct wildlife towards existing culverts beneath the road, and compared mortality frequency before and after the intervention. We observed a sharp decrease in the concentration of roadkill events where the barriers were erected (from 0.23 roadkills/day/km to 0.04 roadkills/day/km), as compared to control sites, although this decline was not quite significant (Friedman's test, $\chi2 = 0.1$, $p = 0.09$), probably due to the small sample size. Our results suggest that low-level fencing can reduce the incidence of roadkill for small terrestrial vertebrates, although its potential negative effects, for example on population connectivity, still need to be investigated.

## Talk- 2.6

### Infrastructure and biodiversity roadkill in Africa

# Watch the road: Assessing roadkill in Addo Elephant National Park

**Author(s):** Wendy Jane Collinson, Gareth David Nuttall-Smith, Lizanne Roxburgh, Daniel M Parker

**Contact:** Wendy Collinson, The Endangered Wildlife Trust

**E-mail:** wendyc@ewt.org.za

**URL:** https://www.ewt.org.za/

Roads are an increasing threat to biodiversity, particularly in the case of developing countries such as South Africa of which 364 131 km of roads criss-cross the country (17% paved) fragmenting much of the viable habitat available to wildlife. Roadkill is the most visual impact that roads have on wildlife populations and whilst the majority of roadkill studies have occurred in 'western countries', understanding of the threat from roads on biodiversity has increased in the last five years in South Africa. Globally, understanding of roadkill events is for national and regional roads, with little known of the impacts of roads in protected areas – the prime custodians of biodiversity, intended for the conservation of flora and fauna and ecosystems. South Africa contains 23 national parks with 6.3% of the country committed to terrestrial protected areas. This study was conducted in Addo Elephant National Park (AENP). Our aim was to determine which factors of the road and roadside environment are correlated with roadkill. A priori, we created a model of roadkill risk based on characteristics of the road and roadside environment, where proximity to lodges, a paved road surface and low vegetation density were considered higher risk. We then assessed the ecological characteristics of the landscape as well as road characteristics at actual roadkill events, by driving transects in AENP on two randomly selected days/month over a six month period (May to October, 2015; winter). In AENP, we found more invertebrate (63) roadkill than vertebrate (23) roadkill throughout the study period. The distance between roadside vegetation and the road significantly influenced the presence of roadkill: the closer the vegetation to the edge of the road the higher the likelihood of roadkill events occurring. Related to this was grass thickness on the verge of the roads: where thicker grass occurred there were fewer roadkill events. Road type and the regulations implemented on the road are correlated with roadkill events. Roadkill in AENP was related to the vegetation characteristics, the road surface and status (park road or provincial road) in the park having the largest impacts on biodiversity. Modelling can be used to determine where roadkill could potentially be highest using predictors determined in this study.

# Talk- 2.6

## Infrastructure and biodiversity roadkill in Africa

## Road kills and parasites, South Africa

**Author(s):** Ali Halajian, Wilmien J Luus-Powell, Sareh Tavakol, Katlego David Kunutu, Makubu Mokgawa

**Contact:** Ali Halajian, Department of Biodiversity, University of Limpopo, Private Bag X1106, Sovenga 0727, South Africa

**E-mail:** ali_hal572002@yahoo.com

Both ecto- and endoparasites (external and internal respectively) are interesting organisms that entail a lot of information on the health of their host, or lack thereof. One way of collecting, describing and studying parasites is to investigate road kills. South Africa has a high diversity of animals and every year we lose lots of them because of road accidents with vehicles. While collecting animals killed on the road might seem a bit macabre, the amount of information that can be collected from these specimens is vast and interesting. Between July 2012 and May 2015, 375 road-killed animals were recorded on different roads of Limpopo province by the Biodiversity Research Chair team. Unfortunately, in most cases the bodies were too damaged to check for parasites or stomach contents. When the carcasses were not too damaged, they were brought to the Parasitology Laboratory at the University of Limpopo and checked for ecto- and endoparasites, as well as the stomach contents. In all cases the locality name, coordinates, host species, age and sex were recorded and a photo of the host was taken. We tried to identify the road kills as good as possible, although in many cases the amount of damage made it impossible. These were then recorded as undetermined. Among the animals we could identify and record were 27 bird species, 5 domestic animal species, 11 carnivore species, 1 Chameleon species, 3 primate species, 3 rodent species, 1 hedgehog species, 1 hyrax species, 2 tortoise species, 1 freshwater turtle, 3 snake species and 1 frog species. The road killed animals provided many interesting parasitology findings. For example, we recorded the first locality records in Limpopo of the acanthocephalan parasite, Moniliformis kalahariensis, in two road-killed Southern African Hedgehogs. This parasite was originally described in Botswana and never seen in South Africa before our study. The research team found road-killed Flap-necked Chameleon at the University of Limpopo (not many people were aware of their existence at Turfloop campus), surprisingly on a road with maximum speed limit of 30km/hr(!) also African Helmeted Turtle in a spot not recorded before. The finding of 45 long filarial nematodes under the skin of a road killed Striped Polecat found on the R71 was particularly interesting as these nematodes could be very pathogenic for the host. In general, road-killed animals are a significant source of information on parasites and their feeding habits. Analysis of the data can also identify the hot spots for road kills in different areas. The results of these kind of studies can also help the conservation of our unique wildlife in South Africa. Although comparison of results of study on road kills with animals dead from other causes or alive animals is tricky and most of the time impossible as most of the road kills we find are wild animals and sampling them for comparison with road kills data is most of the time impossible. But studying road kills in long term will solve this issue to some extent.

## Talk- 2.6

### Infrastructure and biodiversity roadkill in Africa

# Samango monkey road kill mitigation in the Soutpansberg, South Africa

**Author(s):** Birthe Linden, Quentin Hota-Lacueva, Ian G Gaiger

**Contact:** Birthe Linden, Department of Zollogy, University of VendaLajuma Research Centre

**E-mail:** bibi@lajuma.com

The samango monkey (Cercopithecus albogularis) is South Africa's only exclusively forest dwelling primate representing the southernmost extent of the range of arboreal guenons in Africa. In South Africa the species distribution is closely correlated with distribution of Afromontane, Coastal and Scarp forests. Forests are South Africa's smallest, most fragmented and most vulnerable biome and samango monkeys play an important role dispersing seeds of many forest plants. In the Red Data Book of the Mammals of South Africa, the samango is listed as Vulnerable and is considered rare. The samango population in the study area represents the northernmost population of the species in the country and is considered to be completely isolated from samango populations further south. A threat assessment has shown that one major threat to samangos in the area are provincial roads, specifically one stretch of ~30 km tar road. Forests in that particular area extend down the southern slopes of the mountain and are bisected by this road. Since June 2012 17 road killed samangos of all age and sex classes were collected and more than a dozen road crossings were observed. A solution to this problem could be the establishment of road crossing structures, more specifically canopy bridges that allow safe road crossing for samangos. 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 for samango monkeys we are conducting experiments on habituated samangos at the Lajuma Research Centre. Parameters tested are 1) solid pole bridge versus flexible rope bridge and 2) different levels of vegetation cover over the bridges. The effectiveness of the bridges is evaluated through direct behavioural observations. Preliminary results show that the samangos prefer using a solid pole canopy bridge design (99.6% of crossings) over a flexible rope bridge design. Results of behavioural data collected show that sub-adult individuals and adult females were most likely to use bridges when crossing the road, juvenile samangos preferred crossing the road in the tree canopy and adult male samango monkeys mostly crossed roads on the ground. Further, the results showed that bridges partially covered with vegetation were used more frequently than uncovered bridges and that the more vegetation cover over the bridges, the more likely the monkeys were to cross the roads using the forest canopy. Results from the experiments will be used to design the most suitable and cost-effective bridge prototype for erection at the actual road kill hot spots.

## Talk- 2.7

### Wildlife monitoring and field studies - Part 2/3

# Wildlife Crossings Identification for Road Development in Guyana

**Author(s):** Evi A.D. Paemelaere, Curtis Bernard, Esteban Payán, David Singh

**Contact:** Evi Paemelaere, Panthera

**E-mail:** epaemelaere@panthera.org

Expanding road networks pose one of the largest threats to the Guiana Shield biodiversity hotspot, where wildlife has mostly remained protected through inaccessibility. Responsibility for smart road building and management should lie with investors and developers; as scientists we can provide data-driven recommendations for wildlife-friendlier roads. We conducted a study on wildlife crossings in Guyana for government and the International Development Bank as part of a larger pre-investment study on the Linden-Lethem Road (LLR) in the framework of the Integration of Regional Infrastructure in South America. This 438km section is the only unpaved part of the road connecting metropolis Manaus (Brazil) to the Atlantic Ocean. LLR bisects Guyana and provides the main access to the country's hinterland, traversing logging, mining, agriculture, settlements, biodiversity conservation areas and tourism regions. For our short-term study in May-June 2014, we prioritized road sections based on vegetation and land-use, selecting the Rupununi - a unique habitat of seasonally flooded savannah - and Iwokrama – the adjacent protected forested site. Previous research here had demonstrated vast mammal richness and abundance. A road upgrade with augmented traffic flow could have large negative effects on wildlife. Generally, for the Neotropics, but especially for savannah, limited data on road impacts on wildlife are available. LLR offered a unique opportunity to gather data prior to pavement, and present recommendations to the developers. Based on surveys of scat, road kill, live sightings, and camera traps under bridges in the Rupununi, and existing life sighting and road kill data from 6 years in Iwokrama, we identified two major crossing locations in the savannahs, while for the protected forest animals crossed randomly. Under-passage use was negligible. Road kill rate - 0.0048 individual mammals killed per kilometre of savannah road surveyed (0.64 kills/24hrs) - was very low compared to other records from unpaved and paved roads in the Neotropics, but followed similar patterns in species vulnerability. While the most common mammal, the savannah fox (Cerdocyon thous), also had the highest kill rate, this direct relationship was not true for other species. Road kill species diversity was also very low, perhaps due to a short survey time in relation to road kill rates. Applying the lowest reported rates for similar environments, pavement of this section can be expected to result in a minimum 10-fold increase in road kill, depending on traffic volume, with the biggest concern for the threatened giant anteaters (Myrmecophaga tridactyla). We recommend protection of habitat along the road (wildlife friendly segments), speed limit reduction through signage and speed bumps in the identified locations, and continuation of the no-night-driving policy within Iwokrama. We also recommend implementation of hunting management to help mitigate indirect impacts from the road upgrade on fauna. Finally, very little is known about road impacts on Neotropical mammals, and we advocate for mitigation strategies of road development projects to include research on barrier effects and effectiveness of underpasses and rope bridges in maintaining genetic connectivity to assist with adaptive management of the LLR and inform future road projects in Central-and South America.

## Talk- 2.7

### Wildlife monitoring and field studies - Part 2/3

# MoRIS: Model of Routes of Invasive Spread. Human-mediated dispersal, road network and invasion parameters

**Author(s):** Jérôme Gippet

**Contact:** Jérôme Gippet, LEHNA UMR 5023 Université Claude Bernard Lyon 1 FRANCE

**E-mail:** jgippet@gmail.com

Human-mediated dispersal acts as a vector for many exotic species, both at the introduction and secondary spread stages. The introduction stage is a consequence of human-mediated long distance dispersal and is known to happen at continental or global scales. Secondary spread occurs at smaller spatial and time scales (e.g. landscape), and can result from natural or human-mediated dispersal . Despite the importance of local goods and materials (e.g. for landscaping, construction, or road-building) transport for the spread of invasive species, few studies have investigated short distance human-mediated dispersal. This lack of consideration seems to be the consequence of multiple factors:

- human-mediated dispersal is generally considered as a long distance dispersal process, more important for invasive species introduction than for secondary spread,
- it is difficult to qualify and quantify this mode of dispersal because of the multiplicity of potentially involved human activities,
- for organisms that can disperse naturally, it is complicated to distinguish between natural and human-mediated dispersal, as they may occur at similar scales.  Even though a range of methodologies are available for describing population spread by natural dispersal, only few models have been developed to describe and predict human-mediated dispersal consequences at small scales, and none of them take into account the topology of the transport infrastructure (roads, waterways). Therefore, in order to fill this gap and provide new insights into invasion dynamics, we combined ecological (invasive species occurrence data) and geographical (transportation network topology) data and used a computer modeling and simulation approach to provide estimate frequencies and distances of materials transportations through landscapes. In the present work, we studied the spreading pattern of Lasius neglectus, an invasive ant species originating from Turkey, which spread into Europe in the last decades. In this species, no mating or dispersal flights are performed, its spread is therefore solely ensured by the transport of soil materials in which individuals are present. We present a numerical model enabling the estimation of multiple human-mediated dispersal parameters, based on ground-truth sampling and a priori minimizing. The first step of this work was to build a model of the landscape-level spreading process taking explicitly into account the topology of the road network. Subsequently, initializing our model with field data, we localized the most probable sites of introduction, the number of jump events, as well as parameters of jump distances linked to the road network. Our model is also able to compute presence probability map, and can be used to calibrate sampling campaigns, explore invasion scenarios, and more generally perform invasion spread predictions. It could be applied to all the species that can be disseminated at local to regional scales by human activities through transportation networks.

## Talk- 2.7

### Wildlife monitoring and field studies - Part 2/3

# Measuring simultaneously habitat loss and fragmentation due to infrastructures: a novel Habitat Functionality metric

**Author(s):** Bram Van Moorter, Ilkka Kivimäki, Robin Devooght, Manuela Panzacchi

**Contact:** Bram Van Moorter, Norwegian Institute for Nature Research

**E-mail:** bram.van.moorter@nina.no

The ecological impact of transportation infrastructures is often considerably higher than their mere footprint in terms of direct habitat loss. Roads and railways can represent barriers to movements preventing access to potentially suitable habitat. When assessing the total effect of a given transportation infrastructure, it is crucial to quantify both direct habitat loss, and indirect habitat loss due to fragmentation. We developed a novel Habitat Functionality Metric, HFM, to quantify simultaneously the total effect of habitat loss and fragmentation. The metric is calculated using animal movement data (GPS), based on a graph theoretical approach.First, using a large set of GPS-tracking data for wild reindeer in Norway, we estimated reindeer Habitat Quality (using Habitat Selection Probability Functions; Lele 2009), and Movement connectivity (using the Randomized Shortest Path framework; Kivimäki et al. 2014). After, the HFM was computed by calculating the connectivity of all pixels in the landscape weighted by their habitat quality. This weighted sum allowed us to integrate effects from anthropogenic infrastructures on habitat quality (e.g. habitat loss) and connectivity (e.g. habitat fragmentation) within one metric. Hence, landscapes with highest HFM scores indicate large amounts of connected, high-quality habitat, while landscapes with lowest HFM score indicate highly fragmented and/or poor-quality habitat. HFM can be used in a scenario-approach to quantify the total impact of existing or planned infrastructures and, therefore, it allows identifying land-planning or mitigation options causing the lowest cumulative impact on animal space use. The HFM will be used to guide Environmental Impact Assessment and support the identification of the most sustainable mitigation measures for wild reindeer in Norway.Our approach does not include demographic data, and therefore relies on the assumption that habitat quality is adequately captured by the preference exhibited by the individual animals. Despite this limitation, that needs to be addressed in future studies, we believe that our approach represents a major step forward towards a more comprehensive assessment of the ecological impacts of transport infrastructures, as it combines and synthesizes both effects in terms of habitat loss and fragmentation.

## Talk- 2.7

### Wildlife monitoring and field studies - Part 2/3

# What are the effects of road-kills on mammal population's persistence?

**Author(s):** Clara Grilo, Kylie Soanes, Aliza le Roux, Elena Koroleva, Flávio Ferreira, Sarah Gagne, Yun Wang, Alex Bager, Luis Borda-de-Água

**Contact:** Clara Grilo, Centro Brasileiro de Estudos em Ecologia de Estradas/Programa de Pós-graduação Ecologia Aplicada, Universidade Federal de Lavras, 37200-000, Lavras, Minas Gerais, Brazil

**E-mail:** clarabentesgrilo@gmail.com

Roads and associated traffic can negatively affect individual wildlife, populations and communities through additional mortality from wildlife-vehicle collisions. Road-kill rates are well documented for a wide range of terrestrial vertebrates, suggesting that endangered and common species face a new threat with the global road network expansion. Previous studies indicated that road-kill can account for up to 40% of the annual mortality of wild mammals (e.g. Eurasian badger Meles meles in Britain). However, the effects of wildlife-vehicle collisions on long-term population persistence are still undetermined. The main goal of this study is to estimate the extinction risk of mammals due to wildlife-vehicle collisions across all continents. For each continent, we modelled the population viability analysis for all endangered species with observed road-kill rates and the five species with the highest observed road-kill rates that are Least Concerned by IUCN. We compiled road-kill rates from 199 peer–reviewed publications, reports and personal communications. We ran age-structured stochastic models to analyse the effect of road-kill rates on the populations of each selected species taking into account the life history traits (population density, age at first birth, interval between births, litter size, litter per year, month of recruitment, survival rates, life span). We used the study area reported in each publication to estimate the road and population density in order to calculate the proportion of the population removed annually through road-kills. The radius of the study area was based on the median daily movement of the individuals for species living in colonies (e.g. bats) and for the other species 5km and 50km for small (<1kg) and large-bodied species (> 1kg), respectively. We obtained 1411 records of 406 different mammal species from 199 different sources (scientific, grey literature and unpublished data) across the globe. A total of 111 species were selected to run the age-structured models (68 threatened species and 43 species with high road-kill rates). Among the compiled species we found that the three species with highest road-kill rates were: white-tailed deer Odocoileus virginianus (68 ind./km/year in USA), southern opossum Didelphis marsupialis (40 ind./km/year in Mexico), Long-tailed field mouse Apodemus sylvaticus (35 ind./km/year in Russia). Apparently road-kills can remove a high proportion of the population for the following threatened species: maned wolf Chrysocyon brachyurus (36%), Eurasian otter Lutra lutra (9-26%), Little spotted cat Leopardus tigrinus (6-20%), Margay Leopardus wiedii (4-19%) and Iberian lynx Lynx pardinus (12%). Models show that road-kills can have strong impacts on the population density with a reduction of more than 50% for some populations of Barbastelle Barbastella barbastellus, maned wolf, Eurasian otter, raccoon Procyon lotor, roe deer Capreolus capreolus and tammar wallaby Macropus eugenii. Preliminary results show that the analysed species are not currently threatened to extinction except maned wolf that has 5% of extinction risk with the observed road-kill rate of 0.084 ind./km/year. This study highlights that although the extinction risk is null or very low, the reduction in population density on several species may make them more vulnerable to stochastic events and other threats.

## Talk- 2.7

### Wildlife monitoring and field studies - Part 2/3

# Biodiversity in Sustainable Urban Drainage Systems – Good or Bad?

**Author(s):** Sondre Meland

**Contact**: Sondre Meland

**E-mail:** sondre.meland@vegvesen.no

Transport and mobility is fundamental in a modern society. However, roads are pervasive in the landscape and may cause harm to the aquatic environment because of their short- and long-term physical, chemical and biological impacts. Hence, awareness of environmental constraints is important for the National Road Administrations (NRA). For example, building of road increase the amount of impervious and semi-impervious areas and reduces the infiltration capacity of runoff water during storm events. This alteration of the natural hydrologic cycle may cause flooding and physical damages as an uttermost consequence. In addition, traffic, including operating and maintenance of the road network are considered as a major source of diffuse pollution to the aquatic environment. Road runoffs and the discharge of tunnel wash water contain a plethora of various contaminants including e.g. particles, nutrients, de-icing chemicals, metals, herbicides, detergents and persistent organic pollutants. Mitigating peak runoff volumes as well as pollution reduction are now considered important, and is often mandatory both from a regulatory perspective and for the NRAs. This acceptance, has led to a shift from conventional drainage systems towards more blue-green solutions also known as Sustainable Urban Drainage Systems (SUDS). Engineered detention ponds and wetland are two examples of SUDS commonly applied by many NRAs. If properly designed and operated, these SUDS have proven to mitigate peak runoff volumes and protecting waterbodies from road related pollution. Thus, managing water quantity and quality are the primary functions of the SUDS. Secondary, a range of aquatic organisms unintendedly inhabit the SUDS. Some studies have documented that SUDS such engineered ponds and wetland may play an important role in preserving and even increasing the biodiversity at a local and regional scale. For example, amphibians worldwide are declining in both abundance and species diversity due to many anthropogenic factors such land take, climate change and pollution. However, amphibians such as frogs and newts seem to thrive in this type of environment. Similarly, several species on the Norwegian Red List such as water beetle species also appears present in SUDS. Thus, SUDS along the road network may be important in preserving viable populations of vulnerable aquatic organisms. The backside of the coin is, however, that these organisms are inevitably exposed to a cocktail of contaminants at concentrations potentially harmful to them. Recent research have shown that e.g. frog larvae readily take up metals during their development followed by physiological effects linked to oxidative stress. In addition, frog larvae exposed to elevated road salt concentrations may cause deformities during their early life stage development. Hence, there is an apparent conflict between the SUDS' primary function, which include mitigating peak runoff volumes and pollution reduction on one side, and the SUDS' secondary function being a facilitator for biodiversity on the other side. At its utmost, SUDS may act as ecological sinks and traps. This apparent contradiction will be reviewed and discussed in the present talk, using data from Norway as well as internationally published research.

# Talk- 2.8

## Integration with Landscape plans - Part 1/2

# Tendering for ecological value in a Dutch road expansion: evaluation of the results

**Author(s):** Victor Loehr

**Contact:** Victor Loehr, Rijkswaterstaat Netherlands

**E-mail:** victor.loehr@rws.nl

In 2013-2014, the Dutch National Roads Agency used a new approach to select a contractor for a road expansion based on ecological value. The tendering process actively challenged contractors to develop plans to minimise the impact on nature beyond the contract requirements, resulting in the selection of a contractor that had drawn up a plan that contained 55% of the maximum obtainable ecological value. This plan was presented at IENE 2014. In 2015-2016, the road expansion was constructed, allowing us to evaluate how much ecological value was eventually realised. The contractor created an extra 20 ha of heathland corridors to enable reptiles and other species to move between core habitats. The corridors included several infrastructure crossings. In addition, three new badger tunnels and two new pine marten bridges with accompanying fences were constructed. Reptile and mammal measures were created in collaboration with NGO's and all nature conservation organisations owning land along the road involved in the project. A bat hibernation site that was unexpectedly discovered was successfully conserved without causing project delays, and was subsequently improved to host larger numbers of bats. Some measures could not be realised. For example, Ulex europaeus shrubs turned out to be too fragile for transplantation and one of the heathland corridors could not be constructed as a result of second thoughts of the land owner. Furthermore, the contractor did not deliver the anticipated quality when it came to the maintenance of temporary reptile fences. Considering the project as a whole, the natural environment of the road benefited from the road expansion project. Since the contract includes 16 years of maintenance, the contractor will continue to monitor all measures. Meanwhile, the National Roads Agency is repeating the new approach for another road expansion.

## Talk- 2.8

### Integration with Landscape plans - Part 1/2

# Influence of the regional landscape connectivity on the location of roe deer roadkill hotspots

**Author(s):** Xavier Girardet, Céline Clauzel, Jean-Christophe Foltête

**Contact:** Xavier Girardet, Laboratoire ThéMA UMR 6049 Université de Franche-Comté CNRS

**E-mail:** xavier.girardet@gmail.com

**URL:** http://thema.univ-fcomte.fr/page_personnelle/userprofile/xgirardet

Linear infrastructures threaten ecosystems and have both direct and indirect effects on ecological habitats and individuals. The fragmentation effect (i.e. splitting or loss of habitat patches) and the barrier effect (i.e. fences, traffic noise avoidance, and roadkill) are widely reported. Wildlife-vehicle collisions are the most visible direct effect and can result in severe human injuries. In Europe, the roe deer population is growing and roe deer roadkills are becoming more common. Roe deer movements depend on landscape features and regional-scale connectivity. Here, we investigate the influence of the landscape network on the location of roe deer roadkill hotspots. In order to localize new potential hotspots along the national roads of Franche-Comté (Eastern France), we first show that roe deer roadkills are not distributed randomly and we identify hotspots. Then, we explain roe deer hotspot locations using a predictive model by combining landscape composition variables, road-related properties, and graph-based connectivity metrics. We test three centrality metrics at three dispersal distances and we assess the relative contribution of the connectivity metrics to the best model. In order to define high-risk sections, we find the probability that reduces the costs of misclassification that the model produces. We validate the model with a new set of roe deer roadkills. Finally, to help the road manager to prioritize mitigation measures, the three 500m road sections with the highest value of probability defined by the model were identified. These sections are located near well-known hotspots.

## Talk- 2.7

### Wildlife monitoring and field studies - Part 2/3

# Building an ecoduct in an agricultural environment - a challenge for people and animals

**Author(s):** Katja Claus

**Contact:** Katja Claus, Flemish Government - Environment, Nature and Energy Department

**E-mail:** katja.claus@lne.vlaanderen.be

Ecoducts are usually built in a natural environment, often even in special protection areas or with the intention to (re)connect the habitat of endangered species. However, in Flanders (northern part of Belgium) a wildlife crossing was constructed in a fairly intensive agricultural area in 2011. A new high speed train line (HSL) was planned between Antwerp and Rotterdam parallel to the busy existing E19 highway. To almost all (non-flying) animals, this meant a total barrier to animal passage. The negative effect on flora and fauna was shown in several preliminary studies and in the Environmental Impact Assessment. Moreover, the planning permission for the construction of the HSL explicitly listed a series of mitigation measures, including the building of an ecoduct. An ecological study that considered ecological, technical, financial, spatial and political aspects determined the location and technical implementation of the ecoduct. Finally a wildlife crossing of 60 m width, bridging both the highway and the HSL (100 m), was proposed at Wuustwezel. This is a rural municipality in the northern part of Flanders with traditional agriculture focused on dairy cattle and pig farms. Building an ecoduct in such a setting encounters a lot of opposition. Therefore, from the very beginning, we paid much attention to communication, involvement of the local government, inhabitants and especially the dispossessed farmers. In addition a decent landscape fitting of the ecoduct in this agricultural area was required. In a supporting landscape study a lot of attention was paid to local sensitivity and practicability. This entire process has been accompanied by a regional association with strong roots in the local community. The construction of the ecoduct was fully funded by the infrastructure sector (roads and railway). The actions to enhance the local support were however paid by the environmental sector of the Flemish Government. Above all, animals must use this new wildlife crossing. To counter the scepticism on the usage by proposed target species, the Environment, Nature and Energy Department performed a monitoring study. The ecological situation before the construction of the overpass was registered, followed by two years of monitoring, respectively one and three years after completing the construction. The results were above all expectations: after three years all target species used the ecoduct, some even on a very regular basis.

## Talk- 2.8

### Integration with Landscape plans - Part 1/2

# Brandenbark™: Mitigation/Management tool for projects involving bark roostings bats

**Author(s):** Zachary Baer, Mark Gumbert, Joshua Adams, Piper Roby, Price Sewell, L. Kate Baer, Michael Brandenburg

**Contact:** Zachary Baer, Copperhead Environmental Consulting

**E-mail:** zbaer@copperheadconsulting.com

Multiple imperiled bat species around the world utilize trees with exfoliating bark for warm season roosting. Impacts to this roosting habitat are a concern for transportation projects that occur within the range of a protected species. Disturbance to roosts of protected species can require avoidance, minimization, and mitigation strategies. Current mitigation strategies for impacts to summer habitat of bark roosting bats are not readily available, often ineffective and unproven, and can be cost prohibitive. BrandenBark™ is an artificial roost structure developed to mimic the natural habitat of bark roosting bats. It has been shown to be an effective artificial roost for six species of bats, including the U.S. federally endangered Indiana bat (Myotis sodalis) and other bat species that utilize bark roosts. BrandenBark™ structures at the study site (Fort Knox, Kentucky, USA) have been utilized to provide habitat for Indiana bats within the range of a known maternity colony and have been placed in locations typical for Indiana bat primary roost trees. During the study period (2012-2015), BrandenBark™ structures were selected by Indiana bats regularly with 77.2% (186 of 241) of roost visits documenting occupation and 72.7% (16 of 22) BrandenBark™ structures displaying signs of bat use within three months of installation. Pre-volancy emergence counts (May through June, n=45) of 10 BrandenBark™ structures documented an average maximum emergence count of 92 bats, comparing favorably to the average adult maternity colony size of 80 female bats. Post-volancy emergence counts (July through August, n=47) of 11 BrandenBark™ structures documented an average maximum emergence count of 122 bats. Previous field studies have resulted in a post-volancy average maximum emergence count of 119 bats exiting from natural tree roosts. BrandenBark™ also resulted in the second highest Indiana bat maternity emergence count recorded from a single roost with 451 bats. The highest being 475 bats emerging from a natural tree. Radio tracking and mist netting has resulted in documentation of Indiana bat use of 13 BrandenBark™ structures for a total of 248 bat days. The roost area under BrandenBark™ is slightly warmer (= 24.6±7.2 [SD]°C) than that of natural bark (= 23.1±6.5°C). Temperature differences between BrandenBark™ and ambient (= 2.1±2.7°C) are less variable than the temperature difference between natural bark and ambient (= 3.9±4.0°C), possibly indicating a more stable thermal environment. In addition to being proven at the study site, BrandenBark™ has been deployed as a mitigation/land management tool by a number of transportation, natural gas, and wildlife conservation proponents to provide immediate roosting habitat for imperiled bark roosting species. To date, 127 BrandenBark™ structures have been installed in eight U.S. states and one Canadian province. BrandenBark™ provides instant long-lasting habitat commensurate with natural roosts, is easy to install and monitor, and does not require the purchase of additional land for placement when used as a mitigation option.

# Talk- 2.8

## Integration with Landscape plans - Part 1/2

# Model based dynamic defragmentation tool for Flanders (Belgium)

**Author(s):** Joris Everaert, Inge Uljee, Marleen Moelants, Liesbet Van Laer, Luc Janssens, Guy Engelen

**Contact:** Joris Everaert, Research Institute for Nature and Forest (INBO)

**E-mail:** joris.everaert@inbo.be

Landscape fragmentation due to road infrastructure is very high in Flanders (= northern region of Belgium). Within the framework of environmental, climate adaptation, spatial and mobility policy plans, the Flemish government has the objective to mitigate the ecological impact of this infrastructure. A first priority-atlas for defragmentation in Flanders was made in 2001, using policy maps and species vulnerability maps. Because of the complex and static characteristic of this atlas, a quick and easy update with new information was impossible. Therefore, we decided to make a model based and dynamic defragmentation tool, which can automatically evaluate the current defragmentation and suggest the best locations for new defragmentation measures (with priority) including various spatial scenarios. The defragmentation tool is based on a constrained cellular automata land use model of Flanders region. This model enables calculating and assessing the effectiveness of various spatial scenarios in Flanders, and has been used in many government studies, including spatial policy plans, nature reporting, and as a base for the implementation of Natura 2000 objectives. The model operates on a 100m resolution. It incorporates numerous GIS data layers and computes land use dynamics based on spatial interaction rules among some 50 land uses. The ecological input data layers in the defragmentation tool were (1) suitability maps for about 20 species and (2) the current and already planned defragmentation measures (e.g. fauna passages) with species specific quality values for 'permeability' of the road. The species suitability maps were made with dynamic scripting, using quality requirements for habitat type, landscape properties, slope, soil type, action range and minimum area for viable populations. We also incorporated an extra valuation in these suitability maps, specifically with land use properties and data of actual (known) species distribution including road-kills. The combination of all the ecological data layers and the road transport infrastructure map, resulted in clusters of possible 'migration habitat' and/or 'optimal habitat' for the species, separated by roads. A value of the number of optimal habitat raster cells within each cluster was automatically calculated for each species or group of species. Assuming that one or several defragmentation measures can (re-) connect two clusters, the result was a new value of optimal habitat raster cells in the combined larger cluster. With this method, the model performed an iterative calculation to find the qualitatively best locations for future defragmentation measures, for individual species and groups of species. The results were then presented in a priority map for Flanders. The tool can automatically recalculate the result with new input layers and for different scenarios. Optionally, policy maps (e.g. protected areas) can be included afterwards. The application of this dynamic tool can also be used in other regions around the world.

## Talk- 2.9

### No-Net-Loss Strategy and compensatory measures

# Roadless conservation in central Africa: the challenge of applying the mitigation hierarchy to infrastructure development in large intact forest landscapes

**Author(s):** Fabien Quetier, Pauwel de Wachter, Hélène Dessard, Camille Jepang, Laurène Feintrenie, Juliette Chamagne, Donald Midoko Iponga, Claude Garcia, Annabelle Morcrette, Solène Happert, Charles Bassama

**Contact:** Fabien Quetier, Biotope

**E-mail:** fquetier@biotope.fr

The Tri-National Dja - Odzala - Minkebe Forest landscape (TRIDOM) covers 178000 km² across the borders of Cameroon, Gabon and the Republic of Congo. Almost 97% is covered by sparsely populated lowland tropical rainforest and is globally important for the conservation of large mammals (elephants, gorillas, chimpanzees). Major roads are being built across the TRIDOM, not least to service what is destined to be an emerging iron ore province with several deposits currently being explored and two mining projects ready for exploitation. For decision makers in the area, encouraging investment while respecting the legal and customary rights of local populations and conserving biodiversity represents a major challenge. Conservationists highlight that the infrastructure being built (railroads, roads, powerlines) will have direct and indirect impacts on the ecosystems, especially as they will enable an influx of migrants, which could transform the large intact forest landscape into a mosaic of isolated and thus vulnerable protected areas, no longer fit to conserve its mega-fauna or maintain large scale ecosystem processes. Possible mitigation options include coercive (e.g. anti-poaching patrols) and incentive-based (e.g. support for alternatives such as agroforestry) solutions, which differ in their effectiveness and applicability, in the TRIDOM as anywhere else. Other options include access limitations for new and existing roads, and reclamation of disused roads in forest concessions. To better understand the impact, constraints and limitations of these options, we synthesized available knowledge on the effect of road development in roadless landscapes and used participatory modelling techniques to build a model of the socio-ecological system of the TRIDOM. This model was then used to explore, with stakeholders, future scenarios for the TRIDOM, in terms of infrastructure development and of biodiversity outcomes. Key conclusions from the analysis are that (1) managing these impacts requires a strategic and multi-sectorial landscape-level approach, rather than dealing with each separate project sequentially, which calls for (2) agreement on key biodiversity features and the development of biodiversity metrics for applying the mitigation hierarchy to these features, of which large un-fragmented (roadless) forest blocks are of particular concern, as well as (3) the development of new or improved institutional capacity and engagement, to coordinate and enforce decisions. These conclusions are widely applicable and relevant in a context of expanding infrastructure investments.

# Talk- 2.9

## No-Net-Loss Strategy and compensatory measures

# ES'team - Ecosystem Services and the 'Avoid, Mitigate and offset' approach

**Author(s):** Labarraque Dorothee

**Contact:** Labarraque Dorothee, Egis Structures et Environnement

**E-mail:** dorothee.labarraque@egis.fr

Numerous scientific researchers have focused on Ecosystem Services. However Ecosystem Services (ES) are not yet really taken into consideration in Project's Environmental Assessment.The recently released EU Biodiversity Strategy (2011) has laid down the framework for taking into account ES in managing the development of various European Territories. It was confirmed by the European Directive 2014/52 applicable to member states from 2017. Even if the Directive explains that the goal of those assessments is to contribute «halting biodiversity loss and the degradation of ES», it remains however fairly general on how to achieve this goal. In France, the upcoming law on biodiversity is also aiming toward the same direction.In order to meet this new challenge, Egis environnement has developed a methodological approach called ES'team. This approach is operational, adaptable to project's type (transportation infrastructure, industrial facility, etc.) and development phases (feasibility, preliminary, etc.). It is also coherent with the 'Avoid, Mitigate and Offset (AMO) approach. ES'team is progressive in order to encourage project's owners to integrate this approach in the environmental assessment, starting with a light scoping phase in order to qualitatively identify issues and aspects. In a second phase it applies a much more comprehensive and quantified screening approach.ES'team proposes 3 levels of expertise:- Pre-diagnostic (ES Scoping): established from a typology linking ES (presence, absence) and land cover, it quickly provides the main characteristics of a study area and allows identifying the most important ES. Pre-diagnostic is relevant for small scale assessments (1/100000) solely making use of data that were already collected for the environmental assessment. .Pre-diagnostic was tested by EGIS on two projects: a road project during the Environmental Impact Assessment stage and a rail project during feasibility study. For example, the latter showed that pollination service could be a stake in the studied territory and also for the acceptance of the project by proposing measures specific to pollinators.- Comprehensive assessment (ES screening1) for the priority services: also based on a typology linking ES and land cover, but at a medium scale (1/25000). It requires more complex quantification models. This detailed diagnostic allows quantifying services in biophysics and monetary terms as well as losses related to the development of a Project (IENE, 2014).- Detailed field study (ES screening2), is relevant at a large scale, for study area of less than 1 km2. There is no robust and reproducible methodology allowing quantifying ES at this scale yet. This is why we have developed with the CNRS (National Center for Scientific Research, France) a dedicated research program. This level of expertise will contribute to the development of reduction and even mitigation measures which take ES into account.The two first levels of expertise are related to the first item of the AMO approach: to Avoid. The third level of expertise and the additional data produced will feed a future ES engineering, which will naturally be part of the last two items: Mitigate and Offset.

## Talk- 2.9

### No-Net-Loss Strategy and compensatory measures

# Compensation of impacts on Nature and Landscape

**Author(s):** Thomas Schuh, Lukas Umgeher

**Contact:** Thomas Schuh, ÖBB-Infrastructure Inc. Praterstern 3 1020 Vienna Austria

**E-mail:** thomas.schuh2@oebb.at

Implementationof environmental restoration and compensation measures has become anincreasingly important sphere of action of contemporary nature conservation. Toaddress various approaches on determining, implementing and monitoring naturecompensation measures and in order to suggest a more homogenous approach tothese topics within Austria, the attorney general of the environment of theProvince of Burgenland, of Lower Austria and of Upper Austria together havecommissioned a study that addresses the following topics:Evaluation and calculation model todetermine the need and extent of compensation measures Management of compensation areas Administrative implementation ofcompensation measures

## Talk- 2.9

### No-Net-Loss Strategy and compensatory measures

# Roadless space is greatly diminished by logging in intact forest landscapes of the Congo Basin

**Author(s):** Fritz Kleinschroth, John R Healey, Sylvie Gourlet-Fleury, Frédéric Mortier, Radu Stoica

**Contact:** Fritz Kleinschroth, CIRAD, Biens et Services des Ecosystèmes Forestiers Tropicaux, 34398 Montpellier, France

**E-mail:** fritz.kln@gmail.com

**URL:** http://fritzk.weebly.com/

Forest degradation in tropical regions is often associated with roads built for selective logging. Forest areas that are not accessible by roads are considered valuable because they provide habitat that is not immediately impacted by major human activities. The protection of such Intact Forest Landscapes (IFL) is high on the biodiversity conservation agenda, leading to a motion of the Forest Stewardship Council (FSC) to better protect IFL in certified forest concessions. However, in many parts of Central Africa logging takes place at very low intensities and most roads are abandoned after few years of timber harvesting. Taking limited road persistence into account we asked: How did road networks in FSC certified concessions affect IFL? Intact forest landscapes can be conserved by retention of "roadless space", a concept based on distance to the nearest road from any point. We developed a novel use of the empty space function – a general statistical tool based on stochastic geometry and random sets theory – to calculate roadless space based on time series of LANDSAT images. We followed the spatial and temporal dynamics of logging roads in a part of the Congo Basin that has recently seen rapid expansion of road networks for selective logging. We compared the temporal development of roadless space in certified and noncertified logging concessions inside and outside areas declared as IFL in the year 2000. The persistence of logging roads was limited over time, with only 12% of the overall network being permanently open. However, also taking only actively used roads into account, roadless space inside IFL has decreased rapidly due to expansion of logging into previously nlogged areas. Between 1999 and 2007, rapid road network expansion led to a marked loss of roadless space in IFL. After 2007, this trajectory levelled out in most areas, due to an equilibrium between newly built roads and abandoned roads that became revegetated. However, concessions within IFL that have been certified by FSC since around 2007 showed continued decreases in roadless space, thus reaching a level comparable to all other concessions. Only national parks remained mostly road-free. The established concessions outside IFL even showed a slight increase in roadless space due to forest recovery on abandoned roads. We recommend that forest management should make the preservation of large connected forest areas a top priority by effectively monitoring - and limiting – the occupation of space by roads that are accessible at the same time. We suggest the empty space function as a viable method to calculate roadless space. We identified the highest fragmentation-effect resulting from a new public road corridor that is crossing the Congo Basin forest on a south-north axis. We point out the urgent need for measures to guarantee ecological corridors between protected areas and remaining intact forests. Logging concessions might play a key role in conserving forest connectivity by controlling road access and maintaining crossing facilities.

## Talk- 2.9

### No-Net-Loss Strategy and compensatory measures

# Integrating transportation and conservation planning at the regional scale: An example from Florida, USA

**Author(s):** Daniel J Smith, Stephen D Tonjes, Thomas Roberts

**Contact:** Daniel Smith, Department of Biology, University of Central Florida, Orlando, FL, USA

**E-mail:** daniel.smith@ucf.edu

An important objective of conservation planning and reserve design is the provision for functional landscape connectivity. For instance, development of a well-connected network of reserves might support viable populations or metapopulations of species that otherwise might not be supported within single, isolated reserves. Roads present significant obstacles in achieving this objective. Over the past few decades, more focused research on the ecological effects of roads has demonstrated the range and intensity of impacts to landscapes and biodiversity and led to development of a range of measures to avoid, minimize and mitigate these negative effects. The large-scale impacts of road networks and urban growth on conservation of biodiversity were first recognized in Florida in 1990 and led to the Governor's creation of the Florida Ecological Greenways Network Initiative. This program was created to develop a statewide plan to identify and protect important conservation reserves and critical linkages that together constitute an interconnected system enabling long-term maintenance of Florida's biodiversity. Key aspects associated with success of the program included collaborative public-private partnerships and dedicated funding of $300 million annually for 20 years to acquire and protect conservation lands identified in the plan. Over 2.4 million acres of land has been protected since the program's inception. On a parallel track with the Florida Ecological Greenway Network (FEGN) program was the policy by the Florida Department of Transportation (FDOT) to develop options to avoid and minimize impacts or include mitigation measures in highway project plans where new or existing roads intersect with protected conservation areas identified in the FEGN plan and supported by State resource agencies. The review process for determining potential environmental conflicts is called the Efficient Transportation Decision-making Program and includes an environmental screening tool used by a team of representatives from state and federal agencies and other non-governmental public groups. This information is used to make preliminary decisions on potential environmental impacts and the need for ecological assessments and special planning considerations as each project moves forward. At the regional level FDOT either works with specially created task forces comprised of public and private stakeholders familiar with the specific issues of each project, or consults with state and federal experts throughout the project planning and design process. We will discuss actions within one region that have led to multiple projects designed to maintain and/or restore landscape connectivity as part of the FEGN vision. In east central Florida, FDOT working in collaboration with public stakeholder groups and state and federal experts have researched, planned, designed and constructed 20 roads that include 146 wildlife crossing structures or other mitigation measures. Three specific large-scale projects within this District will be discussed in detail: State Road 40 through Ocala National Forest (155,000 ha) that includes plans for 76 wildlife crossings, Wekiva Parkway that includes 4 landscape-scale wildlife crossings, and Interstate Highway 4 that includes 10 wildlife crossings. These projects included collection of preconstruction baseline data that provided valuable information needed to minimize negative impacts on native biodiversity, landscape patterns and processes.

# Workshop- 2.10

## A new european handbook on roads and Wildlife!

## Interactions between linear Infrastructure and territories: A new European handbook!

**Author(s):** Eugene O'Brien, Morten Elmeros, Anders Sjölund

**Contact:** Eugene O'Brien,

**E-mail:** eugene.obrien@rod.ie

The European road network not only provides an extensive and vital transport system but it also results in impacts on the surrounding environment. Consequently, road investments are subjected to extensive discussions between road authorities and environmental authorities. In order to achieve a more cost-efficient approach to comply with environmental demands, including demands from the various EU Directives, a Transnational Research Call - known as "Roads and Wildlife" - was commissioned by the Conference of European Directors of Roads (CEDR) in 2013 to ensure the latest knowledge and best practices related to wildlife are adopted during the development and maintenance of road infrastructure. The aim of the CEDR call was to understand the effectiveness of various mitigation strategies in order to solve the conflict between wildlife and roads, and investigate more cost-efficient methods for building and maintaining road structures as well as structures for reducing road impacts on wildlife. In 2014 three projects, known as SAFEROAD, HARMONY and SAFEBATPATHS, were successfully procured under this call. These projects will be completed in the first half of 2016. In a next step, CEDR aims to use the outcomes of these projects to extend the COST 341 Handbook. This handbook was published in 2003 and is widely used. However, knowledge on road mitigation strategies has significantly increased over the past decade. Therefore the need for an update of the handbook became evident. At this workshop we will present a draft of the new handbook - further referred to as CEDR Roads and Wildlife Manual - and will ask for your feedback in order to improve the practical value of the drafted guidelines. The workshop will consist of a plenary introduction with a presentation of the new handbook, followed by two parallel sessions in which the focus is on cost-efficient road mitigating strategies for wildlife (session 1), and cost-efficient road maintenance practices for wildlife (session 2). In these moderated sessions participants will be asked to share their ideas, opinions and recommendations. These consultations will be used to better meet the needs of practitioners in the new handbook.

## Talk- 2.11

### Natural revegetation, road side management and ecological restoration

# From plan to practice in development projects: ecological restoration in the mitigation hierarchy framework

**Author(s):** Dagmar Hagen, Astrid Skrindo

**Contact:** Dagmar Hagen, Norwegian Institute for Nature Research

**E-mail:** dagmar.hagen@nina.no

Development projects, like roads and other infrastructure, cause heavy pressure on land and ecosystems, and habitat degradation is today the most severe threat to global biodiversity. In the future, developers will meet increased legal, economic and moral pressure to reduce and minimize negative impacts from their activity on landscapes, ecosystems and species. Ecological restoration in recent years has got large attention globally as one important activity to change this trend. In the mitigation hierarchy framework this becomes apparent, as the contribution from ecological restoration is essential to achieve real mitigation in all steps of the hierarchy. To minimize negative impacts in new development projects all stages of the mitigation hierarchy must be involved (avoidance, minimization, restoration and compensation. Development projects involve a range of stakeholders, professions, and planning systems, and mitigation is about combining these. Examples of contribution from restoration can be by describing ecological status before and after, formulate goals, suggesting restoration techniques (from the restoration toolbox), involve the actors to bring up all relevant knowledge, establish relevant systems for documentation and monitoring. Successful ecological restoration is based on a sound integration of science, society and technology, and applying this understanding into new development projects this both essential and novel. In this presentation, we will illustrate how such integration can be done in the field for real development project, and present a structured model for cooperation between planners, project owners, ecologists, entrepreneurs and machine drivers. We will demonstrate how local knowledge, practical experience, in combination with scientific knowledge has improved different categories of projects, including hydropower plants, roads, and urban development. Based on observations from real projects we will discuss and suggest how these field-based experiences can improve future projects and contribute through all parts of the mitigation hierarchy. We conclude that an integrated approach, including different categories of knowledge, can contribute to reduce negative impacts on nature values in development projects. However, this call for improved procedures for documentation and monitoring that will allow for exchange of experiences between projects and sectors.

## Talk- 2.11

### Natural revegetation, road side management and ecological restoration

# Near-natural methods promote restoration of species-rich grassland vegetation—revisiting a road verge trial after nine years

**Author(s):** Inger Auestad, Knut Rydgren, Ingvild Austad

**Contact:** Inger Auestad, Sogn og Fjordane University College, Norway

**E-mail:** inger.auestad@hisf.no

**URL:** http://vev.hisf.no/no/ansatt/vis/inger.auestad

The present loss of species-rich grasslands makes it vital to restore these valuable habitat types, including novel habitat variants such as road verges. Due to the lack of knowledge on long-term outcomes of restoration initiatives, well-designed studies comparing different restoration methods are needed. In this study, we examined fine-scale vegetation recovery patterns over nine years in a field experiment with several near-natural restoration methods (adding local seed mixtures, transferring hay from local grasslands using hard or light raking, and natural regeneration) in a road verge. We compared this to standard revegetation (hydro-seeding species-poor commercial seed mixtures). We found major temporal changes in vegetation restored by local seed or hay transfer, before it gradually became more similar to the donor grasslands and seed mixtures, which served as references for the experiment. Natural (spontaneous) regeneration with seed dispersal from surroundings gave similar results, whereas areas revegetated using standard methods became more dissimilar to the reference sites during the study period. The main variation in species composition reflected the contrast between local donor grasslands and seed mixtures and the species-poor early-successional grasslands. We conclude that near-natural methods (hay transfer and seeding) successfully restored species-rich grassland, including road verges. Our study underlines the importance of comparing several treatments over a sufficiently long period to assess their success in restoring species-rich grassland.

## Talk- 2.11

### Natural revegetation, road side management and ecological restoration

# Environmental challenges encountered during planning and construction of a new highway through the south east of Norway

**Author(s):** Lene Sørlie Heier

**Contact:** Lene Heier, Norwegian Public Roads Administration

**E-mail:** lene.sorlie.heier@vegvesen.no

During the planning and construction of European Road E18 in the south east of Norway, various challenges related to environmental issues have emerged. The total length of this sectionof the highway is 70 km, which has been divided into nine different sections during the development. Two of the sections are under construction, one is still in the area development planning phase, and the six other sections have been built. Some of the environmental challenges concern the building of a bridge over a protected watercourse inhabited by many aquatic species, and crossing a bog inhabited by several endangered species of dragonflies. This paper aims to explain the background and the measures taken to reduce any negative effects on the environment during construction and in the operating phase of the highway for the two examples given. The first example involves building a bridge over a protected watercourse. The river also has an outlet to a lake that is a major drinking water source. Additional challenges in the area include severe ground conditions with quickclay. The area is also very vulnerable to flooding, which occurs frequently during the year. Because of the quick clay, bridge foundation to bedrock was necessary, which induced the need of piling a total of about 3000 m. This again led to large amounts of drilling fluids (suspended solids) in the piling process. To prevent the drilling fluids from contaminating the river, a large treatment plant was set up using chemical precipitation and sedimentation for the removal of suspended materials. Extensive monitoring of the water quality was performed before, during and after the work. The results show that the piling work did not significantly affect the water quality in the recipient;thus, the measures used worked as intended. Another challenge encountered in the project was the building of a bridge across an area inhabited by many speciesof dragonflies, including some endangered ones, through a bog area. The main measures included increasing the length and height of the bridge to ensure enough space for the dragonflies to move around. During the construction phase, the peat bog was removed. It is currently being stored and will be returned to the area under the bridge after the construction is finished. This work is still ongoing, and thus no evaluation of the work has yet been carried out.

## Talk- 2.11

### Natural revegetation, road side management and ecological restoration

# Trade-offs in multifunctionality of road verges and their delivery of ecosystem services

**Author(s):** Hans Martin Hanslin

**Contact:** Hans Martin Hanslin, Urban greening and environmental engineering, Norwegian institute of bioeconomy research

**E-mail:** Hans.martin.hanslin@nibio.no

Road verges may contribute substantially to ecological functions and delivery of ecosystem goods and services in both urban and rural greenspaces. The function as habitat, dispersal corridor or stepping stone for both plants and animals, provision of pollen and nectar resources for pollinators, aesthetic aspects, noise reduction, trapping pollution, intercept runoff and manage stormwater are among the valued contributions. Road verges are however narrow, built on disturbed soils and with traffic having an impact on environment and mortality risks. Thus there are certain limitations and trade-offs between functions and services. Here I present results from a literature review on how establishment and management can be tailored to specific functions and services within the boundaries of road safety and management costs. I especially address how the interactions between soil, soil biota, vegetation and management can be used to maintain biodiversity based ecosystem services over time. The conflict between avoiding establishment of invasive species and promoting diverse vegetation is given special attention and referred to the potential use and limitations of assembly filters. A combination of abiotic and biotic filters can be used to reduce establishment of invasive species. Biotic resistance to invasion can be increased by manipulating competition and plant-soil feedbacks. A rapid establishment of high density redundant vegetation composed of competitive species with overlapping niches, occupying available niches and rapidly closing open spaces usually is successful in preventing establishment of invasive species. Combined with abiotic filters like reduced availability of nutrients and water and maintenance of regular cutting, these measures usually are efficient in preventing establishment of invasive species from seed. This approach also strongly reduce the possibility to establish a diverse self-sustaining vegetation as it cuts of possibilities to regenerate from seeds and increase species turnover through competition. The challenge of combining these targets is further discussed, possible solutions presented and knowledge gaps identified.

# Talk- 2.11

## Natural revegetation, road side management and ecological restoration

# Roadside allotment gardens to produce living landscapes ?

**Author(s):** Magali Paris, Grégoire Chelkoff, Marine Linglart

**Contact:** Magali Paris, CRESSON-ENSAG

**E-mail:** parismagali@yahoo.fr

Allotment gardens are grouped vegetable' plots gardened for non profit and that gather a group of gardeners. Their history (end of the 19th century for the French context) is strongly linked to the history of railways and roads because they were specially located there ("jardins des cheminots") or because they found there the opportunity of a non coveted land. These gardens could be part of the road verge, in this case they are illegal and temporary gardens, the gardeners take care of the land out of any frame. They could also be along the road as a buffer between the road and the urban fabric. Then they could be manage by a ONG, the municipality, a social housing organization, private persons… In all the cases, we choose to study urban roads that shelter more than 30.000 vehicles/day (2 ways). What is the fauna-flora biodiversity of roadside allotment gardens ? Is this biodiversity different from the one of the semi-natural verges? Where does this biodiversity come from and come to? How roadside nature contributes to the ecological network? Could nature and humans cohabite on the roadsides to produce living landscapes? Is it healthy to cultivate the roadside? To answer those questions, the « roadside-nature » multi-disciplinary research conducted since 2010 - with the financial support of MEDDE and ADEME - articulates an ecological evaluation and a landscape evaluation. The ecology of the gardens in their environment has been studied through biodiversity with a survey of fauna-flora in presence/absence and landscape ecology with maps analysis. The pollutions of the garden (soil, air and vegetables) have been investigated through in situ measures (CEREMA and Agroparistech). Landscape should be outlined here through its sensory and human dimensions: sightscape, soundscape and taskscape, approached by sound measures and recordings, observations and interviews with gardeners. The specificity of the methodology implemented is to cross-reference quantitative and qualitative datas, ecological and human questionings around the ecological issues. 18 roadside allotment gardens, located in France (A480, A41, N87 /Isère and A86, A6, A13/ Ile-de-France), Portugal (E1, subway, railway and the express way /Lisboa) and United-States/California (280 and 101 Freeway /San Francisco) and their nearby « wild » nature have been studied in situ. 3 types of roadside gardens have been highlight in the 3 countries: the island gardens surrounded by roads and railways and disconnected from the urban fabric, the home gardens surrounded by dwellings, the parks gardens included in a public park. The roadside allotment gardens shelter an ordinary fauna-flora biodiversity, generally more important than the biodiversity of the semi-natural verges colonised with invasive plants. This ordinary biodiversity of the roadside gardens is variable from one site to another (59-169 wild flora species), from one plot to another and from the inside of the gardened plots and the outside. 4 criteria should be take into consideration to understand this variability : era/species ratio (insular geography), maintenance and accessibility of the walkways, gardening practices, ecotonal structure (in-between structures at different scales). Roadside allotment gardens are ecological dilatations of the roadside and roadbank nature, their habitats are different and complementary.

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# Talk- 2.11

## Natural revegetation, road side management and ecological restoration

## Roadside allotment gardens to produce living landscapes ?

**Author(s):** Magali Paris, Grégoire Chelkoff, Marine Linglart

**Contact:** Magali Paris, CRESSON-ENSAG

**E-mail:** parismagali@yahoo.fr

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Roadside gardened and « wild » nature contribute to linear ecological network in the surroundings of transport infrastructure: some birds and insects could find temporary habitats and they are for all animals linear corridors. The dilated structure of the gardens are also very important in terms of soundscape and pollution. Since a 200 meters width, it's possible to escape the noise of the road and to find a sound level under 53 dBA. Also, the pollutions' level decrease significantly from 30 meters from the road. Some measures should be implemented in this buffer space (0-30 meters from the road) to avoid to cultivate polluted area. Roadside allotment gardens are places where human and nature could cohabitate, they are human and nature living landscapes. Indeed the gardeners could have a positive impact on biodiversity and gardens could be corridor for humans (gardeners and visitors) as well as animals. Otherwise, a strong improvement should be made to cross scales and to articulate ecological network to living landscapes implementation policies.

Today, in the French context, the regional eco-network (SRCE) is realized at a too large scale to take the gardens into consideration. Gardens could find a place as a proximity landscape in the development of roadside urban new area where unhopefully the ecological stakes are forgotten or misunderstood. To inform the French context about actor games, the Californian and Portuguese situations reveals different bottom-up and top-down processes to articulate urban and garden development.

We will also see that the ecological and pollution issues are taking into account differently (legal and political frames, actors, stakes…) in the two foreign cities. The road sides could become urban agriculture areas in order to satisfy the social need. They can be an alternative to expensive maintenance of large areas. These road sides are one of the rare soil areas in the urban artificial context, they contribute to the heat island reduction. They could be and become a part of urban project that contribute to a better connectivity to retrofit the fragmented fabrics and their atmospheres.

# Talk- 2.12

## Infrastructure, amphibians and reptiles (special tribute to Miklos Puky)

# Making light in amphibian road tunnels; Novel automated technology shows large seasonal, life stage and species-specific variation in amphibian usage in the UK

**Author(s):** Silviu Petrovan, Michael Hartup

**Contact:** Silviu Petrovan, Froglife Trust and University of Hull, UK

**E-mail:** silviu.petrovan@froglife.org

Road mortality, habitat fragmentation and loss of connectivity represent major threats for amphibian populations worldwide and especially in Europe where the road network is exceptionally dense. Road mitigation using tunnels represents the most promising solution yet most tunnels remain poorly investigated and insufficiently monitored, largely due to methodological constraints and high costs of pitfall trapping. Since 2013 we developed and deployed a custom-made automated system for monitoring such tunnels and investigated multiple sites in the UK and Sweden over three years. We used high-frequency timelapse infrared image recording for relatively cheap and robust monitoring and undertook intensive data collection focusing on the amphibian maximum periods of activity (spring, late summer and autumn). We recorded over 5.3 million images and developed a software script for image analysis which reduced the workload by as much as 85%. We categorised all amphibian observations by species, age class, sex (for some species), time and position inside the tunnel as well as behaviour (e.g. crossing, foraging, turning, hesitant, etc.) and directionality (moving in or out of the tunnel). Since 2014 we investigated the almost completely unknown aspects of amphibian road mitigation usage by post-metamorphic juveniles following emergence from the ponds. We recorded over 13000 amphibian observations from 5 species at the six different sites as well as over 1500 records of other species including 4 species of reptiles and 11 species of mammals. Where possible we used site context and data to interpret tunnel usage at a population level. We used generalised linear models to understand the relationship between amphibian success rate during tunnel crossing, specie, life stage and season. A large percentage of all amphibian observations did not result in a full crossing but rather in/out movement at one tunnel entrance and this percentage varied significantly with species, site and season. There were substantial differences between speed of travel inside the mitigation system by different amphibian species, with common frogs (Rana temporaria) typically the fastest. Juveniles of some amphibian species, especially common frogs and common toads (Bufo bufo), used the tunnels almost exclusively during the day compared to newt species which were entirely nocturnal, suggesting important differences in road traffic impacts on juveniles in unmitigated sites. Overall, road mitigation appeared significantly more successful for some species than others at different sites. Crossing success rates were very poor for some reptile species but not others. Effectiveness in maintaining habitat connectivity needs to be evaluated carefully at species level rather than in large taxonomic groups. Automated passive monitoring systems such as our timelapse camera systems can gather highly detailed data over long periods of time in a cost-effective manner and can transform our knowledge of road mitigation efficacy.

## Talk- 2.12

### Infrastructure, amphibians and reptiles (special tribute to Miklos Puky)

# Amphibians and land transport infrastructure: from land management to ecological engineering.

**Author(s):** Alain Morand, Jean Carsignol

**Contact:** Alain Morand, Cerema - Dt Est 1, boulevard Solidarité - BP 85230 - 57076 Metz Cedex 03

**E-mail:** alain.morand@cerema.fr

Linear land transport infrastructure can impact amphibians in different ways, either directly (loss and fragmentation of habitat, crushing,) or indirectly (habitat degradation by chemical or noise pollution, changing landscapes, reduction of genetic diversity). This presentation details the services provided to humans by amphibians species, who are nevertheless under threats. It describes the main biological traits necessary for the implementation of effective protection measures in new project impact studies or modernization of existing infrastructure. It is illustrated by the French experience on amphibian crossings, dedicated to reduce the impact of ground transportation networks (road and rail) on these protected species. Often invisible to motorists, hundreds of amphibian crossings have been built over the past three decades in France. Others are in the planning stage. These infrastructures, which result from cheap, ingenious DIY (do it yourself) by self-motivated volunteers, or cost sometimes hundreds of thousands of euros while involving the state, different public corporation and nature protection associations, belong to the history of road ecology. They have been through considerable changes, from specific two-way «amphibian» tunnels, to one way and small wildlife passages used by a greater number of species. Many questions still arise from the elaboration of new projects, especially when it comes to the modernization of existing roads, or the assessment of the effectiveness of these structures. This presentation aims at shedding a new light on some issues that have found no clear answers and solutions so far. The comparative analysis of 30 years of experience and study questions conservation ecologists and road engineers : What are the amphibian species that benefit from these environmental engineering actions? How does the system affect population viability ? Will it systematically be followed up, and if so, what are the nature and duration of such follow-up? What are the studies able to assess the effectiveness of these infrastructures (tunnels, fences and rescues) ? Are there any functional differences depending on the size and shape of the crossings devices? What are the possibilities for innovation and the opportunities offered by the use synthetic materials, recyclable or not? What is the social acceptance of these devices, which are sometimes considerably costly? Thanks to the collaboration between road managers and scientific partners working on these issues (in behavioral ecology and / or population dynamics), are we now able to offer reproducible, effective and affordable solutions to respond to situations emerging from new projects or resulting from the modernization of existing infrastructure?

## Talk- 2.12

### Infrastructure, amphibians and reptiles (special tribute to Miklos Puky)

# Intelligent systems for mapping amphibian roadkills

**Author(s):** Neftali Sillero, Marc Franch, Cristiano Silva, Gil Lopes, Fernando Ribeiro, Paulo Trigueiros, Luís Seco

**Contact:** Neftali Sillero, CICGE, Centro de Investigação em Ciências Geo-Espaciais / Faculdade de Ciências da Universidade do Porto

**E-mail:** neftali.sillero@gmail.com

Roads have multiple effects on wildlife, from animal mortality, habitat and population fragmentation, to modification of animal reproductive behaviour. Amphibians in particular, due to their activity patterns, population structure, and preferred habitats, are strongly affected by traffic intensity and road density. Monitoring road-kills is expensive and time consuming, and depend mainly on volunteers. Thus, cheap, easy to implement, and automatic methods for detecting road-kills over larger areas and along time are necessary. We present results from the research project Roadkills, a cheap and efficient system for detecting amphibians road-kills using computer vision techniques from robotics. We propose two different solutions: 1) a Mobile Mapping System to detect automatically amphibians' road-kills in roads, and 2) a Fixed Detection System to monitor automatically road-kills in a particular road place during a long time. The first system detects and locates road-kills through the automatic classification of road surface images taken from a linear camera installed in a trailer with a standalone power generation, an imaging recording computer, an accurate GPS receiver, and a linear standardised lighting. The linear camera has an optical resolution between 250 µm/pixel at 35 km/h, 500 µm/pixel at 70 km/h and 1000 µm/pixel at 140 km/h. The camera acquire sequential images of 4096 pixels width and 1 pixel length (approx. 1.0 m x 0.25 mm). The fixed system consists on a standalone tower which captures a section of a road and allows close-up snapshots of instances moving along that section of the road. The tower is easy to setup and it is energetically autonomous to provide long runs without human intervention or mains powering. Both Fixed and Mobile system use similar software, based on robotic computer vision techniques such as object recognition or structure from motion. The algorithms are trained with existing data from pictures of roadkilled amphibians. We have tested several solutions for classifying the images: SIFT (Scale-Invariant Feature Transform), SURF (Speeded Up Robust Features), BRIEF (Binary Robust Independent Elementary Features), ORB (Oriented and Rotated BRIEF), and Haar Cascade, which provided the best results. All algorithms are implemented in the OpenCV library. Both systems were developed using low cost components with the idea of saving funds, time and personal resources for wildlife preservation.

## Talk- 2.12

### Infrastructure, amphibians and reptiles (special tribute to Miklos Puky)

# Motorway and road edges as amphibian, reptile and small mammal habitats in Hungary

**Author(s):** Blanka Gál, János Farkas, Ferenc Kádár, András Weiperth, Miklós Puky†, Balázs Kiss

**Contact:** Blanka Gál, Doctoral School of Environmental Sciences, Eötvös Loránd University, 1117 Budapest, Pázmány Péter sétány 1/C

**E-mail:** galblankaa@gmail.com

Most biological studies on linear infrastructures focus on fragmentation, road kills, invasion by exotic species, effect of air, noise and chemical pollution on animal behaviour or the effect of preventing measures. Relatively little attention is given to the habitat function of road, motorway, railway and channel verges, even if the extension of these areas increases yearly. To collect information on this aspect of linear infrastructures, the presence and relative abundances of species within different taxonomic groups was investigated in the framework of a complex several year- long study on native and invasive arthropod pest and their natural predators (amphibians, reptiles, small mammals) along four Hungarian motorways, three roads and the ring-road around Budapest. The presentation summarises results of the arthropods's vertebrate predators of three research seasons on motorways verges between 2011-2013, and three research seasons on road verges between 2014-2015. The traps operated 3x3 weeks in April- May, July, September- October annually, on the motorways was 6-6 traps per each site (33 in total) and on the roads was 15 traps per each sites (4 in total). Amphibians (newts, frogs and toads), reptiles (lizards) and small mammals were found in all sampling sites. Seven amphibian, five reptile and three mammal species were caught in the projects including taxa listed in Annex II of the Habitats Directive (Triturus dobrogicus, Bombina bombina, Crocidura leucodon). Pelobates fuscus was the most common species in the traps, representing 75% of amphibian captures while the most common reptile species was the common wall lizard (Podarcis muralis) with 44% of the reptile captures. The surrounding habitats had a key role in determining species composition of the sites along the different types of roads. For example the Lissotriton vulgaris was only collected at one site (Hajdúnánás), which was the only sampling site near a permanent water body. Other amphibian species were regularly occurring near periodic water bodies. Anguis fragilis was only found at the forest edge site (Letenye), while shrew and mouse species were found near the grasslands. Not only the number of amphibians, but also the number of reptiles and mammals increased in the wet year 2011, and 2013 along the sampling site of Motorways. In road verges similar trends were observed. Though sites adjacent to motorway and road are highly polluted, only one deformed amphibian individual (Pelobates fuscus) was found during the research projects. The researches were managed by MTA Centre for Agricultural Research and MTA Centre for Ecological Research. The project was supported by the K75889 and K83829 grants of the Hungarian Research Fund.

## Talk- 2.12

### Infrastructure, amphibians and reptiles (special tribute to Miklos Puky)

# Roads and Ecological Infrastructure: Concepts and Applications for Small Animals

**Author(s):** Kimberly Marie Andrews, Priya Nanjappa, Seth P. D. Riley

**Contact:** Kimberly Andrews, University of Georgia and Jekyll Island Authority

**E-mail:** andrews@srel.uga.edu

**URL:** http://wildlifelab.wix.com/jekyllresearch#!kimberly-andrews/c428

Imagine that one day, as you were driving to the grocery store, you found that there was now a minefield across the main road. There is no way for you to get to the store without crossing the minefield. What would you do? Then, another day, a nice smooth bridge is built over the minefield. Your pathway is restored! This is the concept behind our new book, Roads and Ecological Infrastructure: Concepts and Applications for Small Animals. Because of public infrastructure, we are able to get back and forth from the grocery store, or from our homes and the places we go to have fun. For animals, this is ecological infrastructure – the basic habitat components and their connections necessary for species survival, and for natural populations, communities, and ecosystems to function properly. Small animals in particular are considered low profile on roads for several reasons. Small animals are less visually obvious to drivers and pose a reduced risk in terms of human safety and economic property damage. They are more vulnerable to being struck on the road, and it is also less apparent when they are declining in populations. Further, wildlife taxa, such as snakes, are not popular in today's society and do not raise public concern to the same extent as large vertebrates when there are elevated road effects. Best practices for design and mitigation are sorely needed. Our book attempts to address these needs, and describes and recommends considerations for planning, mitigation, and enhancement of existing structures. It encompasses the suite of both direct and indirect effects of roads on small animals with attention to minimizing costs and conflicts while maximizing connectivity and natural ecological functions. The ecosystem perspective also allows for species groupings beyond taxonomic similarity and into habitat-based similarities or specializations. We also offer information on how transportation agencies operate and how road projects are funded, and how conservation practitioners can engage with these agencies. The book printed in spring 2015 by Johns Hopkins University Press as part of The Wildlife Society book series. Here, we will highlight examples of the book's content and how it can be applied to urbanization to better achieve long-term sustainability of wildlife populations. The presentation will include management results from these case studies and reflect on lessons learned from small vertebrate mitigation projects in both North America and Europe. In order to facilitate networking and available resources for current projects, we will highlight on-going global efforts that are attempting to tackle some of the challenges for which we have not yet developed solutions. To direct efficiency and application in transportation infrastructure planning and management, we will identify areas in need of ecological field investigation and validation of structure effectiveness.

## Talk- 2.13

### Global Carcass & Accident Reporting Systems

# The Evolution of Global Carcass & Accident Reporting Systems

**Author(s):** Fraser M Shilling

**Contact:** Fraser Shilling, Road Ecology Center, University of California Davis

**E-mail:** fmshilling@ucdavis.edu

**URL:** http://roadecology.ucdavis.edu

There are dozens of systems around the world for collecting observations of a few species, or all species of animals killed on roads. Large extent (territory or nation-scale) Carcass and/or Accident Reporting Systems (CARS) are becoming increasingly common. These range in complexity from the WAZE app that allows the recording of a roadkill with no identification, to records emailed to project managers, to combined phone app and web-system collection and management of data. Although the system developers and managers are increasingly in contact with each other, there has been little attempt to develop or use a standard format for:

1) field data collection,
2) metadata,
3) data organization,
4) data visualization,
5) data analysis,
6) data sharing, and
7) system administration/participation.

These systems have the ability to revolutionize the awareness of wildlife losses and risk to drivers from wildlife-vehicle collisions. Because of the extent, resolution, and taxonomic variety possible in the datasets from the systems, they have the potential for contributing to ecological studies at a wide range of extents. The systems seem to fall under a particular typology defined by classification of goals and objectives, methods of reporting, methods of visualization, types of metadata collected, and analytical outputs. The proposed session will explore this typology, using examples of CARS from around the world. These systems range considerably in their stage of evolution and use of particular technologies. Each paper in the proposed session will describe the evolution of their particular system to meet their stated goals and objectives, elucidate their methods of data collection, and discuss ways that the data collected can be analyzed and used to improve transportation systems. The primary goals of systems are: 1) to inform efforts to reduce risks to drivers; 2) reducing risks to wildlife from collisions; and 3) a combination of (1) and (2).

Minor, but increasingly important goals are: 1) to understand the role of avoidance of collisions with animals in resulting accidents; 2) long-term tracking of individual species presence/absence and species diversity; and 3) to involve people in scientific projects and wildlife conservation.

The primary methods of data collection include: 1) web-based forms, 2) smartphone apps, 3) manually processed, text-based reporting, and 4) collection of agency-collected data (e.g., carcass removal or crash data).

The primary data collected about an observation include: 1) location of observation/event, 2) date/time, 3) species or species group, 4) method of observation, 5) observer identity and affiliation, and 6) environmental/infrastructural conditions.

Most systems use some form of online mapping to report and visualize observations. This mapping is carried forward into analysis and reporting to agencies and the public. Participants in the session will come away with a greater understanding of the current state of knowledge and practice in global CARS. It is likely that they will have an improved ability to begin their own system in other regions, or to improve existing systems.

# Talk- 2.13

## Global Carcass & Accident Reporting Systems

## Next Generation of Carcass and Accident Reporting Systems

**Author(s):** Fraser M Shilling, David Paul Waetjen, Kathryn Harrold

**Contact:** Fraser Shilling, Road Ecology Center, University of California Davis

**E-mail:** fmshilling@ucdavis.edu

**URL**: http://roadecology.ucdavis.edu

Large-extent Carcass and Accident Reporting Systems (CARS) have a fairly typical set of goals and methods, which help in standardizing methods of data collection, analysis, visualization, and use in decision-making across systems. Most systems around the world collect carcass and/or crash data to increase the understanding of degree and geography of ecological impact, risks to drivers, placement and effectiveness of mitigation structures. Most systems also follow a common rubric for data collection of: where, when, what (species), who (observer), how, why and «other», where the latter category refers to characteristics of the roadway, habitat, or carcass. Most systems also use web-systems and databases to collect, store, and share mapped and tabular data. We report here on two major types of advancement in the collection and uses of CARS data.The California Roadkill Observation System (CROS, http://wildlifecrossing.net/california) uses a form-based data entry system to record observations of carcasses that result from wildlife-vehicle collisions (WVC). Operating since 2009, it currently (Jun, 2016) contains >1,200 users and ~50,000 observations of >400 species of ground-dwelling vertebrates and birds, making it one of the most successful examples of crowd-sourced, roadkill data collection. The system can be used directly on a smart-phone screen, via a browser, making an app unnecessary. We have used data from this system to determine locations of high-density and/or statistically-significant clustering of WVC. These hotspots are potential locations for mitigation actions to reduce risks to drivers and wildlife. We have also used the data to inform two ecological studies: a state-wide study of mammal invasion and assessment of the ability of landscape «linkages» models to predict wildlife movement. Finally, volunteer-observers are carrying out studies to help us estimate total roadkill impact on species: collecting observations on transect roads and re-observing roadkill to estimate disappearance rates of carcasses from roads.The newer California Highway Incident Processing System (CHIPS) scrapes publicly-available crash reports from the California Highway Patrol (CHP) incident website and stores them in a local database. The user can query and tag incidents for involvement of animals, type of accident (e.g., collision vs. avoidance), and outcome of accidents for driver and animal. After 11 months (Feb, 2015 - Jan, 2016), there were 1.23 million total crash records in the system, with ~8 incidents/day involving mule deer. About 1/3 of these resulted in the deer getting injured, but not dying immediately. A similar proportion involved a vehicle swerving to avoid an animal in the road and subsequently crashing. These accidents were more likely to involve significant vehicle damage and injury than collisions with animals. Data from this system will be used to estimate significance of WVC avoidance as a type of human-wildlife conflict that threatens driver safety, to estimate injury and property damage rates from all types of crashes involving different animal species and vehicles, and to compare crash hotspots with carcass hotspots. Because the system operates in real-time, we are also investigating the possibility of a continuously updated smart-phone application or Twitter feed to inform drivers and others of animal-related safety issues on highways.The combination of crowd-sourced carcass data, agency-collected carcass data, and agency-reported crash data allows for a comprehensive and real-time view of human-wildlife conflict on roads. This means that the system provides decision-support from the individual driver scale to the state scale and from an historical perspective to what is happening right now.

## Talk- 2.13

### Global Carcass & Accident Reporting Systems

# Seeking roadkill data through public awareness, partnerships and citizen science

**Author(s):** Wendy Jane Collinson, Claire Patterson-Abrolat, Laura Goodman, Thandiwe Rakale, Miles le Roux, Charmaine van Wyk, Lizanne Roxburgh

**Contact:** Wendy Collinson, The Endangered Wildlife Trust

**E-mail:** wendyc@ewt.org.za

**URL:** https://www.ewt.org.za/

Roads are integral to the continued development and prosperity of South Africa's economy. However, roads also have the potential to destroy and degrade habitat, as well as fragment wildlife populations. Traffic, particularly when reckless driving is involved, can have a direct negative impact on wildlife, with many species at risk from wildlife-vehicle-collisions (WVCs), often resulting in an animal's death, or 'roadkill'. A relatively large body of international literature is available on mitigation measures to reduce conflict between road infrastructure and wildlife. However, few of these techniques have been tested for applicability to the species and situations found in South Africa, despite the country's legislative framework that necessitates environmental impact assessments for development. This is in part due to a lack of understanding of the impacts of road development on wildlife. The Endangered Wildlife Trust (EWT) has improved our understanding of the impacts of road infrastructure on wildlife in South Africa over the last six years. Through our work, we have been gathering WVC data from across the country by driving set routes and encouraging members of the public to submit data. In January 2014 we launched a national public awareness campaign to report WVC sightings. The campaign reached over 1,100 members (nationally and internationally) on the Road Ecology LinkedIn group, almost 800 members on the Road Ecology Facebook page and almost 250 followers on the EWTRoads Twitter account. In addition to this, a cellphone app called 'Road Watch' was launched to enable members of the public to assist with data collection. As a result of these WVC reporting platforms, almost 10,000 roadkill data points have been collected with the assistance of over 150 volunteers from across the country. From these data, we can identify problem species and sites, and develop and implement targeted measures to reduce wildlife-road-mortality. Apart from public engagement, we are also establishing partnerships with relevant stakeholders, such as the N3 Toll Concession and Bakwena N1/N4 Toll road agencies, to provide measures to reduce the impacts of roads on wildlife as well as expand on current public awareness roadkill campaigns. Through these partnerships, we provide training workshops for data collection and species identification, and capacitate road patrol teams, as well as members of the public, to record and submit roadkill sightings from across the country.

# Talk- 2.13

## Global Carcass & Accident Reporting Systems

# How many animals are really killed on highways

**Author(s):** Tatjana Gregorc, Marjana Hönigsfeld Adamič

**Contact:** Tatjana Gregorc, LUTRA, Institute for Conservation of Natural Heritage.

**E-mail:** tatjana@lutra.si

**URL:** http://www.lutra.si

The 23 km long section of the Motorway A5 Beltinci – Lendava (NE Slovenia) was brought into usage in August 2008. With the chosen variant of highway, the largest lowland forest of Alnus glutinosa (Črni log) in South Europe was intersected. Monitoring of road kills for mammals and birds was performed for three and two years respectively, in the period 2010 – 2012.

The method required by contracting authority (DARS, Motorway Company in the Republic of Slovenia) was constituted of counting of dead animals from a car driving with the minimal highway-speed of 60 km/h. During the monitoring period, 25 car surveys were carried out. Data on road kills of larger animals were also collected by highway maintenance service (ACB Murska Sobota), which is daily checking the highways three times; larger road kills (mainly mammals) are removed from the roadway at the same time.

Thanks to the project STOPJEZ, supported by Swiss NGO Fund, we were able to upgrade the methodology with eight (4 pairs) of extra surveys of highway sub-section (7.9 km) by foot (from April 2011 till January 2012). Mainly, we have found bird victims. Two surveys were carried out in April (early nesting period and spring migration), two surveys in June (late nesting period and spring migration), two surveys in late summer (end of August and beginning of September - autumn migration and dispersion of offspring) and two in January. The selected stretch included different habitats surrounding the highways (forest, scrubs, smaller streams and fields). On each survey, we first counted road kills from car. Later on, we counted road kills by foot checking both sides of the highway including the wider green belt aside the road and middle belt, separating both driving lanes of the highway.

The results obtained according to different methods, differed significantly. In 25 car surveys of the whole stretch (23 km) of the highway, we found 104 mammal road kills from 18 different taxa and 261 bird road kills (only 49 Passeriformes). Additionally, Highway maintenance service found 54 mammal road kills belonging to10 taxa and 75 bird victims belonging to 10 taxa. In 8 surveys done by foot on selected stretch (7.9 km) of the highway we found 346 bird road kills (203 Passeriformes, 108 non-Passeriformes, 35 unidentified) and 205 mammal road kills.

With additional surveys done by foot we have proved that method required by contracting authority reveals only small part of road kills and is therefore unsuitable for detecting animals bumped of the road and smaller animals like birds, bats and other small mammals. With surveying by car, only 12,86% of road kills were recorded in comparison with alternative “by foot” method.

Using the method of removing of cadavers and repeating the survey after 7 days we established the average number of killed birds on 7,9 km long section and the whole 23 km long stretch of highway: 30 individuals per week and app. 5800 per year respectively.

# Talk- 2.13

## Global Carcass & Accident Reporting Systems

# Carcass Removal and Detectability: Reducing the Uncertainty Surrounding Wildlife-Vehicle Collision Surveys

**Author(s):** Rodrigo Augusto Lima Santos, Sarah Maria Santos, Fernando Ascensão

**Contact:** Rodrigo Augusto Santos, Universidade de Brasília - UnB IBRAM - Instituto Brasília Ambiental

**E-mail:** rodrigosaantos@gmail.com

Wildlife-vehicle collisions (WVC) are recognized as an important source of non-natural animal mortality. To accurately quantify this impact, two main sources of uncertainty have to be accounted for: carcass persistence time and carcass detectability. In this study, we evaluate the influence of these uncertainties on roadkill surveys. We expect the size of the carcass, road type and traffic, the probability of occurrence of scavengers in the roads' vicinity, and weather conditions to be the main drivers of carcass removal, but their relative importance was unknown. To estimate carcass persistence time, we conducted road surveys on a monthly basis, for two years. Each survey consisted of five consecutive days, during which three observers searched for WVC by car. To estimate carcass detectability, we randomly selected stretches of 500 m to be additionally surveyed on foot by two other observers (total 292 walked stretches). Overall, we recorded low persistence times (median one day) and low detectability (<10%) for all vertebrates. The results suggest that body size and probability of scavenger occurrence are the major drivers of carcass removal. We estimated that our recorded mortality rates underestimated actual values 3-10 fold. Although persistence times were similar to previous studies, the detectability rates described here and those of previous studies were very dissimilar. We suggest that detectability is the main source of bias across WVC studies and, therefore, more than persistence times, studies should carefully account for differing detectability when comparing WVC studies. This study is of interest for road managers and researchers aiming to better understand the impacts of WVC on biodiversity.

## Talk- 2.13

### Global Carcass & Accident Reporting Systems

# U. S. Rocky Mountain States' Use of Wildlife Vehicle Collision Carcass Data to Plan for Wildlife Mitigation

**Author(s):** Patricia C Cramer

**Contact:** Patricia Cramer, Utah State University

**E-mail:** cramerwildlife@gmail.com

The collection of accurate wildlife-vehicle collision (WVC) carcass data is a critical part of planning processes for developing priority wildlife mitigation efforts. In western U.S. states in the Rocky Mountains, the collection of these carcass data is becoming standardized and incorporated into transportation planning. This paper presents the results of several transportation agency-funded studies in the U.S. where the objectives were to help reduce WVC through the collection and synthesis of such data. In Idaho the researchers created a WVC mitigation prioritization process to standardize how locations for future mitigation were objectively selected. In Utah, a smartphone app was created and is used to locate top priority WVC locations. In South Dakota, a Department of Transportation study used WVC crash and carcass data to help identify top WVC locations and and to identify the needed improvements for future data collection. During these studies the researchers learned how other jurisdictions collected and used carcass data.

Results from these studies demonstrated that: 1. If the carcass data are not collected accurately and systematically across a state, the data cannot be used in making systemic transportation decisions; 2. When the data collection is accurate, robust, and standardized, agencies use the carcass data to document the extent of the WVC problem and to help justify their actions; and 3.When carcass data are systematically collected, a conversion factor of carcasses to reported collisions can be estimated to help establish a more true estimate of the number of animals killed, and thus help place a monetary value on the magnitude of the problem. An ancillary result of the studies was that agency professionals in regions within a state with lower WVC carcass reporting effort came to realize that future funding for mitigation was tied to data that their regions did not have, thus disqualifying them for receiving potential funding.

Our team found there were seven basic steps to helping reduce WVC with data: 1. Compile accurate WVC crash and carcass data; 2. Map WVC crash and possibly carcass data; 3. Integrate wildlife agency wildlife habitat and linkage maps into transportation planning; 4. Evaluate the potential mitigation action choices; 5. Perform benefit-cost analyses on mitigation options; 6. Standardize regular interactions between transportation and wildlife agencies; and 7.

Create a statewide process to objectively prioritize locations for mitigation. In conclusion, our studies found that states with standardized WVC carcass collection systematically used the data to make decisions on where to mitigate roads for wildlife, and other states were working toward this goal. The results of these studies build on one another, as each state learns of what others are accomplishing with carcass and other data collected. The presentation of the series of steps and the longer term steps along this continuum of actions will help other international efforts to evaluate how far each effort needs to progress to best incorporate carcass data into decision-making for transportation.

## Talk- 2.14

### Systematic reviews and maps: transport infrastructure - perspectives and challenges

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

**Author(s):** Arzhvael Jeusset, Romain Sordello, Yves Bertheau, Aurélie Coulon, Marianne Vargac, Julien Touroult, Sylvie Vanpeene, Hervé Jactel, Isabelle Witté, Nadine Deniaud, Frédérique Flamerie, Emmanuel Jaslier, Véronique Roy, Eric Guinard, Eric Le Mitouard, Patric

**Contact:** Arzhvael Jeusset, Service du Patrimoine Naturel Muséum national d'Histoire naturelle 36 rue Geoffroy Saint-Hilaire - CP 41 75231 Paris cedex 05

**E-mail:** arzhvael.jeusset@mnhn.fr

**URL:** http://cohnecsit.mnhn.fr/

Background: The role of linear transportation infrastructures (roads, railways, oil and gas pipelines, power lines, rivers and canals) in fragmenting natural habitats has been demonstrated. Yet, the potential of habitat or corridor of their verges (road and railway embankments, strips of grass under power lines or above buried pipelines, or waterway banks) for biodiversity remains controversial. In a context of decreasing natural habitats, the potential of anthropogenic areas for contributing to wildlife conservation should be considered. Here, we will present a systematic review on the potential of linear transportation infrastructure verges as corridor and/or habitat for insects in temperate landscapes. A systematic review is a methodology of evidence synthesis, which consists in collecting, screening, appraising and synthesizing all available evidence on a subject. Methods: Searches for literature were made using an online publication database, a search engine and by sending a call for literature to subject experts. Search terms were developed in English. Identified articles were screened for relevance based on titles, abstracts and full texts using inclusion criteria detailed in an a priori protocol. Included articles were subject to critical appraisal of susceptibility to bias. A narrative synthesis of studies with low or medium susceptibility to bias was finally made. Results: Our searches identified over 45,000 articles about all biodiversity. During the successive screening stages, articles about non-insect species were put aside in order to comply with the time frame of the project. At the end of the screening stages, 165 articles about insect species remained relating to four specific synthesis questions. 140 of these articles relating to the two first synthesis questions are still being critically appraised. Of the 25 articles left relating to the two other synthesis questions, 11 were excluded during critical appraisal, leaving 14 included articles. This low number of articles did not allow to conduct a meta-analysis but a narrative synthesis was made. Conclusions: A knowledge gap was identified regarding the role of corridor of linear transportation infrastructure verges for insects. The effect of the surrounding landscape on insect diversity of verges seems to depend on the type of landscape and on the taxa considered. On these two specific synthesis questions more studies are hence needed, in order to allow for making meta-analysis and drawing more robust conclusions.

## Workshop- 2.14

### Systematic reviews and maps: transport infrastructure - perspectives and challenges

# Transport infrastructure : biodiversity vectors in urban areas ?

**Author(s):** Romain Fillon, Pierre Pech

**Contact:** Romain Fillon, Université Paris 1 Laboratoire LADYSS

**E-mail:** Romain.Fillon@me.com

Land transport infrastructure (ITT) are most often addressed as corridors undoubtedly having an impact on the landscape. While these incriminating negative linear effects are now well appreciated, studies on the potentially positive effects of ITT on biodiversity and the place and role they play on ecological corridors in urban areas are relatively marginal. This systematic review, constituted from the work and research findings extracted from the French and international literature, formalizes a commitment to progress in the knowledge of the interrelationships between linear infrastructure technical issues of different nature (railway, river, road, electricity and gas) and écopaysagères dimensions of urban areas crossed. Our results illustrate that transport infrastructure frequently involved in the decline of biodiversity can also have a positive impact on certain communities of flora and fauna species. However, the assessments until recently limited incorporate components of biodiversity often approach based on indicators constructed from the presence of species, usually of heritage interest, and not of the functionality of these habitats environments. Through this review, we provide ecologists, ITT managers and other stakeholders involved in the conservation or urban planning, a state of the art thinking on the benefits of proper management ITT in the consideration of biodiversity in urban environments.

# Workshop- 2.14

## Systematic reviews and maps: transport infrastructure - perspectives and challenges

## Systematic reviews and maps: transport infrastructure - perspectives and challenges

**Author(s):** Barbara Livoreil

**Contact:** Barbara Livoreil, Fondation pour la Recherche sur la Biodiversité

**E-mail:** barbara.livoreil@fondationbiodiversite.fr

**URL:** http://www.fondationbiodiversite.fr/en/

Systematic reviews aim at synthesizing evidence to answer a precise question aimed at implementing some actions. They critically appraise existing knowledge, examine causes for variability and heterogeneity of results, and highlight biases and confounding variables which can affect decision-making. This methodology is now developing in France in environmental management, and a systematic review is currently conducted within the CIL&B-ITTECOP-FRB programme by the National Museum of Natural History of Paris. The review team is going to present its work.

Les revues systématiques sont des synthèses de connaissances en réponse à une question précise posée à des fins d'action. Elles ont pour objectif une évaluation des résultats déjà obtenu, un examen des causes de variabilité, et la mise en lumière des biais et autres variables pouvant affecter les conclusions. Cette méthode se développe en France dans le domaine de la gestion environnementale et une revue systématique est menée actuellement dans le cadre du projet CIL&B-ITTECOP-FRB par le Museum National d'Histoire Naturelle de Paris, qui va vous être présentée ici.

# Poster Session 2

## Poster

# Ecologically stealth construction works » for the reinstatement of the corridor's functionality through an existing highway

**Author(s):** Labarraque Dorothee, Habasque Gilles

**Contact:** Labarraque Dorothee, Egis Structures et Environnement

**E-mail:** dorothee.labarraque@egis.fr

The 100 kms section of A63 highway in Aquitaine, South-West France is supporting a heavy traffic between Spain and Northern Europe.The bidirectional double lane widening works (undertaken between 2011 and 2013) was entrusted to concessionaire Atlandes with the requirement to improve environmental integration of the highway, particularly regarding ecological connectivity of wildlife corridors at a regional scale and quality of water resource. One of the project's main challenges was to reconnect the ecological corridors from either side of a busy highway. In its initial state, the highway was almost impassable for major species such as the European Otter, the European Pond turtle and migrating fishes such as Lamprey and Eels.The most efficient and standard ecological way to reestablish the connectivity is to install concrete ledges etc. via the existing bridges and culverts. However, these are reducing the hydraulic capacity of existing structures, which were already considered as under-sized for centennial storm events. Some structures had also waterfalls, making them particularly difficult to be crossed by aquatic fauna. In addition, the construction of concrete ledges along the existing culverts would generate severe issues since it requires the drying out and temporary diversion of the stream.The challenge was then to reinstate the ecological connectivity for small and semi-aquatic animals without negatively affecting the hydraulic capacity of the existing structure and limit impacts induced by the construction works to the minimum .Egis developed the "ecologically stealth construction work" concept for stream/river with the collaboration of a construction company (Colas), by :1 - Installation of wooden ledges, designed for use by small and semi-aquatic animals (otter, mink…), adapted to the biological needs of the species : stepped ledges, made of wood, are fixed to the structure with non-rusting metal brackets. This set-up has been confirmed as useful in terms of :- ecology : no interruption to the flow of water, no need to pour concrete and no suspended material diffusion…,- hydraulic ; flow capacity roughly preserved,- construction; faster and economic since the lightweight materials was easy to move and quick to install in a few days by boat or on foot without significant disturbance within the stream bed.2 - Installation of water flow control systems at the impassable waterfalls to stimulate the ascent and descent of migrating Lamprey and Eels with strong involvement of the National Rivers Authority in France (ONEMA).3 - Protection fence and signage to preserve the protected water-born plant communities during works.The post-construction monitoring showed that for 3 years the culverts have been regularly used by fauna, noticeably by semi-aquatic mammals. The wooden ledges have been resistant despite many heavy floods.The "ecologically stealth construction work" resulted in minimal perturbation to the stream or waterway and to wildlife during the construction period, a period which is normally the most sensitive. The concept produced satisfying results regarding the upgrade of the ecological corridor functionality, truly documented by photo traps monitoring.

## Poster Session 2

### Poster

# An International Comparison of AVC Clustering Patterns on Roads

**Author(s):** Michal Bíl

**Contact:** Michal Bíl, CDV - Transport Research Centre

**E-mail:** michal.bil@cdv.cz

We present a comparison of animal-vehicle collision patterns which we have computed for selected roads in several countries (e. g. Poland, Finland, France, Hungary, Italy, Slovakia, Spain, Sweden and the USA). We used the KDE+ method for objective identification of dangerous locations (hotspots, clusters). Application of the KDE+ method returns AVC divided into two groups: within a cluster and outside the cluster. Collisions within the clusters were predominantly caused by local factors directly connected to the location of the cluster (the parameters of the road and its closest vicinity). Collisions outside of the clusters were more likely induced by global factors (e. g. the time of day, regional weather). The data from national or local AVC databases differed by a system of localization (GPS, linear stationing, other) and road network data. Various GIS approaches had to be, therefore, used to prepare the input files. The outcomes of these pilot studies with regard to the similarities and differences of the AVC patterns will be discussed.

# Poster Session 2

## Poster

# Ecological landscaping Development of Watercourse Crosssing Highway A89 France

**Author(s):** Cécile Dauriat

**Contact:** Cécile Dauriat, BIOTEC biologie appliquée

**E-mail:** cecile.dauriat@biotec.fr

**URL:** http://www.biotec.fr/index.html

The last stretch of the A89 highway between Lyon and Bordeaux has been launched in 2009 by ASF (Autoroutes du Sud de la France). This stretch, 80 kms long between Balbigny (Loire county) and la Tour de Salvagny (Rhone county), has been opened at the end 2012. Within the Rhone region between Violay (42) and Tour de Salvagny (69), the A89 intercepts 16 streams. At every stream crossing, a watercourse diversion has been implemented .Then ecological restoration and environmental integration measures have always been carried out on the river parts impacted by the works. The implementation of technical measures has mainly taken into account the longitudinal profile of the diverted segments of watercourses, the flow type and the hydraulic regime of the streams as well as their geomorphological and ecological conditions. Moreover the constraints relative to river development can be listed as follows: Comply with the course of the river and slopes of watercourses required by the location of the hydraulic structures and properties required by the highway construction Keep the hydraulic capacities of the diverted river resulting from the hydraulic studies linked with the A89 construction project. Check the flow speeds and stabilize the longitudinal profile of the watercourses in order to reduce the risk of potential regressive erosion and lateral erosion near hydraulic structures. Promote an environmental restoration of high quality while preserving ecological continuity. Every watercourse has benefited of a specific development project well adapted to his intrinsic physical and ecological characteristics. In each case, the implemented techniques were as follows: Temporary diversion of the watercourse and construction of an hydraulic structureEarthmoving of the new river bed according to a sectional profile matching the various natural formations seen on the sections free of worksPossible stabilization of the watercourse longitudinal profile by installing rip rap structuresReconstitution of an alluvial soil by bringing biogenic materials with a well-fitted granulometryReshaping of the riverbanks and spreading topsoil. Possible stabilization of the riverbanks bottom by using bioengineering techniques, such as planting well-suited native species with ramified dead and living branches. Covering the riverbanks with a biodegradable coir geotextile canvas, seeding and planting some willow stem cuttings and bushes consisting of well-suited native species. Since the achievement in 2011, the follow-up of the landscaping developments by the various technical stakeholders, mainly the Federation de Pêche du Rhône (Fishing Federation)has shown that all the techniques implemented have limited the impacts due to the infrastructure and preserved the ecological continuity on each crossed streams. These promising results have shown a high level of commitment and have been carried out thanks to the involvement of a project manager specialized in ecological landscaping development and stream restoration from the design phase until the completion.This early involvement has ensured a positive cooperation with the technical and administrative units and has allowed the concern about river-crossings to be considered as one of the main features of the motorway project

# Poster Session 2

## Poster

# A integrated mapping tool for harmonizing ecological assessment and transport infrastructure planning

**Author(s):** Pierre Jorcin, Benjamin Allegrini, Olivier Peyre

**Contact:** Pierre Jorcin, Naturalia-Environnement

**E-mail:** p.jorcin@naturalia-environnement.fr

**URL:** http://www.naturalia-environnement.fr/

Effective transport infrastructure planning along with conservation of high ecological value areas, depend mostly on conducting accurate and reliable ecological assessments, for minimizing the impacts of such projects. Producing a precise synthesis with a reliable computation of all ecological sensibilities on site requires a scientific evaluation free from individual and subjective point of view, leading too often to questionable conclusions. In most biodiversity reports, evaluation grids remain user defined on case by case basis, and these approaches are not able to generate integrated reports from a set of spatial variables, especially for areas with high data density. Naturalia-Environnement has developed a software application for accurately ranking nature conservation areas using the official European classification references. The project described in this presentation proposes a model using geospatial parameters to create indices of ranked ecological concerns for every patch of wildlife habitats crossed by transport infrastructure. The software uses quantitative and qualitative observations made over small landscape units to compile data and classify results through calibrated indices. The core application is a spatial data aggregation formula, where large data inputs such as habitat profile and multiple occurrences of protected flora and fauna are processed together in relation to the attribution of numeric coefficients. The system is built to provide ranked values for every taxon, apply conditional weighting factors, and calculate a cumulative index corresponding to the status of each individual habitat patch. By applying a spatial data aggregation formula to a set of input variables, the model can produce detailed maps of ranked ecological concerns, while using calculation rules respecting the underlying concepts in biodiversity resource evaluation. The process follows a standardization and mathematical approach in order to be applied consistently when used by different people, and facilitate a balanced comparison among different territories. The traceability of the results is an inbuilt advantage of such model. The replicability of the method is ensured by the reference made to protection status lists from the International Union for Conservation of Nature (UICN), the French Natural Heritage National Inventory (INPN), and the European Nature Information System (EUNIS). This application provides an effective and efficient operational tool that is easy to put in place, thus allowing infrastructure planning to meet conservation planning. It delivers the foundation to identify project layouts and alternatives routes that will minimize the negative impacts to the environment.

## Poster Session 2

### Poster

# Landscape-change frequency and land-use dynamics around High-speed railway (HSR) projects at large scale: diffuse impacts on biodiversity and their mitigation

**Author(s):** Jean-Marc Foures, Pierre Pech

**Contact:** Jean-Marc Foures, Paris 1 Pantheon Sorbonne University Ladyss - UMR CNRS 7533

**E-mail:** jean-marc.foures@univ-paris1.fr

Land transport infrastructure (LTI) projects, such as HSR projects, produce numerous impacts on biodiversity at many scale-levels throughout their development (land-buying, construction, exploitation etc.), and both strategic-impact studies and the scientific literature already show impacts at fine scale: roadkill, pollutions, barrier-effects etc. Models have been developed through geomatics to evaluate the diffusion of direct, indirect, cumulative or induced LTI impacts: some of them conclude that global landscape change may impact biodiversity, others that the barrier-effect e.g. should be observed till more than ten kilometres right of the line –depending on what species is impacted. It is chosen to analyse land-use dynamics in such spatial areas around HSRs, in a suburban-rural context, from the 47 land-use-types digital map Mode d'occupation du sol d'Île-de-France (Mos-IdF) realised regularly for seven times between 1982 and 2012 in the Paris region (France). Methodology consists, according to distances of impact diffusion observed in the scientific literature, in calculating the frequency-of-change for each landscape patch in 5100m both-sides buffer-areas (except a thousand meters-large central strip) around HSRs, among six potential changes (seven observations) given by the Mos-IdF within thirty years. Average landscape-change frequency is then calculated for groups of patches selected by their «type» of land-use. Landscape-change frequencies at such «land-use» scale are finally compared to the age of closest HSR. Land-use type at patch level is defined as the most-frequent-in-time type among the seven regularly interspaced mappings. With help of spatial-join and distance tools, the age of HSR, that every landscape patch is closest to, is integrated to data, aswell as the distance (meters) of every patch to its nearest HSR. Geographic information system (GIS) and statistic softwares (ArcGIS™, Excel™) are used in this study.Results show very few variations for landscape-change frequency at near or far distance from HSR. They also show some variations between single project areas and areas impacted by two different projects. In detail, two results can be observed. 1/ Frequency tends to decrease for some land-use types (greenhouse, glade, vacant land or logistic warehouse) according to the seniority of the closest HSR. 2/ On the contrary, frequency tends to increase for some other types (orchard, home garden, suburbanization or store) according to the seniority of closest HSR. These results suggest that HSR projects would tend to «fix» some land-use types in their surrounding landscape, while they would «mobilize» other types within the landscape change, so that they may impact diffusely biodiversity.The willing interest of our study is to show how watching landscape diffuse change (in frequency; on fixed geometry) and dominant-over-time land-uses may help mitigating HSR impacts at long-term on biodiversity.

## Poster Session 2

### Poster

# Functional connectivity of biodiversity across an accumulation of large-scale transportation infrastructures in the South-West of France

**Author(s):** Jonathan Remon, Sylvain Moulherat

**Contact:** Jonathan Remon, TerrOïko ; SEEM-CNRS

**E-mail:** jonathan.remon@terroiko.fr

**URL:** http://www.terroiko.fr/

Large-scale Transportation Infrastructures (LTIs) influence the biological functioning of ecosystems by modifying gene flow across landscapes. LTIs can have different effects depending on the type of infrastructure, species under study and the landscape structure. Most studies estimate the effects of one single LTI because measuring the real impact of several LTIs is hard to achieve (cumulative effects), especially when several species are followed. Recently, thanks to the development of landscape ecology and the growth of computing possibilities, there is a multiplication of modeling tools which are very useful to quantify the effects of LTIs. However, most of these tools were neither confirmed with empirical data neither applied to LTIs issues. In this context, the goal of our study is to compare the capacity of different modeling tools to evaluate correctly the effects of several LTIs on four common and abundant species with different mobility capacities (an amphibian, a snake, a butterfly and a ground beetle). Five different cumulative LTIs parallel to each other were studied in a 240km² limestone Causse study site dominated by dry grasslands, forests and agricultural lands in the South-West of France. Species were monitored, throughout this landscape in 2015 and 2016. Empirical data were obtained with genetic tools (microsatellite primers) completed with mark-recapture studies. Aims of the project will be presented as well as preliminary mark-recapture results for the butterfly Maniola jurtina and the amphibian Alytes obstetricans. The effects of LTIs on the functional connectivity of these species will be discussed.

# Poster Session 2

## Poster

# New tools for Motorway assessment

**Author(s):** Gaia Sgaramella

**Contact:** Gaia Sgaramella, University of Trento

**E-mail:** gaia.sgaramella@gmail.com

Nowadays in the general vision of the environmental analysis process, infrastructures, especially roads, affect negatively on the landscape. In particular, negative impacts are highlighted in connection with natural landscape through air, soil and water pollution, as well as the territorial fragmentation. The latter in addition to not ensure the continuity of ecosystems, causes the wildlife's death on the roads. The impact of a big infrastructure threatens to damage the value of local landscapes. Above all, actual policies do not take into account the potential for thinking infrastructure in a different way. The motorway should no longer be just a closed tube that creates more or less fast connections between far places, but a settlement material that is an organic part of a dynamic habitation conditions (M. Ricci, 2012). In this frame, the research Reinventing A22 promoted by Autostrada del Brennero S.p.a. and developed by University of Trento, focused on the concept of motorway like a backbone that holds together a fragmented, dispersive urban structure, and like an osmotic surface that absorbs everything around itself. In this way it is created a relationship between contexts and elements nearest Motorway's paths. Today the research is carrying on following this concept. The idea is to design osmotic devices that can establish a one-to-one energetic and functional relationship with the contexts such as noise barriers, over and underpasses, rest areas and toll booths. In order to achieve this deliverable the research define a new analytical tool, in particular an index useful to evaluated the design action in a preliminary step of the project. In Soil Bioengineering and Road Ecology, mitigation's and offsetting tools are used widely to limit negative impacts caused by roads. This new index, besides to systematize these existent tactics, analyzes motorway's network in order to take advantage of its potentialities. It could be done imagining motorways differently, reflecting on their metabolism, their function, their structure and internal organization, as if they were ecosystems. Exactly as an ecosystem, or rather as a techno-ecosystem (Naveh, 1983), motorway could exploit its structural, metabolic and morphologic potential to provide energy, ecosystem and functional services to contexts it passes through. Starting from this point, the future design process will aim to maximize the use of this wherewithal, based on the new evaluation index, which will drive the next strategic and tactical choices. The index will help the design and planning process along the large existing infrastructure to be more sustainable, besides to open up to new prospective for the use of residual, dross and functional spaces that make up the motorway's system. For this reason, imaging a motorway not only safe and smooth with petrol station of environmentally friendly fuels, the landscape planning and design must also work for an infrastructure as resource for surrounding territories and tool of landscape enhancement.

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# Poster Session 2

## Poster

## Abandoned tunnels as habitats for bats and measures to improve habitat quality

**Author(s):** Thomas Schuh

**Contact:** Thomas Schuh, ÖBB-Infrastructure Inc. Praterstern 3 1020 Vienna Austria

**E-mail:** thomas.schuh2@oebb.at

Scientific investigation of the use of abondened railway tunnels as a habitat for bats.A total of twelve tunnels at the Tauernbahn railway line in Carinthia, Austria, were abandoned due to a relocation of the main tracks. As part of the ÖBB initiative “Green Points”, a project was launched to investigate the role of the tunnels as habitat for bats. Furthermore, measures for improving their habitat quality for bats were planned and put into action. To obtain information about temperature and humidity conditions, we placed data loggers in some of the tunnels. Different bat species have different temperature requirements for their hibernation, so detailed knowledge about temperature range and fluctuations is of great importance. The present use of the tunnels by hibernating bats was checked visually during the winter months. We were, however, also interested to find out if bats use the tunnels during summer. Therefore, we used automated recording devices for the recording of bat calls as well as mist netting. So far, six bat species were registered in the tunnels: Lesser horseshoe bat (Rhinolophus hipposideros), Natterers’ bat (Myotis nattereri), Mouse-eared bat (Myotis myotis), Common pipistrelle (Pipistrellus pipistrellus), Barbastelle (Barbastella barbastellus) and a species of the genus Plecotus. Based on the first results, conservation measures were applied: We made sure, i) that the tunnel entrances allow bats access and support the microclimatic conditions aimed for in the different tunnels, ii) that human disturbances in the tunnels are minimized, and iii) that hollow concrete blocks were placed in the tunnels to increase the number of available crevices for bats. The effectiveness of these measures and the population trend of the bats will be monitored in the oncoming years. Thus, the results will provide important guidelines for the improvement of abandoned tunnels as habitats for bats.

## Poster Session 2

### Poster

# Do animals use wildlife crossings in the Netherlands? An analysis of 450 crossing structures

**Author(s):** Gerard Smit, Jeroen Brandjes, Dimitri Emond, Dennis Wansink

**Contact:** Gerard Smit, Bureau Waardenburg

**E-mail**: g.f.j.smit@buwa.nl

In the Netherlands the total number of wildlife crossing structures for roads and waterways is estimated at 1725. An overview of the use of crossing types by animals is still lacking. When the use of crossing structures by animals is evaluated, it is done within the scope of the individual project. We carried out a meta-analysis of 45 field studies for assessing the target species that use crossing structures for mitigating the barrier effect of roads. The 45 field studies cover a total of more than 450 wildlife crossings, surveyed in a period of twenty years and including different types of wildlife crossings. Though in twenty years time different field methods are applied, all studies included methods for track registration. We assessed the minimum survey time for track surveys to detect 95% of the target species. We found that for practical reasons not all 45 studies meet the minimum survey time. Still the overall results for all 450 wildlife crossings are consistent enough to draw some general conclusions. Mammals and amphibians use a wide variety of wild life crossing structures. The average number of species that use Culverts with ledges is small, but only a few species avoid this type of crossing. As expected the average number of species that use Large wildlife tunnels is highest when compared with other type of underpasses. The frequency of animal usage (number of tracks) varies between crossing types and is strongly influenced by crossing dimensions, proximity to natural habitat and landscape type. We provide rule of thumbs for selecting the appropriate wildlife crossing for target species.

# Poster Session 2

## Poster

## Wildlife road kills in southeastern Brazil: A spatiotemporal analysis towards mitigation

**Author(s):** Carlos Henrique de Freitas, Eleonore Zulnara Freire Setz

**Contact:** Carlos de Freitas, University Center of Araxá - Minas Gerais

**E-mail:** biologiatg@uol.com.br

**URL:** http://www.uniaraxa.edu.br

Loss of wildlife due to road kills is a critical problem in South America that may lead to a decline in species populations and ultimately threaten biodiversity. In Brazil alone animal-vehicle collisions kill about 1.3 million vertebrates every day, making it crucial to develop studies that identify determinants of such mortalities. During 2007, we investigated the spatial and temporal factors of road kills on two connecting highways in southeastern Brazil. We conducted weekly surveys (60 km/h) by vehicle along 160 km of two connecting state highways (total n=8320 km), passing through Cerrado and Atlantic Forest biomes, seasonal forest, farms and urban areas. For each roadkill, we recorded coordinates (GPS), highway and roadside attributes (road design, topography, hard shoulder, constructions, vegetation and slope variables) as spatial determinants. To evaluate seasonality we applied analysis of variance combining monthly roadkill data in two treatments (dry cool versus rainy warm season). We performed logistic regression to investigate the relation of road kills to landscape and road attributes presence or absence. For multiple category variables (slope-design and topography), we used ANOVA with months as replicates. Additionally to evaluate spatial aggregation, a Ripley K-statistics simulation with a 95% confidence interval was applied. We recorded 615 road kills (3.84 roadkills. km-1.year-1): 57.8% birds (67 species), 23.7% mammals (23 species), 11.1% amphibians (four species), and 7.5% reptiles (20 species). There were proportionately more reptile road kills during the rainy season. Straight road stretches were associated with a doubling risk of roadkill ($p<0.001$) and vegetation with 26% increase ($p<0.05$). Road deaths were more frequent on straight/level stretches ($p<0.01$), and on straight/downhill stretches ($p<0.01$). In terms of topography, level ($p<0.01$) and hillside ($p<0.01$) road terrain was also associated with increased wildlife deaths. The aggregation size for all carcasses was within a 0-46 km radius (with a peak at 35 km); for amphibians it was 0-39 km and 46-97 km (62 km) related to water sources, 69-89 km for reptiles (70 km), 0-46 km for mammals (15 km) and 0-9 km for birds (3.5 km). The high number of road kills is closely related to traffic conditions such as speed and traffic intensity, and this is further affected by weather and roadside conditions, that favour animal presence. Results suggest that straight stretches of road that encourage high-speed traffic increase the likelihood of animal-vehicle collisions, especially where dense roadside vegetation may restrict drivers' vision. For mitigation, clearing roadside vegetation and installing speed reduction devices on straight stretches of road would likely reduce the number of wildlife deaths. Large extension of carcasses aggregation (0-97 Km) in four taxonomic categories turns inviable a specialized mitigation measure (e.g. wildlife fences). Therefore, on wildlife habitat cut by roads on level or sloping vegetated terrain, mitigation might entail the use of fences coupled with under or overpasses for wildlife crossing. The construction of new roads should follow the topography of the landscape and include the safety features mentioned above, to avoid wildlife loss to vehicle collisions.

## Poster Session 2

### Poster

# Multimodal platforms of transport and services. The logistic landscapes in Region Nord-Pas de Calais/France

**Author(s):** Fabrice Raffin

**Contact:** Fabrice Raffin, Université de Picardie Jules Verne Amiens - Paris 3 Sorbonne NouvelleSEA EUROPE Paris

**E-mail:** fbraffin@gmail.com

Substantial amounts of urban research aim to understand infracstructures and landscapes development via political decisions and planning, , real estate developers, inhabitants' struggles and involvement, spectacular operations, heritage, problems, etc. But in fact, using a socio-anthropological methodology, we have decided to consider, some invisible facts linked to what we call logistics activities. More precisely, the hypothesis we will present is that the economics of goods, their transportation from the production area to consumers, and what we call logistics, is today the most important key player in building a city and urban landscape. To say it another way: the action you do alone at your computer when you order a book or phone or any other goods online, is actually building a large part of a city today. This way globalized trade are fully localized in built areas, from a very locally scale, interacting with the entire metropolis, up to scale world. Most pertinently for the present discussion it should be noted that these infrastructure are generally located on the outer layers of metropolitan areas. These spaces of the logistic and the «commodity» component of transportation are seldom analyzed by social sciences. Yet, they would shape our cities and especially contemporary metropolises, on a large scale, drastically. It is at least the initial hypothesis of our work on the spaces of logistic which we have been carrying out in Nord Pas de Calais from two years, precisely around the Delta 3 multimodal and logistics Platform Delta 3 located in the urban community of Hénin-Carvin (CAHC) south of the metropolitan area of Lille. The frame of our problematization shares the same paradoxical conclusion: although 'huge and spectacular' the logistic spaces and those of transport, could go 'unnoticed' and "non-controversial". Thus, for the geographical area of our research, the recent arrival of the warehouses of 100 000 m² of the Amazon company, which we also take into account here, does of course give rise to an opportunistic media promotion in terms of economy and employment, but not in terms of spatial planning and territorial disruption. Not far from there, 2.5 km, the Delta 3 multimodal platform extends to nearly 300 000 m² and has never aroused outraged advertising. This is only the warehouses, the global infrastructure make a total of more than 2 km².

# Poster Session 2

## Poster

# Implementing measures to avoid wildlife-vehicle collisions and other environmental impacts in an old road inside a State Park in Brazil

**Author(s):** Juliana Moreno Pina, Camilo Fragoso Giorgi, Paul Joseph Dale

**Contact:** Juliana Pina, CETESB - São Paulo Environmental Agency

**E-mail:** julianampina@gmail.com

Nequinho Fogaça Road (SP-139), managed by the State Government, was built in 1942. Linking state and federal highways, it enables connection between coast and inland of São Paulo State, in a region that still preserves considerable amount of native forest remnants. The main characteristic of this unpaved two-lane road is to cross the Carlos Botelho State Park for about 33 kilometers. This park was established in 1982 in an area of 376 km², mostly occupied by Atlantic Forest. It has a high species richness and a high endemism level, as well as threatened and endangered species as southern-muriqui (Brachyteles arachoides), brown howler monkeys (Alouatta clamitans), vinegar-dog (Speothos venaticus), jaguar (Panthera onca), puma (Puma concolor), oncilla (Leopardus tigrinus) and tapir (Tapirus terrestris). In 2011, the paving and drainage project of the road was submitted to the São Paulo Environmental Agency (CETESB) for approval via an environmental impact assessment. In addition, this project was analyzed by a working group composed of members from the park, CETESB, Environmental State Secretariat, Transportation State Department and those responsible for the project. The purpose of the project was to improve Park visitation, State patrolling and traffic conditions. However, these improvements could result in a higher probability of wildlife-vehicles collision, due to an expected increase in traffic intensity and speed. Considering SP-139 route transverses steep slopes, with sharp turns and forest adjacent to the track, locational or structural changes were rejected, since they could entail in deforestation and fragmentation, besides being expensive. Furthermore, the Environmental Impact Statement (EIS) concluded that all road segment could be considered a hotspot to roadkill, since data indicated that animals cross the road at any point. In fact, it was observed that some species, like tapir, use SP-139 as a path, rather than just cross it. In this sense, mitigation measures put in place to prevent roadkill in SP-139, after paving, involved reduction of speed limit to 40km/h, 16 rope bridge overpasses, warning signs, programs of public orientation and education and temporary road closure in the evenings, from 8.00pm to 6.00am. Others measures, that it will be implemented in the next six months, include ten speed cameras and 15 speed bumps. In spite of the importance of all mitigation measures to reduce wildlife-vehicle collisions, the most important one was temporary road closure. This is evidenced in the fact that most animals are more active at night, including threatened species and large and medium size mammals, and also because visibility conditions are hampered by vegetation, lack of lightning and fog. Evaluation of mitigation measures will be based on the results of both roadkills and overpasses monitoring programs, which will also signal the need for additional measures. After two months of operation, public acceptance has been positive and Park visitation has increased. We believe that the creation of a forum for discussions (working group) as well as the articulation of different stakeholders were essential to implement concrete actions and measures to mitigate impacts on road SP-139, with special regard to temporary road closure.

# Poster Session 2

## Poster

# Practical aspects of the ecological management along highway and national roads motorway verges in Flanders (Belgium)

**Author(s):** Marleen Moelants, Andy Vankerckvoorde

**Contact:** Marleen Moelants, Flemish Government Agency for Roads and Traffic

**E-mail:** marleen.moelants@mow.vlaanderen.be

For several years verges of Flemish highways and National roads are managed to optimize their ecological function. The main function of verges is to be a safety strip for traffic. Traffic in Flanders is one the most dense of Europe. Therefor it is not always easy to adapt roadside management to the ecological goals. Management machinery has to be deployed very efficiently during low traffic periods. Specific regional legislation stipulates that the first mowing of verges has to be after June the 15th, a possible second mowing after September the 15th. This schedule however is not optimal for the different types of grasland or to improve their ecological quality. The legislation also specifies to remove the clippings within 10 days after mowing, which is rather difficult on steep slopes and other locations out of reach for heavy machinery. However these places can have a high ecological potential. In the past verges often were densely planted with trees. These plantations are now disrupting traffic and form a possible risk due to falling trees. Strict legislation prevents a simple improvement of this situation . Another problem is the presence of invasive alien species. Species such as Japanese knotweed (Fallopia japonica) should be treated separately from the normal mowing activities. To meet all these challenges, the Agency for Roads and Traffic develops 'Ecological Roadside Management Plans'. These plans can prescribe integrated and optimized management alternatives based on field data and scientific knowledge. The most important advantage of such an approved management plan is that nutrient-rich verges can be mowed earlier and more frequently in order to maintain or optimize their ecological value. For hard-to-manage locations, alternatives can be applied: - Sheep grazing; - Removal of the clipping by volunteers of NGO's; - Less frequent mowing for the development of scrubsPlanting bushes. Management plans also allow to remove woody vegetation in situations where they hinder traffic without additional approvals. For other woody vegetation a coppice management every 8 – 15 years is introduced. The plan also describes the possibilities to control the most important invasive exotic plants. A management plan also pays attention to the corridor or stepping stone function of the verges in relation to the surrounding landscape: is it better to have a planted verge to connect forests, or is it preferable to restore the grassland to give other species a last habitat? The presence of defragmentation infrastructure as ecotunnels is also important when defining the management of the adjacent road verges. A negative side of an ecological verge is the increased risk of traffic casualties. Appropriate measures can be included in the management plan in problem areas.

# Poster Session 2

## Poster

# Road 73 in Sweden: Follow-up studies of compensation measures

**Author(s):** Malin Delvenne, Torbjörn Persson

**Contact:** Malin Delvenne, Swedish Transport Administration

**E-mail:** malin.delvenne@trafikverket.se

Project Road 73 had a high ambition to build a road that would be well adapted to the natural landscape. The aim of the project was also to reduce the shortcomings of adaptation on the existing road. A few years after construction several questions arose: How successful were the measures taken? Did they maintain and increase the biological biodiversity? The road was one of the most dangerous roads in Sweden, called the «Road of death». The road went through areas rich in natural scenery, natural and cultural values, and also contained sensitive waterways. The road was a barrier for humans, wildlife and aquatic animal movement in the landscape. The challenge of building the new road was to have a holistic view of the landscape with nature, animals and humans in focus - a road in harmony with nature and animals.In total 25 km four-lane highway, 5 interchanges and 33 bridges were built, as well as 35 km of local and private roads. The road was completed and opened in the summer of 2012.

Examples of measures taken:

- Meadow vegetation establishment adapted to location and climate.
- Seeding and planting of host plants for insects and butterflies.
- Creation of new spawning area and migration routes for fish (Salmon trout).
- Compensation measures to protect and promote endangered insect species.Methods

a) Seeding and planting of vegetationIn 2009 a stretch of the roadside of the highway in Överfors was planted with wild thyme (Thymus serphyllum) and was seeded with a mix of meadow plants. The presence of thyme and meadow vegetation was surveyed in 2015.b)

b) Bush removal to benefit insectsIn 2012 measures to provide improved insect habitats were performed through bush removal and creation of sand blots in Älby. In 2015 an inventory was performed to follow-up the presence of insects. The inventory was focused on the group aculeate wasps, but other species were also sited.

c) Creation of new spawning area and migration routes for fishIn 2009 several migratory barriers in the stream Muskån were removed. The stream got a recreated course and a new spawning area was created. Population density of Salmon trout was followed by electrofishing between 2009 and 2012.Resultas)

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## Poster Session 2

### Poster

# Road 73 in Sweden: Follow-up studies of compensation measures

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**Contact:** Malin Delvenne, Swedish Transport Administration

**E-mail:** malin.delvenne@trafikverket.se

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d) Seeding and planting of vegetation

- There was a high presence of wild thyme. Thyme was well established along with the sown meadow. In some parts Thyme dominated the field layer.
- The results showed that the area has a good ecological functionality with high nature conservation values for butterflies and hymenopterans.b) Bush removal to benefit insects
- A total of 15 species of aculeate wasp were collected, two other species of aculeate wasps observed, one species of damselfly, 13 species of butterflies, 3 species of flies, and 5 species of beetles.
- Several species found are red-listed, and the area was assessed as valuable from a conservation perspective.c) Creation of new spawning area and migration routes for fish
- The density of Salmon trout was high and did not vary over the years.
- Creation of spawning areas and the elimination of barriers had positive effects on the salmon trout population.
- The high densities of both juveniles and older fish suggest that the environment became very favorable.

# Poster Session 2

## Poster

# Analysis of linear road barriers and their permeability for wildlife species in the Czech landscape

**Author(s):** Ivo Dostál, Jiří Jedlička, Josef Svoboda

**Contact:** Ivo Dostál, Transport Research CentreDivision of Infrastructure and EnvironmentLíšeňská 33a636 00 BrnoCzech Republic

**E-mail:** ivo.dostal@cdv.cz

The road networks, especially motorways and expressways, are the most harmful anthropogenic barriers to biodiversity and landscape and contribute to landscape fragmentation. This fact required to add specific activities in the framework of the project «A complex approach to the protection of fauna of terrestrial ecosystems from landscape fragmentation in the Czech Republic» (see another presentation for information on the overall concept of the project). These activities covering the whole territory of the Czech Republic are focused on the identification, analysis and evaluation of linear barriers (incl. historical development) and on the identification of suitable or potential passages in infrastructure. Knowledge and assessment of the current level of landscape fragmentation and its dynamics is a prerequisite for the main activity of the project, i.e. the definition of habitats of specially protected species. The identification of linear barriers is processed through a spatial geodatabase representing the evolution of the road network in different periods of time. This linear layer includes all dual carriageways – motorways, expressways and some 1st class roads. These road categories can be considered as virtually complete barriers to the migration of wildlife without accompanying measures. The geometry of the layer was digitized employing actual aerial photos. Historical information has been specified using historical topographic maps and the opening date of each section was determined from historical publications and the contemporary press. For planning purposes the database was also extended to motorways and expressways that are only planned on the basis of spatial land-use planning documents, particularly on national and regional levels. The road network covered in this activity includes approximately 1,600 km of existing and 1,250 km of planned carriageways. The activity following the analysis of barriers is to identify the spatial position and to evaluate the potential of individual passages on the roads. The two older thematic databases with limited territorial coverage (one maintained by the Transport Research Centre and another by the Nature Conservation Agency of the Czech Republic) were merged and expanded to cover the entire mapped network. Considered as potential passages were all objects with dimensions meeting the minimum requirements for the passage of larger mammals (width 12 m and height 3 m for common length of passage 25 m – permeability index 1.4). Important objects that are located on potential migration routes were visited in the field. The whole database of passages currently contains 1,076 objects (incl. impassable ones) and is accompanied by an extensive photo gallery of individual objects composed of both internal and publicly available photos. These two layers are used in defining the spatial layer of habitats of specially protected species in order to allow an easy identification of conflict points in the intersection of green and transport infrastructure. We assume, however, that their use will be broader in other research activities, therefore both layers will be continuously updated and expanded to follow further development of transport infrastructure, its construction and technical layout.

## Poster Session 2

### Poster

# Impacts of pairing transport infrastructures on biodiversity (plants, butterfly and reptiles) inside interstitial zones between infrastructures

**Author(s):** Nadia MICHEL, Jean Carsignol, Charles Uyttenhoven, Colin Van Reeth, Virginie Billon, Severine Hubert, Eric Le Mitouard, Joris Biaunier, Sophie Noiret

**Contact:** Nadia MICHEL, Université de Lorraine

**E-mail:** nadia.michel@univ-lorraine.fr

Major transport infrastructures (i.e. high-speed railways, highways) are known to have major impacts on landscapes and biodiversity. These impacts can be direct (i.e. mortality by collision) or indirect (i.e. pollutions, loss of habitat quality and quantity). The developments of such infrastructures in past and future decades make this phenomenon worse. In order to reduce the negative effects of such constructions (pollutions, landscape fragmentation etc), the pairing of transport infrastructures has been proposed. Two paired infrastructures are next to the other, just separated by an interstitial zone (variable width from few meters to 10-100m or more). We focused this study on these understudied interstitial zones with the objective to compare biodiversity inside these particular zones with biodiversity outside (along transport infrastructures). The hypothesis is that if connectivity between interstitial zones and landscape around paired infrastructures is deteriorated (or totally broken), then biodiversity can be different inside interstitial zones and outside (probably lower than outside). In that way, two case studies of paired transport infrastructures were studied in France, both in a context of farming landscapes. In the two cases the pairing is asynchronous: for one of the study cases the railway was first constructed and few decades later the highway was paired. For the other case the highway was first constructed and few decades later the railway was paired. In all studied situations, interstitial zones were always herbaceous habitats. We chose to study biodiversity through several different taxa, with different dispersion capabilities: plants, butterflies, reptiles, with appropriate inventory methodologies (quadrat method for plants; transect method for butterfly; shelter method for reptiles). The inventories were carried out on the one hand in different kind of interstitial zone width (few meters to few dozen of meters and more), and on the other hand outside the infrastructures, along railway or highway (control plots). Our results show that studied biodiversity is not significantly different inside interstitial zones and outside infrastructures. Indeed, butterflies are not impacted (both when considering species richness, abundance or diversity indices). The very low number of observed reptiles make the conclusions difficult to do for this taxa. Nevertheless, we can affirm that interstitial zones are not deprived of reptiles. Plans communities are characteristics of ruderal habitats and are very similar in the different configurations (both for species richness and diversity indices). This study was only conducted on two study cases, in one year. It emphasizes the necessity of long term inventories, in order to conclude on population fitness in interstitial zones. If populations are stabilized, we can think that functional connectivity between interstitial zones and outside is efficient and that habitat quality is suitable. Otherwise, we could suspect a great inbreeding due to functional isolation, leading to population shrinking and weakness.

## Poster Session 2

### Poster

# Impacts of pairing transport infrastructures on composition and structures of landscapes and on functional connectivity of ecological networks

**Author(s):** Nadia MICHEL, Jean Carsignol, Marc Hervé, Manon Balbi, Cécile Douay-Bertrand, Virginie Billon, Sophie Noiret

**Contact:** Nadia MICHEL, Université de Lorraine Laboratoire Agronomie et Environnement

**E-mail:** nadia.michel@univ-lorraine.fr

Major transport infrastructures (i.e. high-speed railways, highways) are known to have major impacts on landscape transformation, including ecological habitat fragmentation. Their developments in past and future decades make this phenomenon worse. In order to reduce the negative effects of such constructions, the pairing of such transport infrastructures has been proposed. For the moment, pairing processes have been asynchronous: i.e. first of all construction of a high-speed railway, and few years or decades later, pairing of a new highway (or the reverse order). In that context, our study aims to test the impacts of the different stages of constructions on landscapes. In that way, two case studies of paired transport infrastructures were studied in France, both in a context of farming landscapes. We focused our study on three stages: first stage before the first infrastructure construction; second stage after the first infrastructure construction (in order to evaluate its impacts); third stage after the pairing of the second infrastructure (in order to evaluate the impacts of pairing). Several analysis methods were used in order to comprehend and measure the landscape changes at these different stages. We firstly compared the global landscape composition at the three stages, and we measured which kinds of habitats were destructed by the constructions. We then measured more accurately the changes in landscape composition and structure (landscape metrics) in concentric buffers around the transport infrastructure constructions. Finally we carried out a functional analysis/modelling of ecological networks (forest habitats and herbaceous habitats were focused) for several species with different dispersion capabilities. ArcGis (10.2) and Fragstat were used for GIS and landscape metrics analyses; Spatial Analyst ArcGIS Extension was used for modelling ecological networks. The results of our study cases show that the major impacts on landscape composition and structure are due to the construction of the first transport infrastructure; particularly important changes in fragmentation level are induced by this first infrastructure. These results are similar whatever the order of construction and pairing (one of the study cases: first the railway then the paired highway or the other case: first the highway then the paired railway). Nevertheless results on landscape functional connectivity are quite different if they are focused on herbaceous habitats (connectivity increase because of increase of herbaceous habitats along infrastructures) or on forest habitats (decrease of connectivity). These results are consistent with the hypothesis that the approach of pairing transport infrastructures is a good opportunity to avoid drastic ecological changes in landscape. However we hypothesize that it should be much more effective if the construction of the two paired infrastructures would be synchronous (potential decrease of costs; common reflections on mitigation measures and their impacts on biodiversity and landscapes).

# Poster Session 2

## Poster

## The importance of roadside vegetation on plant diversity in Northern Germany

**Author(s):** Kerrin Müller, Alica Tetzlaff, Heinrich Reck

**Contact:** Kerrin Müller, Christian-Albrechts-University Kiel

**E-mail:** kmueller@ecology.uni-kiel.de

Loss and degradation of habitats but also increasing habitat fragmentation have caused a strong decline of plant diversity in Germany. Despite possible limitations due to their vicinity to roads, roadsides could be valuable habitats for many plant species for several reasons: They are ubiquitous, consist of different habitat types and are well connected along the road network. Thus, roadsides came more and more into focus as alternative habitats and corridors for threatened plant species in recent decades. The aim of this study was to evaluate the value of roadsides for plant conservation in Northern Germany. We investigated the plant species richness and composition of roadside vegetation along highways and main roads. Therefore, we divided the roadside vegetation into open vegetation and shrubberies. To assess the value of roadsides for plant conservation, we compared fifty roadsides to habitats without roads in their immediate vicinity: Open roadside vegetation was compared to open linear habitats and species-rich grasslands, road shrubbery was compared to linear habitats rich in shrubs and forests. Our results showed that roadsides and linear habitats away from roads had a similar species richness and composition. While species richness of open roadside vegetation was comparable to species richness observed in species-rich grasslands, plant species richness of road shrubberies was even higher than species richness in the selected forests. Despite the high species richness in roadside vegetation, the number of threatened and specialized species was comparatively low, whereas high numbers of ruderal species and several neophytes could be found. Specifically searched valuable roadsides also showed high amounts of neophytes and ruderal species, but could reach higher proportions of threatened and specialized species than ordinary roadside vegetation. However, based on different studies we estimate that not more than 1 % of roadsides can actually be classified as valuable. According to these results, we conclude, that present roadsides play a minor role as alternative habitats for threatened and specialized plant species in Northern Germany, although the potential for plant species conservation could be increased through purposeful design and management.

# Poster Session 2

## Poster

# Exclusion habitats – a way to avoid unnecessary conflict when building new transport infrastructure

**Author(s):** Jan Olof Helldin, Anders Sjölund, Anders Jacobson, Leif Andersson

**Contact:** Jan Olof Helldin, Calluna AB

**E-mail:** j-o.helldin@calluna.se

To facilitate the planning process of new transport infrastructure, it is essential to avoid unnecessary conflict with biodiversity conservation. By ”unnecessary conflict” we mean impacts on biodiversity that can be easily avoided if brought to the table on an early planning stage, but may cause predicaments, distress and delays later in the process if not well acknowledged. One such unnecessary conflict is that over small biodiversity hotspots. Most landscapes, also seminatural, cultivated or urbanized landscapes, contain certain habitat patches or features that are critical to the welfare of many or rare species; thus, conserving those features can have huge pay off for species conservation. Large solitary trees, hedgerows, rocky outcrops, natural springs, ponds and streams are all examples of ecosystem features that support far more species than one would predict based on their size alone. The small size of such ecosystem features make them particularly sensitive to the large scale habitat transformation caused by infrastructure construction, as they easily loose their ecological function or are wiped out completely. Their small size should however also make them relatively easy to avoid exploiting. Even in lack of formal protection of these small biodiversity hotspots, infrastructure developers should, for the sake of both biodiversity conservation and planning efficiency, voluntarily acknowledge and protect them. Accordingly, we have established the concept of ”exclusion habitats” for the Swedish Transport Administration (STA) – small habitats patches or features that should not be touched by new state-owned roads or railways. We have listed a number of exclusion habitats for Sweden, based on four criteria: the habitat should be i) limited in size, ii) well defined/easily identified, iii) non-restorable, and iv) important for species conservation. The exclusion habitat concept, including the habitat list, has been communicated with a range of conservation professionals, and is now integrated into planning guidelines for STA. In this poster, we present the exclusion habitat concept and describe some potential opportunities and risks that we have identified with the concept. The opportunities include, i.a, a smoother planning process, new options for biodiversity monitoring, and a ”spill-over” effect on conservation of and research on biodiversity hotspots in the larger society. The risks include a loss of focus on other (larger) conservation areas or non-listed habitats, and a loss of landscape perspective. Exclusion habitats provide a new tool for road and railway planning, but the outcome of this new tool is yet to be followed up.

# Poster Session 2

## Poster

# Research and Popularization, for Dormouse Bridge and Animal Pathways as corridor for protecting Arboreal Animals

**Author(s):** Minato Shusaku

**Contact:** Minato Shusaku, «Dormouse Museum» and «Kwansei Gakuin University»

**E-mail:** aag33239@kwansei.ac.jp

Development of "techniques for environmentally harmonious coexistence" is essential for achieving conservation of biodiversity while human activities obstruct global environment. We have studied and built bridges that arboreal animals could use to pass over roads since 1988. We built a dormouse bridge over a toll road in Yamanashi Prefecture in 1998. The bridge also serves as a traffic signal. To make it easy for dormice to pass, we incorporated the following measures into the bridge structure: (1) a metal net enclosing the bridge to keep away natural enemies, (2) plates on the bridge floor to shield the bridge from car light at ight, (3) ivy and branches placed in the bridge in order for dormice to move easily inside, (4) nest boxes as shelters, (5) approaches from woods to branches for access to the bridge, and (6) trees planted around both ends of the bridge for dormice to use as feed and nest materials. We found that dormice made nests inside the bridge and crossed over the road, squirrels also used the bridge to cross and Japanese wood mice and Japanese great tits made nests. To achieve environmental conservation, it is essential to "popularize" means that can be used globally. Hence, we studied and developed low-cost and simply designed "animal pathways" (hereafter "pathway") that arboreal animals can utilise easily. We studied pathway materials in 2004 to determine whether dormice would walk over noncorrosive, man-made wires and what an appropriate wire diameter would be. We found a diameter of six millimeters optimal. We studied pathway structure again in 2005. A triangular model made of wire was placed in a large cage accommodating dormice to observe how the dormice used the model. An aluminum roof was also provided to prevent icicle development. The dormice used the model. We built an improved animal pathway over a city road in Hokuto City on 2007. The pathway included the following measures: (1) shelters, (2) an aluminum roof to keep the bridge from snow, (3) space for squirrels, (4) a rope for dormice, which walk on the downside, (5) cider bark wrappings around utility poles, (6) video cameras for monitoring. Dormice, wood mice, squirrels, martens used. The arboreal animals used the pathway 1510 times in 2670 hours (about 111 days). Because this is the first pathway of its kind for arboreal animals, there is no similar usage data available for comparison. Japan now has a total of 6 pathways, the fourth of which is also used by Japanese flying squirrel used another. This evidence showed that most Japanese arboreal mammals used pathways.

# Poster Session 2

## Poster

# On toads and roads: The case of Spångavägen and Kyrksjölöten – tunnel mitigation is effective for spring migration, but toads are still killed in large numbers

**Author(s):** Jan Olof Helldin, Anna Koffman, Christina Söderström-Lööf, Erik Jondelius, Silviu Petrovan, Michael Hartup

**Contact:** Jan Olof Helldin, Calluna AB

**E-mail:** j-o.helldin@calluna.se

The nature reserve Kyrksjölöten in suburbian Stockholm is an important breeding area for common toad (Bufo bufo). The reserve is however surrounded by roads of different size, the largest being the municipal commuting road Spångavägen with 6,000-7,800 vehicles/ day. Over winter, toads are distributed over a larger area, in particular on the opposite side of the commuting road. For many years, local observers have reported high numbers of amphibians killed along this road during spring migration. As a response, Stockholm municipality installed two ACO amphibian tunnels with permanent guiding fences over a 300 m road section. The permanent mitigation was installed in 2014, in connection with a road upgrading, but it was preceded by two springs (2012-2013) with temporary fencing and pitfall traps, when amphibians were counted along the fence and in traps, and manually translocated over the road. In 2015, we monitored tunnel usage and counted live and dead amphibians along the guiding fences (2x300 m) and roads (3925 m) surrounding the nature reserve, in order to assess the mitigation effectiveness in preventing road kill, maintaining connectivity and preserving the toad population. Tunnel usage was monitored with Froglife timelapse cameras, for one month covering peak migration. We used counts from the previous two springs as a reference. Counts along roads and guiding fences were done three evenings during peak migration time. As no count of road killed toads were done before fencing (i.e. not before 2012 when temporary fences were installed), we interpolated the pre-fencing number along the mitigated stretch based on adjacent, unmitigated road sections. Common toad was the totally dominant amphibian species (ca 98 % of all observations). Cameras showed toads moving in both directions, but the net movement was 866 toads towards the breeding area, which is a higher number than what was translocated in previous years (419 in 2012, 647 in 2013). Results from the counts of toads along the fenced road section suggested a 90-98 % decrease in live and dead toads on the road surface. Large numbers of toads were found on other parts of the commuting road and smaller roads surrounding the reserve, indicating that only part of the local toad population is approaching the breeding area over the fenced road section. We found peaks in road kills just outside the fenced section, suggesting some animals bypassing the fence ends. The lack of quantitative data on the local population and road kill numbers before mitigation limits the inference of the results, but we find it safe to conclude that the fencing has significantly reduced the number of road killed toads along this previous ”black stretch”, and that the tunnels allow the vast majority of the toads reaching the fence to safely pass to their breeding area. It remains unclear what proportion of the local population is protected by this measure and what are the effects on mortality and movements during summer and autumn migration in the opposite direction, especially for juveniles.

# Poster Session 2

## Poster

# Wildlife crossing structures monitoring in the Catalonia's road network

**Author(s):** Jordi Solina Angelet, Mònica Laje

**Contact:** Jordi Solina Angelet, Ministry of Territory and Sustainability. Government of Catalonia (Generalitat de Caatalunya)

**E-mail:** jsolina@gencat.cat

In the environmental impact assessment (EIA) procedure of transport infrastructures, have a special significance the analysis of the several effects related with habitat fragmentation. During the environmental impact assessment some measures are incorporated to mitigate them. Additional ones are implemented by the environmental administration of Catalonia (NE Spain). A monitoring of the functionality of the different types of wildlife crossing structures built is needed to improve the EIA of new roads. The efficiency of these structures is measured by the monitoring which is included in the tasks of the road conservation plan during the first two years. These works include plantation and their maintenance, and other restoration works. A good collaboration between different organisms of administration is needed (environmental and constructive). A total of 101 monitoring reports have been done (data from Wildlife Crossing Points Inventory in Catalonia's Road Network): mainly modified culverts as well as multiuse underpasses and some specific wildlife underpasses. The groups that use mostly the structures are medium and large mammals and other vertebrates with some differences between adapted culverts, specific underpasses and multiuse underpasses. The more significant incidences detected are: erosive phenomena and the lack of drain; deteriorated elements; human disturbances, frequentation and the pass of vehicles. Some general conclusions of these monitoring are: The applied corrective measures are well designed The construction or adaptation of crossing structures reduce the impacts The construction or adaptation of structures reduce the risk of collision in the road security  In spite the quite important number of monitoring until now, any of wildlife overpasses haven't been done yet.  During 2015, a monitoring of ecoducts have been carried out in an important road of the catalan road network (C-25). The goals are determining the functionality as an animal passage and as a new habitat which connect both sides of the infrastructure. Different animal groups have been studied: invertebrates; mammals; amphibians; reptiles and birds. Standardized methodologies according to the animal group have been used. Some conclusions are:  The ecoducts give a new habitat for invertebrates, small mammals, reptiles and birds and is similar to natural ones (open herbaceous spaces). Ecoducts provide of permeability to the road and allows the continuity of the habitats of both sides of the infrastructure. The importance of microhabitats to offer ecological requirements of the different species for crossing, shelter, feeding of reproduction.

# Poster Session 2

## Poster

## Landscape and road variables describing clusters of ungulate vehicle collisions on southern Swedish roads

**Author(s):** Andreas Seiler, Magnus Sjölund, Richard Andrášik, Jiří Sedoník, Michal Bíl, Carme Rosell, Marina Torellas

**Contact**: Andreas Seiler, Swedish University of Agricultural Sciences, Dep. of Ecology, Grimsö Wildlife Research Station

**E-mail:** andreas.seiler@slu.se

**URL**: http://www.slu.se

Ungulate-vehicle collisions (UVC) in Sweden are an increasing concern to traffic safety socio-economics and wildlife management. Accident numbers are steadily growing but the trends are not well related to the changes in ungulate population sizes or hunting statistics. Authorities ask for better mitigation strategies than currently available. One crucial prerequisite to this is a good understanding of where and when UVC occur more frequent in some areas then elsewhere and which factors produce these aggregated pattern. We used UVC records during 2010 - 2014 provided by hunters called by the police to the accident site. These hunters' reports contain exact location data as well as correct species identification. A total of 189 733 UVC were reported during the 5-year period, most of which (77%) involved roe deer, fewer involved moose (11%), wild board (9%), fallow deer (3%) and red deer (1%). While roe deer and moose occur broadly across Sweden, the other ungulates have more restricted but expanding distributional ranges. For our study, we therefore selected southern and south-central Sweden where all five species occur and where road density, human population and UVC frequencies are highest. We further focused on public roads, excluding the more comprehensive private road network where about 10% of reported UVC occur. We also considered UVC as a whole and did not distinguish between these species, as mitigation measures most likely are indifferent as well. We used the modified kernel density estimation approach (KDE+) in combination with general rules for e.g., the minimum number of UVC per km to identify a total of 1596 significant UVC clusters. From these, we randomly selected 477, which we compared with 434 UVC control sites that were outside the clusters and thus represented randomly distributed accident sites. Each site corresponded to a minimum of 500 m of road and at each site, we measured 19 local road related factors (ocular evaluation of Google Street ViewTM imagery) and 17 landscape related factors (derived from topographic map data and GIS data bases). We used generalized logistic regression approach to identify the most important factor combinations explaining the clustering of UVC. According to our results, the clustering of UVC tends to occur in areas where the road corridor is attractive, accessible and open for wildlife. Such areas are characterized by agriculture landscapes with forest patches and with many leading structures such as watercourses, other roads, lakes etc. These features, in combination with traffic and road related data (speed, traffic volume, fences) provide a powerful explanation of UVC clustering. Note: this study is part of a Ms.Sc. project that shall be defended in february. In consequence, the abstract will be updated soon to its final version.

# Poster Session 2

## Poster

# Influence of historical and present landscape patterns on plant communities of road-field boundaries

**Author(s):** Clémence Chaudron, Francesca Di Pietro, Rémi Perronne, Sébastien Bonthoux,

**Contact:** Clémence Chaudron, UMR CNRS 7324 CITERES, Université François Rabelais de Tours

**E-mail:** chaudron.c@gmail.com

For many years now, agricultural landscapes have been characterized by an increase in the surface area of arable crops and an enlargement of road networks, leading to a loss of semi-natural habitats. Road verges, which are generally composed of four elements – i.e. the safety zone, the berm, the ditch and the embankment – represent potential favourable remnants for many plant species. While present landscape composition and configuration influence taxonomic composition of plant communities in road verges, past landscape pattern may also explain present observed communities via the soil seed bank. It is known that plant species respond differently to changes of landscape pattern; as an example, specialist species of particular habitats are expected to be more sensitive to changes than generalist species. While many studies have investigated the relationship between past landscape composition and present plant communities on grassland habitats, only a few have focused on road verges and arable field margins. In this context, we addressed the following question: How past and present landscape patterns influence the present diversity and composition of plant communities in road-verges and adjacent field margins? We sampled the berm, the embankment and the field margin in 190 road-field boundaries situated in Central-Western France (i.e. 1 plot of 10 m2 per element, 570 plots in total). We characterised past (1980) and present (2011) landscape covers within a buffer of 1000 m radius around each sampled road-field boundary. Through an original methodology, based on semi-automatic digitalisation of aerial photographs, we produced a past land cover map, while we combined several databases in order to build up the present land cover map. Both past and present maps were created using Arcgis software. In both the maps we distinguished the following habitat types: semi-natural grasslands, forest, vineyard and orchard, annual crops and roads. In each buffer and for each date, we computed the relative surface of grasslands and forest, the Shannon's diversity index and the edge density (landscape variables). Within the study area, the grassland area decreased between 1980 and 2011 (i.e. a loss of 37%), while annual crops area and arable field size increased. Multiple regression analyses were used in order to investigate the influence of landscape variables on plant species richness and diversity of the berm, the embankment and the field margin for each date. Canonical and co-inertia analyses were used to study relationships between landscape variables and the species composition of berms, embankments and field-margins for each date. Results allow assessing the effect of past Vs present land cover on plant biodiversity of intensively managed road verges.

# Poster Session 2

## Poster

## Main landscape and road-related variables describing ungulatevehicle collisions hazardous locations in Catalonia

**Author(s):** Marina Torrellas, Carme Rosell, Marc Fernández-Bou, Richard Andrášik, Jiří Sedoník, Michal Bíl, Ferran Camps, Andreas Seiler, Ferran Rodà

**Contact:** Marina Torrellas, Minuartia wildlife consultancy, Avda Diagonal 523, 08029 Barcelona

**E-mail:** mtorrellas@minuartia.com

Animal-vehicle collisions are a traffic safety and socio-economic topic for many European countries. In Catalonia (NE Spain) the number of accidents involving wildlife is increasing despite to the mitigation strategies applied. Wild ungulates which show rising population sizes are the animals most frequently involved in the accidents. Ungulate-vehicle collisions (UVC) commonly show an aggregated pattern along the road network and clusters could be identified as hotspots for traffic safety. Assessing the effects of road or landscape variables and distinguishing the main explanatory variables associated to this clustered pattern could help road managers in designing more effective mitigation measures. During a five-year period (2007-2011), data from 2,320 accidents involving wild ungulates were registered by traffic police, road management teams and the wildlife management department along 12,124 km of the Catalan road network. In contrast to other European regions where deer are the most frequent species causing traffic accidents, wild boar (Sus scrofa) is the main species involved in our study area being responsible for 85% of the overall accidents. 308 significant UVC clusters were identified using a modified kernel density estimation technique (KDE+) and from those 124 shown the highest-frequency of accidents (≥ 3 accidents/km in the studied period). 600 UVC events were selected randomly, 300 located within the highestfrequency UVC clusters and 300 outside them. 12 landscape variables (road junctions, water and ecotone crossings, distances to urban and vegetation cover patches, proportions of different land uses cover types and landscape diversity) and 9 road-related variables (traffic volume, speed limit, road straightness, road-cross section, presence of barriers and medians, roadside vegetation and presence of garbage containers nearby the road) were selected for characterizing the UVC occurrences. Using multiple logistic regressions, several models were fitted assessing the relationship between the explanatory variables and the probability of UVC clustering. Straighter roads, higher speed limits and dense road verge vegetation were consistently associated with increase probabilities of UVC clustering, whereas built-up areas surrounding roads and the presence of road cuttings or embankments decreased this probability. The presence of garbage containers nearby the road were also positively correlated with UVC clustering probably due to wild boar attraction for garbage. According to the results, UVC clustering in road hotspots is prompted by both landscape and road related factors. Landscape features are relevant for understanding the accidents aggregation, but managing road-related features such as clearing the roadside vegetation might be valuable for reducing wildlife-vehicle collisions in high hazard hotspots.

# Poster Session 2

## Poster

# Landscape architecture process to think the energy transition at school : a spreading concern

**Author(s):** Auréline Doreau, Antoine De Vergnette, Antoine Gabillon, Julien Peguet, Jean Robaudi, Jérémy Di Stefano, Marine Naceri, Sonia Wotus, Clothilde Josserand, Qixuan Yang, Olivia Zanchi

**Contact:** Auréline Doreau, École Nationale Supérieure de Paysage Versailles-Marseille

**E-mail:** a.doreau@ecole-paysage.fr

To fulfill the COP21 objectives, both public sector and energy professional field must install energy transition on territories. Methods had emerged to prepare the shift to more sustainable energy value chain and spatial planning is beginning to set. Inhabitant perceptions and sensitive approaches are frequently used in order to « reduce » visual impacts from infrastructure changes, often programing on the edges of the project planning, as a decorating step. Spatial aspects of energy transition, especially on large easement for transport infrastructures, are treated in separated ways then excluding thinking the complex influences of these aspects. However, thinking beforehand perceptions leads at taking into account projectual visions of territories by the stakeholders. Then,it is possible to suggest a more sustainable project, inspiring from sharing (or not sharing) visions of the infrastructures. The studios driven at the Ecole Nationale Supérieure de Paysage of Versailles Marseille constitute a laboratory to develop the energy transition analysis of young landscape architects by theirs skills in landscape project process. Based on the 6 first studios in 2012-2016, which were built with energy firms also partners of the Landscapes and Energy Chair, we propose a transversal reading of these first results. The graphic analysis on the studio productions and the stakeholders reactions (verbatims) are used to describe this new perspective on energy transition. What we found is an increasing interest in landscape architecture tools from energy transition stakeholders, in local authority as much as in energy firms. Indeed, environmental stakes dealt with social ones ; the synthesis by aesthetic aspect of drawings and maps gives the vision of how could be considered infrastructure areas in the making of energy transition. The example of the landscape project process created on ground easement under high voltage lines brings to consider the connection of spaces and the existance or creation of ecologic corridors, answering social needs as public areas free from access, which comprises new common goods. This affirms that living landscapes could be enhanced by integrated infrastructures. Feed backs from partners underline how this practice distances them from their studying and makes them thinking it different, reflecting their considerations for infrastructures in their environment. Landscape project process seems part of the recipe to provocate modifications of perceptions, essential ingredient to think and trigger the change.

# Poster Session 2

## Poster

# Species richness of some arthropod groups in highway rest areas in Hungary

**Author(s):** Balázs Kiss, Sándor Koczor, Blanka Gál, András Weiperth, Éva Szita

**Contact:** Balázs Kiss, Plant Protection Institute, Centre for Agricultural Research, Hungarian Academy of Sciences

**E-mail:** kiss.balazs@agrar.mta.hu

Plant-covered highway margins and rest areas provide suitable habitats for a number of invertebrate species, however, biodiversity of highway verges is poorly studied in literature. In our previous works we have shown that typically 30-40 % of the Hungarian fauna can be found in highway verges in different arthropod taxa (e.g. orthoptera, heteroptera, araneae), but in exceptional cases, like in scale insects (Coccoidea) more than 50 % of the species occur in these special habitats. In seed beetles (Bruchinae), 29 out of the 36 species known from Hungary, were found in highway verges. In our project, 33 sampling sites were investigated along Hungarian highways in three different periods of the years (2011-2013). The presentation focuses on two taxa. Altogether close to 10.000 Auchenorrhyncha individuals were collected and identified, and 200 species, approximately 37 % of the Hungarian Auchenorrhyncha fauna, were found. 130; 97, 57 and 40 species were caught by sweep netting, suction sampling, branch beating and pitfall trapping, respectively. The dominant species by collecting methods were: sweep netting: Philaenus spumarius (20,3%), Zyginidia pullula (9,2%), Euscelis incisus (6,2%); suction sampling: Z. pullula (12,4%), Anaceratagallia ribauti (9,5%), Graphocraerus ventralis (9,4%), Turrutus socialis (9,4%); branch beating: Opsius stactogalus (44,0%), Liguropia juniperi (19,4%), P. spumarius (9,5%); pitfall trapping: Anoscopus serratulae (33,3 %), Aphrodes bicincta (20,1 %), Doratura homophyla (12,0 %). Three species (Liguropia juniperi, Opsius smaragdinus, Tamaricella tamaricis) were found for the first time in Hungary. L. juniperi was shown to be widespread in the country. In spiders, close 13000 individuals were caught, which belonged to 254 species, thus 35 % of the fauna was found. The three collecting methods applied for spiders have given similar species numbers (suction sampling: 108, branch beating: 115, pitfall trapping: 112), but highly different species composition. The dominant species by collecting methods were Trichoncus hasmani 10 % and Meioneta rurestris 9% (suction sampling), Ebrechtella tricuspidata 14,5 % (branch beating) and Xerolycosa miniata 11,3 %, Pardosa agrestis 9,1 % (pitfall trapping). Our results show that highway rest areas are species rich habitats in several arthropod taxa, and they also provide a good opportunity for monitoring changes in distribution areas of certain species. The project was financed by Hungarian Scientific Research Fund (OTKA 83829).

# Poster Session 2

## Poster

### Sustainable development of road lighting, its impact on the environment and effects of switching to LED (light emitting diodes)

**Author(s):** Annika K. Jägerbrand, Jan-Olof Helldin

**Contact**: Annika Jägerbrand, Swedish National Road and Transport Research Institute

**E-mail:** annika.jagerbrand@vti.se

Light emitting diodes (LEDs) and SSL (solid state lighting) are relatively new light sources, but are already widely applied for outdoor and road lighting. Despite this, there is little available information allowing planners and designers to evaluate and weigh different sustainability aspects of LED/SSL lighting when making decisions, especially when considering environmental or ecological aspects. However, artificial light in natural environments may have a significant impact on nocturnal animals. Recently, a framework of sustainability indicators was proposed to enable a general evaluation or to highlight certain objectives when choosing LED lighting. The effects of road lighting and how the new framework handles ecological and environmental issues will be presented and discussed. Ecological effects of outdoor artificial light will be discussed. Effects of switching to LED light sources will be examined. Aspects that makes LED light different compared to traditional light sources will be discussed, as well as why (if) road planners prefers LED. What kind of aspects ecologists and decision-makers should consider when recommending road lighting if they want to minimize ecological impact will also be presented. For example: reducing illuminance levels, dimming possibilities, using cut-off luminaries and other kinds of measures.

# Poster Session 2

## Poster

# GeneDbase – database for evaluation of road barrier effect road on wildlife genetic variability

**Author(s):** Martin Ernst, Tomáš Libosvár, Tomáš Šikula

**Contact:** Martin Ernst, researcher

**E-mail:** martin.ernst@mendelu.cz

Molecular genetics allows to analyze changes of genetic variability of wildlife populations. According to the results it is possible to recommend specific measures for mitigation of the degradation of the local population. Many subjects and institutions in the Czech Republic and around the world are focused on research in the field. However, the data are not gain systematically and evenly from a wider areas. Furthermore, for the analysis are used different methods, laboratory kits or devices. Due to these differences it is not possible to compare the results of data analyses. There is no single central database for recording analyzed data, which could be used as a useful tool for collaboration between the institutions. Having one would increase the efficiency of interdisciplinary research and practical application of results.The project GeneDbase has created the tool for unifying the process of sample collection, its analyzing and central data storing. It will allow to clarify the research in population management of wildlife. The methodology and the databases are useful tools for:specialists when working with genetic data for the evaluation of the road barrier effect,institutions and companies involved in agriculture, forestry, nature and landscape protection, spatial planning, zoology or game management.A newly created database is used for saving, managing and working with genetic data, gained when analysing individual biological samples. It provides a unified data structure. The access to the database is available only to registered users at webpage: http://www.genedbase.cz or http://www.genedbase.eu. The database allows:a basic work with data: saving data (individually or mass import),searching and filtering data by specified parameters, view sample position on the map, grouping samples into «focus populations,» based on the selected filter parameters,data export, a special export for software Structure,sharing data with co-workers and institutions, and others.During the projects were chosen places, where the population isolation is expected due to a road with high traffic volume. At these locations we were collecting tissues of hunted animals from local gamekeepers. On few locations we were able to collect enough samples for the microsatellite DNA analysis. Then we compared the analyse results with evaluation of road permeability for wildlife on few locations, where we collected enough samples. According to this comparison, we were able to determine the barrier effect of road on genetic variability. In our presentation we would like to present the results of the project – the database GeneDbase and the results of evaluation of barrier effect of road on genetic variability of selected species of mammals.Research project No.TA02031259 “Creating a genetic database of selected species of mammals in the Czech Republic to be used for sustainable transport development” is supported by the Technology Agency of the Czech Republic.

## Poster Session 2

### Poster

# Ecological connectivity and ecosystem plasticity in a transformed corridor habitat – case study of A4 motorway in Southern Poland

**Author(s):** Joanna Nabielec, Wojciech Michał Tokarz

**Contact:** Joanna Nabielec, EKKOM Ltd. Zawiła 65 E Street, 30-390 Kraków, Poland

**E-mail:** joanna.nabielec@gmail.com

Corridor habitats are proven to be highly vulnerable to creation of artificial barriers, such as public transport infrastructure, which in most cases negatively affects their connectivity functions. This effect is especially high in places, where long road lines cross multiple neighboring ecological corridors, connecting important habitats of large area and great ecological value. An example of such case is the A4 motorway in Southern Poland, which interferes with both main ecological corridors and important habitats situated in its close proximity. The aim of this presentation is to report main results of a medium-scale environmental assessment and monitoring conducted since 2014, at a newly built section of the motorway, in the context of ecological corridor functions sustainability and the change of habitat use by different animal taxa. The performed monitoring includes systematic assessment of the general animal mortality at the roadway and within the area of associated infrastructure, together with the assessment of underpass utilization by animals and amphibian habitat quality in surrounding water reservoirs. Results of the monitoring show unusually low mammal mortality, which indicates the important role of using effective well designed fences and other collision preventing systems. The relatively high bird mortality, especially concerning the predatory birds, shows an important negative effect of the habitat change. Increased prey availability resulting in the accumulation of carcasses of animals killed in road collisions at the roadway, seems to induce the additional increase of raptor collision mortality risk. All of the obtained results give a valuable overview on the environmental changes which occure in a fragmented habitat influenced by an intensively used motorway and support the state of knowledge about the ecological connectivity functions of habitats transformed by traffic infrastructure. It also allows to evaluate the effectiveness of specific solutions used in order to prevent excessively large negative impact of motorways on wildlife, e.g.: the data obtained from different types of underpasses reveal the effectiveness of the used designs, contributing the diversity of good practices used for mitigation of environment-infrastructure conflicts.

# Poster Session 2

## Poster

# Is an operational index an efficient way to assess naturalness along land transport infrastructures?

**Author(s):** Romain Fillon, Pierre Pech

**Contact:** Romain Fillon, Université Paris 1 Laboratoire LADYSS

**E-mail:** Romain.Fillon@me.com

The identification and assessment of biodiversity holders landscapes, in relation to land transport infrastructure and rights of way, represent a strong demand from managers operators dense urban environment. In the object of our study, the infrastructure concerned correspond to roads, highways, railways, tram, road or river water per channel, or gas line right-of-power lines. Are considered potentially biodiversity rich landscapes that are not occupied directly and strictly by the elements of the infrastructure network but which correspond to it to the extent that they constitute operator to land territory integrated spaces manager. To improve the recognition of the ecological functioning of transport infrastructure and adapt the choice of way management and associated tools for the conservation and the development of a lasting nature and quality, we developed methodology sheets to better understand how there is a range of landscapes and habitats appropriately constituent patches, islets, continuums or frames including ecological biodiversity within these infrastructures and build on comparative ecological dynamics encountered. The methodology sheets are intended to inform the reader and user of the operational sheets and contribute to the knowledge of some potentially promising biodiversity dynamics on rights of the infrastructure. Therefore there are soil functioning of embryos for the development of a habitat favorable to the establishment of spontaneous living beings or domesticated, we consider that there is a space in nature. In this way, we sought to define a multitude of patches corresponding to space objects, combining a portion of transportation infrastructure space and a form of land use.

# Poster Session 2

## Poster

# Enhancing wildlife connectivity along California's highways: the cas of the state route (SR) 241 wildlife fence in Orange County, California, USA

**Author(s):** Valarie L McFall

**Contact:** Valarie McFall, The Transportation Corridor Agencies

**E-mail:** vmcfall@thetollroads.com

**URL:** http://www.thetollroads.com

This project aims to: Reduce wildlife-vehicle collisions on highways through appropriate design and construction of wildlife exclusionary fence; Reduce habitat loss and fragmentation; Develop reproducible exclusionary fence design guidelines. Southern California's Santa Ana Mountain Range is bound by Interstate 15 to the east and State Routes 91 and 241 to the north. Estimates suggest less than 30 adult pumas (Puma concolor) remain within this area. Threats include wildlife-vehicle collisions, habitat loss and fragmentation, depredation permits, and genetic restriction. Interstate 15 and associated developments are barriers that have resulted in the puma population being semi-isolated with reduced genetic variability and separation from other populations. Vehicle collisions are particularly concerning because of low annual puma survival rates, impacts to human health, and economic implications. Part of the solution lies in appropriately designed wildlife crossings coupled with effective wildlife protection fences. The SR-241 Wildlife Protection Fence Project runs along both sides of a 6.5-mile stretch, from the SR-261 junction north to the SR-91 Freeway in Orange County, California. During construction of SR-241, United States Fish and Wildlife Service (USFWS) required the Foothill/ Eastern Transportation Corridor Agency (TCA) to construct four wildlife undercrossings and conduct a five-year post-construction study to document the usage of the crossings. Although the study documented a substantial number of wildlife using the undercrossings, concerns regarding the number of wildlife still crossing the roadway at-grade remained.In response, TCA contracted with the University of California, Davis (UCD) to conduct an assessment of SR-241 and formulate recommendations to enhance wildlife movement. UCD studied the behavior and movement of wildlife along SR-241 by installing and monitoring cameras, collecting and analyzing data from GPS-collared pumas, documenting intrusions and mortalities along the roadway, modeling crossings, and conducting an extensive on-the-ground examination of the roadway, including the undercrossings and right-of-way fencing. Results confirmed existing wildlife-crossing structures along SR-241 are adequate in size, type, and location to allow wildlife movement. However, due to the ease with which wildlife can access the roadway and cross at-grade, UCD recommended that state-of-the-art wildlife protection fence be constructed. The fence is 10-to-12 feet (3-3.7 meters) high; has an 18-inch (46-centimeter) "outrigger," is buried 24 inches (0.6 meter) to prevent animals from digging under the fence; and is in close proximity to the roadway shoulder to minimize natural habitat loss. The fence is expected to reduce collisions by 90 to 95 percent. For the wildlife that may still enter the roadway, jump-out ramps that provide animals with an escape back into the open space have been included. Effectiveness of the fence and efficacy of the undercrossings will be evaluated through an adaptive management approach over a three-year period. This includes reviewing Caltrans maintenance records; as well as, monitoring cameras at three bridge undercrossings, 27 jump-out-ramps, five culverts, and fence end-points to detect any breaches by wildlife. Monitoring will determine if: The exclusionary fencing reduces collisions; There are changes in use patterns because of the fence; and There is an impact on the overall welfare of the Santa Ana Mountains puma population.

# Poster Session 2

## Poster

## Wildlife’s reaction towards oncoming vehicles

**Author(s):** Anke Benten

**Contact:** Anke Benten, Georg-August-University Göttingen

**E-mail:** abenten@gwdg.de

In Germany approximately 250.000 Wildlife-Vehicle Collisions (WVC’s) with large terrestrial mammals, especially roe deer (Capreolus capreolus) and wild boar (Sus scrofa), are reported every year. However, the reaction of terrestrial mammals towards oncoming vehicles has only scarcely been studied, yet (e.g. Waring et al 1991, D’Angelo et al. 2006, Blackwell and Seamans 2009, Lima et al. 2014). One reason might be that obtaining sufficient data along roads is limited due to laws governing personal data protection. Therefore, we used thermal network cameras to record wildlife’s behavior near roads. We selected 9 testing sites at primary, secondary and tertiary roads with reported hotspots in WVC’s. Each testing site had forest on one side and field on the other site. We recorded three testing sites at the same time for 8 weeks using one thermal network camera for each site (Axis Q1931-E with a 10.7 ° lens, Axis Communications AB, Inc., Lund, Sweden). The study was conducted between August 2015 and January 2016 from dawn till dusk. The frequency of sightings and time spent near roads for each species was analysed. Furthermore, animal’s reactions was categorised into four categories: 1) flight, 2) alarm, 3) movement and 4) no reaction (see Ujvari et al 1998). Between 8 and 60 sightings per night and testing site were recorded. Most abundant were deer (37,5 %), followed by rabbits (29 %), red foxes (23 %), badger (6 %) and wild boar (4 %). Badger and red foxes spent the longest time near roads (160 secs and 154 secs) per sighting. Deer spent on average 130 secs, wild boar 72 secs and rabbits 63 secs near roads. No species showed any significant reaction or change in behavior towards oncoming vehicles. Our results show that deer are the most abundant large mammals near roads, which is not surprising due to their estimated high population density. Though, in areas with roe deer, red deer and fallow deer the species’ differentiation between females was not always possible due to difficulties in size estimation. Furthermore, the relatively long duration of stay of red foxes and badgers near roads might indicate a higher risk in WVCs. However, due to their small body size collisions with these species might be underreported. Nevertheless, the lack of reaction towards oncoming vehicles might show a habituation to traffic and missing risk estimation of approaching vehicles.

# Poster Session 2

## Poster

# Bats and linear land transport infrastructures [Guidelines]

**Author(s):** François Nowicki

**Contact:** François Nowicki, DTRest Cerema

**E-mail:** francois.nowicki@cerema.fr

There is evidence today that the passage of a transportation infrastructure is a major disruption to the ecological functioning of bat populations and a major cause of mortality.

To answer these concerns the government has initiated the implementation of a bats' National Action Plan (NAP) for the 2009-2013. Among the relevant actions, the Cerema was in charge of drafting the guide «Bats and linear land transport infrastructure.» This approach corresponds more particularly to actions 6 and 7 of the plan, ie:

- The elaboration and the implementation of a methodology for the consideration of Chiroptera during the enginiering and the maintenance of infrastructures and bridges,
- The assessment of the effectiveness of these mitigation measures of transport infrastructures.

Organized around a generic text on each of the approached themes and widely illustrated, this guide makes the synthesis of a large number of experience feedbacks and concrete cases resting on several hundreds of studies and French and english technical and scientific references.

It is structured in a simple and educational way in order to provide a document in which everyone can extract the information he needs. The guide is a technical support tool for decision support, including :

- A brief but rigorous description of some notions in the field of ecology useful for the understanding of bat species and the problems,
- A synthesis of the impacts related to the crossing of an infrastructure.
- A detailed overview of the useful data which must be knowed and studied upstream to the construction. If the proposed methodology does not establish a strict frame, it aims to provide a reference approach assuring a quality of expertise.

This guide is therefore a methodological and technical work. It give a range of informations and necessary recommendations for the proper consideration of Chiroptera within the realization of new projects but also during the maintenance and the requalification of existing infrastructures. It is intended for all infrastructure operators like project owners, prime contractors, public communities, consultancy firms, administration, associations, ...

Finally, beyond a synthesis and assessment of the state of knowledge available on this theme, this guide proposes possible and concrete practical solutions to answer a maximum of problems. It also raises some gaps in knowledge, it would be useful to go into them in depth.

# Poster Session 2

## Poster

## Environmental commitments of the Société du Grand Paris for the Grand Paris Express project

**Author(s):** Etienne Pihouee

**Contact:** Etienne Pihouee, Société du Grand Paris - Etablissement public sous tutelle de ministères, dont Ecologie

**E-mail:** etienne.pihouee@societedugrandparis.fr

The Société du Grand Paris is a public body set by the French government to deliver the Grand Paris Express, a new automatic metro network and contribute to the urban development of the areas it will serve. The project aims the construction of four new lines for the inner and outer suburbs, and the extension of one line. The three strategic goals of the Grand Paris Express :

● Create a new public transport offer for everyone finally providing easy and fast travel from suburb to suburb, a genuine alternative to the car, practical, regular and comfortable, providing passengers a train service that is simply less strained.

● Provide the Paris metropolis an essential framework for its future economic growth, guaranteeing better connections between residential and work areas, better circulation of both people and brainpower, opening up the region both nationally and internationally, connecting clusters to the network, launching new business and housing projects…

● Make Greater Paris an example for the regeneration of its environment, the development of public transport and the preservation of natural, agricultural and forested areas. The role of the SGP is that of contractor with three essential assignments : construction of lines, works and fixed installations, construction and development of the stations, the acquisition of rolling stock. The SGP has set out several environmental commitments that will inform its work:

● Avoid, reduce or offset environmental impacts : From establishing the route to the construction phase and final entry into service, the environmental approach is underpinned by a rigorous, comprehensive method that is tailored to each section of the metro, each station and each new building ;

● Anticipate natural risks : In strengthening the principe of “urban resilience”, the SGP is fully in line with the COP21 objectives. More specifically, it has developed a “flood” strategy that sets out guidelines for designing infrastructure exposed to this risk.

● All new buildings must take account of their environmental, architectural and landscape context : The architectural and landscape heritage must be taken into account for each new building, underpinned by an innovative strategic environmental assessment carried out upstream of the project and the impact studies.

● Develop a circular economy for spoil management : Traceability, alternative transport recovery, the SGP intends to pursue an exemplary policy for managing the 43 million tonnes of spoil from the construction sites.

# Poster Session 2

## Poster

# Bats and road collisions: building a risk prediction model incorporating landscape variables

**Author(s):** Charlotte Roemer, Yves Bas, Aurélie Coulon

**Contact:** Charlotte Roemer, Muséum national d'Histoire naturelle

**E-mail:** croemer@biotope.fr

**URL:** http://www.biotope.fr/

Bats use echolocation to operate during darkness, avoid obstacles and forage. Different species have different types of sonars, depending on the habitats they use. Aerial-hawkers use low quasi-constant frequencies which allow them to fly at heights, whereas gleaners use high-pitched modulated frequencies, better suited to fly close to the ground. Knowledge in bat movement has mainly been developed at large scales for the study of migration routes or at middle scales for the study of home ranges. Little is known about bat behaviour at a very small scale, where obstacle avoidance can be observed. This lack of information is notably problematic when it comes to assessing collision risks with vehicles before road construction. It is commonly assumed that aerial hawkers are less prone to road collisions because they prefer to fly at heights, but some studies have reported otherwise. Many assumptions are also formulated concerning the reaction of each species to landscape features and hence the role of these features in road mortality. Gleaners are described as flying close to the ground and close to the vegetation whereas aerial-hawkers are supposedly more plastic. However, these elements rely mainly on bat experts' experience and this flaw leads to hazardous impact assessment studies. Indeed, the current method for the determination of potentially high risk crossings is based on the highest activity rate along a road, although it has never been demonstrated that bat activity is proportionally linked to collision risk in all landscape situations. In this context, a PhD project started in December 2015. The aim is to determine how several types of landscape features (hedges, forest edges, forest driveways, no three-dimensional element) alter collision risks with vehicles. Behavioural observations will be performed with acoustic flight path tracking over a large amount of road locations. Eventually, the goal is to achieve a prediction model for collision risks at pre-existing roads or at road projects before construction, based on local landscape characteristics. Preliminary results such as an interspecific comparison of flight height preferences will be presented and discussed.

# Abstracts

# Friday September 2nd

## Plenary Presentation- P5

# Limiting the environmental impacts of the tropical infrastructure tsunami

**Author(s):** William F. Laurance

**Contact:** William Laurance, Centre for Tropical Environmental and Sustainability Science, James Cook University, Cairns, Queensland, Australia ALERT—the Alliance of Leading Environmental Researchers ; Thinkers

**E-mail:** bill.laurance@jcu.edu.au

The 21st century will see an unprecedented expansion of roads, dams, power lines, and gas lines, as well as massive investments in mining and fossil fuel projects. At least 25 million kilometers of new roads are anticipated by 2050. Nine-tenths of all road construction is projected to occur in developing nations, including many tropical regions that sustain exceptional biodiversity and vital ecosystem services. The penetration of roads and other infrastructure into remote or frontier areas are a major proximate driver of habitat loss and fragmentation, wildfires, overhunting, and other environmental degradation, often with irreversible impacts on native ecosystems. Unfortunately, much infrastructure proliferation is chaotic or poorly planned and the rate of expansion is so great that it often overwhelms the capacity of environmental planners and managers. I will highlight ongoing efforts to plan, prioritize, and mitigate rapid road and infrastructure expansion, focusing predominantly on the tropics.

## Plenary Presentation- P6

# Implementation of Green Infrastructure in the EU

**Author(s):** Jos Jonkhof

**Contact:** Jos Jonkhof, J.O.S consultancy

**E-mail:** jonkhof@xs4all.nl

**URL:** http://www.jonkhof.eu/J.O.S/J.OS.html

Landscape is a constant process of evolution, generated by both autonomous as antropogenetic processes. On the societal agenda there is fortunately still enough space for reflection on the phenomenology of this evolution, and on the ways society can act to adapt to its specific appearances, an act of culture, by designing its habitat: sustainable forms of urban and rural development, connective infrastructure, and sound physical conditions for life. Within the domain of scientific research for instance, we can use the offered spatial opportunities and reveal the products of this cultural evolution, by flying over several domains of reflections.For instance: Comparing the evolution of landscape with the evolution of language appears to open fascinating horizons, especially in the international IENE audience. Vocabulary as a tool for communication in research, design, policy development. Examples: landscape, structure, pattern, system, plan, design, policy. (References: Shama, Luginbühl, Schroevers, Hoekstra, Van Leeuwen)Comparing attitudes in research schools as practiced in different countries can lead to the revelation of different cultures in looking at Landscape and at society interfering in Landscape evolution. Example 1: the use of concepts in research and development, the case of the Randstad. (References: Zonneveld, Hofstede, Delbaere) Example 2: the National Ecological Network, a concept both structuring the research capacity of the scientific programmes in the Netherlands as articulating conservational and developmental policies. (References: Alterra /WageningenUR).Comparing Landscape affecting policies reveals different attitudes and societal energy and it articulates different perspectives for the future. Listing recent public initiatives reveals a common sense of urgency to focus on innovative forms of research, conceptual design and institutional adaptation as well as it enables us to learn from different views and practices.

References: the Plan d'action pour la reconquête des paysages et la place de la nature en ville (MEDDE, France); the National Perspective on spatial environment (Department of Infrastructure and Environment, The Netherlands); the Project Room for the River (Rijkswaterstaat, national agency for water management).

## Talk- 3.1

### Wildlife crossing structures - Part 3/3

# Impacts on moose and deer of railway fencing in northern Sweden

**Author(s):** Åsa Karlberg, Jan Olof Helldin

**Contact:** Åsa Karlberg, Tyréns AB

**E-mail:** asa.karlberg@tyrens.se

In northern Sweden, railways are often fenced to prevent reindeer (semi-domestic but free-ranging) from getting train-killed. Accordingly, the new Bothnia Line railway along the north Swedish coast was fenced in connection with its completion in 2010. This 190 km long railway runs parallel to the already fenced motorway E4 along the coast, partially within meters and partially separated by up to ca 3 km. The proximity between these two main traffic arteries has produced a complex fencing setup, with single-sided fencing of railway sections close to the motorway (within 1 km), and double-sided fencing on more distant sections. We studied the impact of the railway fencing on ungulate movements and collision rate, particularly in relation to the single-sided fencing, the fence openings, and the proximity to the fenced motorway. We monitored moose and deer movements by snowtracking a 47.5 km section of the railway in the winters 2013-2014 and 2014-2015, and we compiled data on wildlife collissions on the same section from the years 2010-2015.The studied railway has 24 bridges for waters and local roads, and two longer tunnels constructed for topographic reasons. In addition, 17 fence openings of various length (50-450 m) are left to allow wildlife movements over the railway. The railway stopped on average ca 76 % of the animals that, according to our interpretation, were intending to pass it. This barrier effect however varied between sections, from 100 % along fenced sections (single- or double-sided), 33 % in fence openings, and 0 % in bridges and tunnels. Only few of the fence openings were used by wildlife, suggesting that also the unfenced railway has a barrier effect, or alternatively that most openings were misplaced for wildlife. Along single-sided fencing several animals were stopped on the unfenced side, i.e. on or very near the track, potentially increasing the collision risk. Observed collisions (n=27) derived primarily from two shorter sections, single-sided fenced, and with two and three fence openings, respectively. We conclude that the fence and the Bothnia Line, jointly and individually, contributes to a demographic, and with time potentially also a genetic, isolation of moose and deer. However, it is difficult to separate the barrier effect of the railway from that caused by the motorway, and likely these work in concert. The results indicate that the single-sided fencing along the already fenced motorway is not effective in preventing wildlife collision. We therefore suggest installation of jump-out ramps, and that some particularly problematic single-sided sections are completed with double-sided fencing. We further suggest that the fence openings are adjusted, for example with active warning systems and prevention from entering into the fenced track. We suggest that the match between fence openings in the railway and potential wildlife passages along the motorway is assessed and coordinated, to ensure that no animals get caught in the habitat strip between the railway and the motorway.

## Talk- 3.1

### Wildlife crossing structures - Part 3/3

# A highway or wall to wildlife? Barriers for wildlife corridors in Slovakian transport infrastructure. A review from a pilot area in North Banská Bystrica County

**Author(s):** Nuno Guimarães, Jerguš Tesák, Peter Urban, Gabriela Ligasova

**Contact:** Nuno Guimarães, Department of biology and ecology, faculty of natural sciences Matej Bel University - Banská Bystrica - Slovakia

**E-mail:** nunoguimaraes08@gmail.com

Transport infrastructures can isolate wildlife populations. Barriers on wildlife corridors, mortality from animal vehicle collision, the decrease of genetic flow of local species, fragmentation of the territory and the creation of artificial boundaries, are key impacts caused by these infrastructures on biodiversity. Green corridors are crucial to link or re-link populations and increase their habitat dispersal and decrease the fragmentation impact in local ecosystems where human infrastructures are implemented. These artificial corridors can help on the preservation and conservation of species richness and biodiversity, avoiding or minimizing the isolation of animal populations and the consequent decrease of the genetic flow.Slovak transport infrastructure length didn't change substantial in recent times (1995 till 2014), a total of 94 km (0.53% of growth). Since the entrance in the European Union in 2004 and with the help of European founds, the Slovak transport network developed. The subsequent increase on traffic frequency result on a higher impact risk for some specific species specially protected. The construction of new highways and the improvement, restructuration and modernization of national and regional roads throw the country, more 223kms of highways (>112.63%) and 219kms of national roads (>7.12%) brought also impacts for local wildlife. We elaborate a review of all the data available on animal vehicles collision in a pilot area, representative of the Slovakian road network (motorway, expressway and from 1st class to 3rd class roads). From 2012 till 2014 there was more than 10.000 animals/year registered on crashes with vehicles with an average of 84.5% of mammals and 30% of protected species were killed. Some species are highly represented (small mammals) others as large carnivores, have a very low number of killed animals on the roads. But the low number of incidents in some species doesn't represent a low impact on these populations. Large carnivores are very sensitive to habitat fragmentation and as umbrella species the impacts on them are not just affecting their populations. We also analyze the protected species involved in animal vehicle colision to understand where this species are having dispersion problems.With this review it was possible to define some sensible locations which need to be readjusted and implemented due to the amount of impacts. Generally we can conclude that much more attention should be addressed in the future with the implementation of green corridors for the conservation and protection of the Slovak biodiversity.

## Talk- 3.1

### Wildlife crossing structures - Part 3/3

# Effects of low and medium traffic roads on bat activity and species richness

**Author(s):** Denis Medinas, Vera Ribeiro, João Tiago Marques, Hugo Rebelo, Ana Márcia Barbosa, António Mira

**Contact:** Denis Medinas, CIBIO-UE – Research Centre in Biodiversity and Genetic Resources. Pole of Évora / InBIO – Research Network in Biodiversity and Evolutionary Biology, University of Évora. Mitra, 7002-554 – Évora, Portugal and UBC – Conservation Biology Lab, Dep

**E-mail:** denimedinas@gmail.com

The adverse effects of roads on bats are a recent and still poorly documented issue. Most of the research focuses on characterizing locations of bat collisions and the factors driving them or describe the negative effect of large and high traffic highways on bat activity and diversity. Low to medium traffic roads are often assumed to have negligible impact on many vertebrates, including bats. To our knowledge no study has focused on the effects of low and medium traffic roads on the activity of different bat guilds defined on the basis of their echolocation range. Purpose We examined the effects of distance to low and medium traffic roads on flight activity, species richness and three bat guilds (short-, mid- and long-range echolocators). We used acoustic recorders to survey bat activity in open agricultural and forest areas along perpendicular transects to low and medium traffic roads, applying a newly developed automatic classifier to identify bat calls. We tested the hypothesis that proximity to roads decreases bat activity and diversity and that this effect is more pronounced in open areas where the sparse shrub and tree cover have a low capacity to buffer road induced disturbance. We expected bats with short-range echolocation to be particularly sensitive to road disturbance because traffic noise reduces their foraging efficiency. Methods The study was done in spring and summer of 2015 in southern Portugal. We surveyed twice (in May and August) 20 transects perpendicular to three national roads. At each transect bat activity was registered simultaneously at 0, 50, 100, 200, 500 and 1000 m from the road with a automatic bat ultrasound recorder. Bat surveys were carried out in the two main land uses at the study site: dense Mediterranean woodland (“montado”) and open agricultural areas (cereal crops and pastures). The effect of distance to road, road type and land use on bat activity and ensemble composition were analysed with generalized estimating equations. Results Overall bat activity and bat species richness increased with increasing distance from the roads for all the road types tested. Bat activity close to roads was approximately one-half the activity level recorded at 1000m. This effect is less noticeable in mid summer hot nights, corresponding to peak activity and first flight of juveniles. We found forest areas as positively affecting bat richness across all distances to roads. The activity of short and mid-range echolocating bats is particularly affected by the proximity to roads. This effect is stronger in forest areas and, surprisingly, near low-traffic roads. Large-range echolocators were unaffected by the presence of roads or landscape characteristics. Discussion This study highlights the negative effects of low traffic roads on bat activity and diversity. We also show that not all bats species are affected in the same way and that species that depend more on hearing are particularly prone to activity reductions near the roads. Implications for road management aiming to reduce its impacts on bats are discussed.

## Talk- 3.1

### Wildlife crossing structures - Part 3/3

# Successful Wildlife Crossing Structure Designs in the United States Mountain West

**Author(s):** Patricia C Cramer

**Contact:** Patricia Cramer, Utah State University

**E-mail:** cramerwildlife@gmail.com

Successful wildlife crossing structure designs in the United States mountain west were documented in multiple studies of ungulate and carnivore use of wildlife crossing structures and existing bridges and culverts. Results from studies in Montana, Idaho, Utah, and Colorado illustrate the optimal wildlife crossing structure types and dimensions for mule deer (Odocoileus hemionus), white-tailed deer (Odocoileus virginianus), elk (Cervus canadensis), moose (Alces alces), and carnivores. The objectives of these studies were to determine structural attributes and fencing characteristics most important to deer and other ungulates in their use of the structures to pass beneath roads. From 2007 through 2016, the studies used remote camera traps to monitor wildlife reactions to 37 wildlife crossing structures and 27 existing culverts and bridges placed for other purposes. These structures were placed on roads ranging from two to six lanes, with daily traffic volumes ranging from 2,000 to 40,000 vehicles per day. The surrounding landscapes varied from wild lands to suburban settings. The studies generated data on over 60,000 wildlife events at structures. Statistical analyses found that the openness of structures was the most important overall predictor of mule deer and white-tailed deer success rates through the structures. In Utah the length of the culvert or bridge, meaning the distance the animal moved beneath the road, was the most important structural dimension in predicting mule deer success rates: the shorter the length, the greater the success rate. The width of the passage or the span of the structure was the second most influential dimension, with wider structures having greater mule deer success rates. The height of the structure was the least important of the three dimensions, but still important to mule deer and was also correlated with white-tailed deer success in Montana; structures under 2 meters did not have as high deer success rates as higher structures. Increased culvert and bridge width, increased openness, and decreased length increased white-tailed deer success rates while decreasing parallel rates and the rate of repellency. Though elk use of structures was quite low in all studies, the most highly used structures were a wildlife overpass and a pair of wildlife crossing span bridges underneath an interstate in Utah. Moose were most often photographed using one culvert in northern Utah. Moose use was extremely low at other individual structures, but in general they were photographed using wildlife crossing bridges that conveyed water. Fencing to structures was found to have mixed results. Fencing played an important role in motivating migrating mule deer to use existing culverts and bridges, but was not a consistent motivating source for animals to use such structures. Length of fencing was not found to be a statistically important factor for white-tailed deer use of crossing structures in a suburban setting. The information from these studies has already helped create cost savings by helping agencies to build structures with the most optimal dimensions for the target species, and to show funding partners how mitigation can pay for itself in savings from reduced wildlife-vehicle collisions.

# Talk- 3.1

## Wildlife crossing structures - Part 3/3

# Simulating population effects of infrastructure permeability and the performance of mitigation strategies

**Author(s):** Andreas Seiler, Guillaume Chapron, Julian Klein, Edgar van der Grift, Peter Schippers

**Contact:** Andreas Seiler, Swedish University of Agricultural Sciences, Dep. of Ecology, Grimsö Wildlife Research Station

**E-mail:** andreas.seiler@slu.se

**URL:** http://www.slu.se

Barrier and mortality effects to wildlife populations induced by transport infrastructure and traffic have provoked comprehensive prevention and mitigation programs in many countries. Such programs are, however, often driven by practical or political considerations rather than by scientific knowledge. In particular, it is often unclear how much mitigation effort may be needed and what type of mitigation will be most efficient to remedy the identified conflicts. To aid this decision making process, we developed a metapopulation & road permeability model (PERM) that allows for calculations of changes in population viability and allele frequency (genetic effects) resulting from changes in connectivity between local populations across infrastructure networks. Hence the model quantifies what effect mitigation measures will have on populations and can be used to optimize road mitigation plans. The model employs two routines: a) an individual-based local population routine (life history, fecundity, survival, dispersal, and allele frequency) and b) a connectivity routine to estimate the degree of permeability of infrastructural barriers between adjacent populations. We defined “local populations» as inhabiting meshes within the infrastructure network, whereby roads with a certain traffic volume were considered as theoretical population boundaries. High road permeability practically implies a merging of local populations, whereas strong boundaries cause isolation and/or high traffic mortality. Changes in permeability can result from the installation of wildlife crossings or fences, from speed reduction and traffic rerouting, etc. Because species respond differently to traffic and thus to mitigation options, we simulated four generic response types (avoiders, speeders, pausers, non-responders, as proposed by Jacobson et al. 2015), representing species groups such as large herbivores, large carnivores, small carnivores and amphibians. The model identifies under which traffic conditions and for which types of species it may be more efficient to reduce mortality through fencing, increase permeability through the construction of wildlife crossing structures or to both reduce mortality and increase permeability through changes in traffic parameters such as speed reduction. At present, our simulations are ongoing. We will update this abstract within 4-6 weeks from now with first results of the model.

# Talk- 3.2

## No-Net-Loss Strategy and compensatory measures - marine biodiversity

# Planning for Transportation and Ecosystem Adaptation to Sea Level Rise

**Author(s):** Fraser M Shilling

**Contact:** Fraser Shilling, Road Ecology Center, University of California Davis

**E-mail:** fmshilling@ucdavis.edu

**URL:** http://roadecology.ucdavis.edu

I describe a generalizable planning and assessment process for adaptive management and adaptation of transportation infrastructure to sea level rise (SLR). A single coastal California (CA) highway and surrounding tidal and terrestrial ecosystems were used as the laboratory. Sea level has risen in CA by >20 cm and by 2100 may be 1 to 1.7 m higher. During the winter of 2015-16, low and high tides were up to 25 cm higher than predicted (probably due to El Nino), providing a view into a world with 25 cm of SLR. Climate change is expected to result in accelerated rates of sea level rise and changing seasonal wave conditions, further exposing the shorelines to impacts. Infrastructural and living systems adaptations will need to occur to avoid a wholesale change in the marshes, estuarine systems, low-lying urban areas, and exposed highway infrastructure along global coastlines. A longitudinal survey of coastal managers in CA found SLR and related problems to be among their most challenging issues. Identifying and modifying infrastructure that is exposed and vulnerable to SLR and increased storminess is complicated and potentially expensive for governments. The physical structures themselves are vulnerable to SLR, which is likely to result in increased costs and eventual adaptation. in addition, the function of linked, regional transportation systems may be vulnerable to disruption if an SLR-vulnerable link fails.State Route 37 (SR 37) is the California highway that may be most vulnerable to temporary flooding and permanent inundation due to SLR. Like many other coastal highways in the US, SR 37 is adjacent to protected coastal ecosystems (e.g., beaches, tidal wetlands), meaning that any activity on the highway is subject to regulatory oversight. Due to a combination of congestion and threats from SLR, planning for a new highway adaptive and resilient to SLR impacts was conducted in the context of stakeholder participation and Eco-Logical, a planning process developed by the (US) Federal Highways Administration to better integrate transportation and environmental planning. In order to understand which stretches of approximately 30 km of SR 37 and adjacent landscape might be most vulnerable to SLR, and to what degree, a model of potential inundation was developed by a contractor (AECOM) using a recent, high-resolution elevation assessment conducted using LiDAR. Potential inundation was modeled based upon comparison of future daily and extreme tide levels with surrounding ground elevations. The risk to and vulnerability of each segment was scored and cost of adaptive structures estimated (US$0.8 to 4 billion) in order to inform infrastructural planning. The adaptive structures were also assessed for potential (dis) benefits.The tidal ecosystems adjacent to SR 37 both buffer the highway from wave and tidal energy and are vulnerable to impacts from SLR. In order to monitor SLR impacts at a timescale relevant to transportation and conservation planning. I developed a combined time-lapse camera and image analysis technique to monitor changes in tidal inundation and shoreline resulting from SLR and storm events. The technique is very sensitive to small vertical changes in SLR (<10 cm) because of the large horizontal changes in shoreline resulting from small vertical changes. This technique is high-resolution and scaleable from local to national extents. Early results from this system will be presented.

## Talk- 3.2

## No-Net-Loss Strategy and compensatory measures - marine biodiversity

# How maintain marine fish population in a context of high anthropic pressure: the role of shallow coastal zones – ecological function and fish nursery restoration

**Author(s):** Philippe Thievent, Philippe Lenfant

**Contact:** Dr Philippe LENFANT, HDR, Professeur UPVD - Ecologie Marine, Océanographie- UMR 5110 CNRS/UPVD - CEFREM

**E-mail:** lenfant@univ-perp.fr

**URL:** http://cefrem.univ-perp.fr

According to the most recent assessments of the Census of Marine Life published in August 2010 in the review PlosOne (Coll and al., 2010), the decrease of marine biodiversity is particularly dramatic in the Mediterranean Sea. Causes of biodiversity loss are multiple and mainly due to human activities such as habitat degradation, are recognized as very important. The specificity of fish life cycle increase the risk of populations collapse: A fish female produce several thousand eggs and larvae per year but during this pelagic stage, mortality is very high until 90% due to predation and nutrition. The arrival and settlement of pelagic post-larvae in their permanent benthic habitat is also a critical phase with more than 90% mortality occurring due to predation and habitat degradation. The success of this first part of life cycle (few month) induce the maintain of fish populations. Our technical platform (CREM) link to the CEFREM lab is dedicated to ecological restoration and we actually have two PHD thesis about the positive role of the harbour on this life cycle. We will present the objectives of both thesis (fish nursery restoration) and initial results.

## Talk- 3.2

### No-Net-Loss Strategy and compensatory measures - marine biodiversity

# Potential role of infrastructures in the restoration of marine biodiversity

**Author(s):** Philippe Thievent, Martin Perrot

**Contact:** Martin Perrot

**E-mail:** Martin.PERROT@egis.fr

Coastal development has led to the destruction of intertidal and shallow subtidal habitats and loss of associated ecological functions. However, recent research programs have shown the capacity of a variety of man-made structures to host marine biodiversity. Coastal road embankments, harbor breakwaters or seawalls have for example proven to be attractive habitats for diverse marine species (algae, fish, crustacean, cephalopod) and of different life stages. In this way, these artificial habitats can contribute to the global quality of urbanized coastal ecosystems. This being said, the magnitude of this contribution and the habitat efficiency of these infrastructures highly depends on a certain number of factors, both environmental (eg. hydrodynamics and water quality) and technical (eg. infrastructure size, macro and microstructure, material). Today, coastal transport infrastructures are not specifically designed to supply key environmental functionalities, and their ecological potential is generally limited. Ecological enhancement (or habitat enhancement) through ecological engineering is a growing discipline aimed at increasing habitat quality of immersed man-made structures in order to reduce global impact of infrastructure development on aquatic ecosystems. This presentation will focus on a few case studies of recent projects for which habitat enhancement was applied to maritime transport infrastructure:

- The Réunion island coastal road

- The extension of the industrial ports of Brest and Marseilles The presentation will conclude on the potential of habitat enhancement of man-built inland waterways and how it could serve a better control of species dispersal and connectivity between distant watersheds.

## Talk- 3.2

### No-Net-Loss Strategy and compensatory measures - marine biodiversity

# Using a commercial harbor for fish nursery

**Author(s):** Philippe Thievent, Gilles Lecaillon

**Contact:** Gilles Lecaillon

**E-mail:** gilles.lecaillon@ecocean.fr

In an intact marine onshore habitat, more than 90% of post-larval fish settlers will naturally die within the first week of their return, but without adequate natural habitats, the survival rate can decline to zero! Unfortunately for young recruits, shoreline modifications such as harbors, bulkheads and piers, are increasingly prevalent, directly affecting their essential habitats. Mitigation for the impacts occurring during this lifecycle stage is crucial to restore the connectivity and life cycles of aquatic populations. Various types of innovative solutions have been introduced to harbor areas as a substitute for the role played by rocky sea bottoms and shorelines in protecting wild post-larval and young-of-the-year marine fish. 1-Biohut® solution work by providing the opportunity to hide and feed in a system creating a predator-free habitat with adapted food. 2-Biorestore® solution work by capturing wild post-larvae, rear them in an inland wetlab and then repopulate growth juveniles into adapted habitats outside the harbor. From 2013 to 2015, a large scale deployment of those technique was implemented within the Grand Port Maritime de Marseille. The talk highlights the importance of protecting and restoring shoreline habitats and will presents the very strong results of the project as well as the on-coming other harbor mitigation projects in France.

## Talk- 3.2

## No-Net-Loss Strategy and compensatory measures - marine biodiversity

# Time, space, skills, partners and innovation management for port integration

**Author(s):** Jean-Michel Bocognano

**Contact:** Jean-Michel Bocognano, Grand Port Maritime de Marseille Port of Marseilles Authority

**E-mail:** jm.bocognano@marseille-port.fr

**URL:** http://www.marseille-port.fr

Unlike linear inland transport infrastructures, ports develop themselves over the same territory, again and again. These huge industrial sites frequently settle in estuaries or deltas for geostrategic reasons, allowing a perfect connection to inland transport networks which preferably follow wide valleys to serve continental markets and production areas. Then, successive projects and extensions, over several decades, cumulate permanent and severe ecological damages in high value ecosystems, from wetlands to marine habitats. This is furthermore building long term social conflicts with different stakeholders, and especially local communities and environmental protection associations. In order to turn the tide, the port of Marseilles authority leads a holistic action, through space planning, nature conservation professionalization, partnership-based ecological projects, net positive impact (NPI) approach and innovation.Though, for continental issues, nature conservation or restoration tools benefit from numerous feedbacks and expertise, they cannot be duplicated in the marine field: this is because of particularities of these ecosystems, difficulties and lacks in marine science, and moreover legal status of the sea. Indeed, it isn't possible to acquire marine spaces for mitigation purposes. This is the reason why the port of Marseilles authority initiated in 2010 an ambitious research and development program (GIREL) to raise knowledge and tools about marine life within and around harbors. Many of its results and applications are presented during the workshop, and part of them are planned to be implemented into the Marseilles basins, such as nursery restoration devices or algae resettlement operations. The program also enlightened priority orientations for a better understanding and scientific knowledge of marine life cycles and connections in relation with artificialized coastal sectors. The presentation will provide a comprehensive picture of the context and further prospects of GIREL, from a public planner point of view.

## Talk- 3.3

### Managing vegetation along infrastructure verges - Part 2/2

# Invasion by Asian knotweed (Fallopia spp.) along linear landscape features: spatial dynamics and perspectives in mountainous environment

**Author(s):** François-Marie Martin, André Evette, Fanny Dommanget, Vincent Breton, Laurent Borgniet, Nathan Daumergue, Marylise Cotter, Virginie Billon, Joris Biaunier, Anne Honnegger, Thomas Spiegelberger, Abry Guillaume, Jean-Jacques Brun

**Contact:** François-Marie Martin, Ph.D Student, IRSTEA (National Research Institute of Science and Technology for Environment and Agriculture), Grenoble.

**E-mail:** francois.martin@irstea.fr

According to IUCN, biological invasions are the second cause of species extinction right after habitat destruction. Among the great variety of alien plant invaders, Asian knotweeds (Fallopia spp.) are considered to be among the worst invasive species in the world, including Europe and North America. A lot of researches have focused on the biology of invasive knotweeds and on the factors explaining their presence, but the factors governing their spatial and temporal dynamics are still poorly known, especially along dispersal and disturbance vectors such as roads or rivers. The same statement could be made for researches on management and control techniques (except for chemical treatments, which are generally unfit for riparian management). Moreover, to our knowledge, there are very few studies that focus on invasive knotweeds dynamics in mountainous environment, and almost none that does it over medium or long time periods. The diachronic study presented here is part of an on-going project called DYNARP, which aims at evaluating the respective roles of management, biotic and abiotic, and perception factors in the spatial and temporal dynamic of exotic Asian knotweeds at the stand and the landscape scales. More precisely, this study intended to highlight the respective roles of biotic, abiotic and management factors on the spatial coverage evolutions of knotweed stands over 7 years.We strongly believe that a more accurate understanding of both “natural” and anthropogenic factors governing Fallopia spp. spatial and temporal dynamics is a prerequisite for better knotweed control.We monitored the evolution of more than 200 knotweed stands distributed over more than 50 sites of the French Alps. Almost every stand was located near a linear landscape features (e.g. roads, rivers) and they were all situated above 800 meters a.s.l.For each date, stands outlines were drawn using precise GPS records and several vigour attributes were measured to estimate knotweeds performance and the stands’ spatial evolutions. Afterwards, biotic andabiotic data were collected in four directions around the stands, and anthropic influences were assessed by both field analysis and managers surveys. Data were then analysed using regular and advanced statistical techniques.First results show truly interesting opposite trends of spatial expansion or reduction, explained by different ecological and management processes. Indeed, it appears that if most stands expanded between the 7 years period, a third of them have known a reduction of their surfaces (up to -150m2 when maximum expansion reached +90m2). If human-induced disturbances and the distance from a transport infrastructure seem to play a role on these dynamics, exact effects of studied factors appear to be context-dependant.Altogether, these results are particularly relevant to improve management strategies especially those that try to prevent the invasion of the still preserved but highly threatened alpine environments.

## Talk- 3.3

### Managing vegetation along infrastructure verges - Part 2/2

# Unintended spillage of viable oilseed rape seeds along transportation routes in Austria: ecological risk assessment and management of feral plants

**Author(s):** Kathrin Pascher

**Contact:** Kathrin Pascher, University of Vienna, Department of Botany and Biodiversity Research, Division of Conservation Biology, Vegetation- and Landscape Ecology, Rennweg 14, A-1030 Vienna, Austria

**E-mail:** kathrin.pascher@univie.ac.at

Oilseed rape (OSR; Brassica napus) is a worldwide cultivated crop of hybrid origin. Although OSR is unknown as a wild plant, it frequently occurs as a feral plant and is able to hybridise with many related species. Because of their small size, OSR seeds are regularly spilled during handling and transportation. Genetically modified (GM), herbicide resistant OSR is now widely grown in North America. Transportation and handling activities have been identified as main cause of the unintended occurrence and subsequent establishment of feral GM OSR populations in countries without GM OSR cultivation, e.g. Japan and Switzerland. Import restrictions in countries banning cultivation of GM OSR are based on concerns that introgression of transgenes may cause problems with weed management and compromise the integrity of genetic resources in wild relatives. We surveyed abundance and genetic diversity of feral OSR at 60 sampling sites in Austria, aiming to assess the risk of establishment of feral populations from non GM seed imports. Sampling sites included predefined hotspots with a high expectation for seed spillage such as switchyards, border railway stations, main ports, and OSR importing oil mills as well as randomly selected road sections (2 kilometres), railway stations and small ports. For comparison, 37 seed samples grown in Austria during the last ten years as well as eight varieties from abroad were obtained from commercial breeders. A total of 2,113 feral OSR individuals were sampled from spring to summer in 2014 and 2015. At 44 sampling sites, feral OSR was found. DNA was extracted from young leaves to assay genotypes at ten microsatellite loci. Genetic diversity among commercial varieties was lower than in earlier studies using similar methods. Feral populations had higher genetic diversity than the commercial varieties, but less than 5% of the genetic variance was distributed among populations. This result indicates that feral populations along transport routes and near processing facilities receive a constant input of diverse seeds. The highest allelic richness was observed at ports and oil mills, rendering these sites of primary concern with respect to possible escape of transgenic OSR. Measures to reduce spillage of imported OSR seeds and their establishment should focus on herbicide application and also on intensification of alternative weed management such as mowing or spraying of organic herbicides. The mode of seed packing during transportation is an important factor: whereas loose transport facilitates seed loss, closed big bags limit spillage. More intense controls should be implemented at railway borders in Austria to prevent spillage due to inappropriate transportation facilities such as defect or sloppily closed unloading hatches of goods wagons. Border railway stations to Italy were identified as spillage hotspots. Because different voltage is used for running the trains (Austria 15 kV, Italy 3 kV), they have to come to a stop at the border. Moreover, sufficient cleaning of goods wagons as well as loading areas of trucks and ships is an essential measure.

## Talk- 3.3

### Managing vegetation along infrastructure verges - Part 2/2

# IPBES key findings on the opportunities of right-of-way infrastructures for pollinators

**Author(s):** Pierre-Edouard GUILLAIN

**Contact:** Pierre-Edouard GUILLAIN

**E-mail:** pe.guillain@fondationbiodiversite.fr

The Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) adopted its first assessment in 2016, focusing on pollinators, pollination and food production. This critical analysis including all existing knowledge from natural and social science, as well as indigenous and local knowledge, bears on the values of pollinators and pollination, their status and trends, and management and policy options to address the drivers impacting pollinators. The assessment deals, among others, with the management of right-of-way infrastructures, for the benefit of pollinators. It looks at the effectiveness of several measures that can be taken. IPBES highlights the increasing opportunities offered by the management of right-of-way infrastructures for pollinators' habitats. Studies in Europe and North America showed that butterflies and bees benefit from the presence of native plants on roadsides. Road verges can also contribute to maintain genetic connectivity at the landscape scale for some pollinated plants. According to a study, railway embankments have a positive impact on bee species richness and abundance, although a negative one on butterfly populations. Another study suggests that a greater butterfly species richness and abundance, including red-listed species, occur within power-line corridors, compared to road verges, clear-cuts or pastures. However, the IPBES assessment points out some risks which need to be considered when managing right-of-way infrastructures for pollinators: for example, cars could disturb or kill foragers by the road. There is also a risk of contamination of bee products, as a study found metal in the pollen, nectar and honey collected by bees from roadside plants. The IPBES assessment also includes good practices adopted when anaging right-of-way infrastructures for pollinators, such as collaboration with engineers working on the infrastructures. Some ideas for funding such management options are identified: for example an American program is funding the establishment of native vegetation on roadsides through road use tax. IPBES experts conclude that, despite some risks which need to be taken into account when managing the right-of-way infrastructures, road verges, power lines and railway embankments have a great potential to support pollinators if they are managed to provide appropriate flowering and nesting resources.

## Talk- 3.3

### Managing vegetation along infrastructure verges - Part 2/2

# Breeding habitat selection and flight characteristics of a farmland raptor species in response to highway in Western France

**Author(s):** Alexandre Villers

**Contact**: Alexandre Villers, CEBC-CNRS, Université de la Rochelle UMR7372, 79360 Villiers en Bois;Groupe Ornithologique des Deux Sèvres 46 rue Rouget de Lisle 79000 Niort

**E-mail:** villers.alexandre@gmail.com

**URL:** http://www.za.plainevalsevre.cnrs.fr/index.php/les-membres/post-doctorants-doctorants-stag

For the past 50 years, agro-ecosystems have been undergoing an intensification of farming practises which resulted in an overall diminution of habitat quality; formerly rich, the biodiversity of those habitats has been steeply decreasing with e.g. ~ 90% of farmland bird specialist species considered as threatened in France. These ecosystems, characterised by a low density of human population, low declivitya nd open habitats, have also been prone to the settlement of infrastructures such as power lines, wind farms or transportation routes. Accurately assessing if and how species respond to such modifications of their environment how farmland birds cope with these structures is indispensable to offer appropriate compensation measures. We propose to determine whether the Montagu's Harrier Circus pygargus, a medium size raptor that breeds mostly in cereal fields and prey upon small rodents, responds to the presence of two highways (among other infrastructures). More precisely, we aim at assessing whether

**1/** the distance to a highway affected the density of nests and

**2/** whether highways' edges were positively selected as hunting grounds or if individuals tended to adjust their flight characteristics when flying over different types of structures . For our first objective, data on the breeding ecology of the species and relevant habitat variables (land use and vole abundance) were collected over 2 study areas cumulating ~ 670 km² (450 and 220 km², between 1997-2015 and 2008-2013 respectively). To investigate the movement ecology of males, 18 individuals were fitted between 2012 and 2015 with light GPS units that allowed us to precisely record their locations and flight characteristics. Analyses conducted on one of the 2 study areas revealed that nests density increases when distance to the highway increases, suggesting that birds avoid the vicinity of highways. Preliminary analyses on birds' behaviour suggest that Montagu's harriers do not use the border of highways as hunting grounds and tend to respond to the presence of highway (or buildings) on their path by increasing their flying altitude. We believe these results, though based on empirical data, will shade new light on the potential effects of highway on a farmland species and will help in implementing efficient mitigation measures in future transportation projects crossing agricultural landscapes.For the past 50 years, agro-ecosystems have been undergoing an intensification of farming practises which resulted in an overall diminution of habitat quality; formerly rich, the biodiversity of those habitats has been steeply decreasing with e.g. ~ 90% of farmland bird specialist species considered as threatened in France. These ecosystems, characterised by a low density of human population, low declivitya nd open habitats, have also been prone to the settlement of infrastructures such as power lines, wind farms or transportation routes. Accurately assessing if and how species respond to such modifications of their environment how farmland birds cope with these structures is indispensable to offer appropriate compensation measures. We propose to determine whether the Montagu's Harrier Circus pygargus, a medium size raptor that breeds mostly in cereal fields and prey upon small rodents, responds to the presence of two highways (among other infrastructures).

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# Talk- 3.3

## Managing vegetation along infrastructure verges - Part 2/2

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**Contact**: Alexandre Villers, CEBC-CNRS, Université de la Rochelle UMR7372, 79360 Villiers en Bois;Groupe Ornithologique des Deux Sèvres 46 rue Rouget de Lisle 79000 Niort

**E-mail:** villers.alexandre@gmail.com

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# Talk- 3.4

## Ecological engineering

# Wetlands and management of runoff upstream of roadways and railways

**Author(s):** Pascal Breil, Camille Fressignac, Lilly-Rose Lagadec, Yannick Matillon, Andréa Nullans, Blandine Chazelle, Benoit Sarrazin, Dominique Vallod

**Contact:** Pascal Breil, IrsteaHydrology-Hydraulics research unit, Hydrological Processes ; Spatial Modelling Team IRSTEA, 5 rue de la Doua, CS 70977, 69626 - Villeurbanne <span clas

**E-mail:** pascal.breil@irstea.fr

**URL:** http://www.irstea.fr/en/institute/centers/lyon-villeurbanne-centre

Road and rail networks are linear transport infrastructure on the ground (ILTS). The ILTS can widely collect the runoff by means of drainage ditches that run along the upstream of ILTS, and then are directed to underground passages to evacuate the runoff downstream. In the aim to not create flash floods in the downstream of a ILTS, a retention device can be installed to complement the upstream drainage device. For security issues, they are placed just downstream of ILTS. The RIZHU project aims to analyze the opportunities of creation or reactivation of wetlands in hillslopes and rivers that are located upstream of a ILTS. The objective is to slowdown the runoff before it reaches the ILTS's drainage system. The RIZHU method aims to reveal, where in a landscape, a humid zone exists, was drained or could take place. This opportunity analysis must be completed with a safety study. On an operational level, RIZHU method is a new approach of the hydraulic context beyond the simple runoff contribution to a ILTS. By knowing which part of a watershed generates the runoff and which are the runoff pathways that feed a storage area where a humid zone takes place or can develop, it seems possible: • to look in a before-project stage, for a planned ILTS, where existing and potential humid zones are located. This, in the aim to reduce the environmental impact of a new ILTS, while seeking to promote the humid zone functioning and as well provide ecosystem service and flood control service. This, to protect the ILTS but also the more downstream issues; • to diagnose, for an existing ILTS, the effects of land use change towards more runoff. This, for considering solutions for maintaining the security-level of the ILTS by integrating the development of humid zones in the land use change; • to reconnect the runoff feeding of humid zones for which the runoff production area has been cut by the ILTS. This strategy of spatial analysis aims to maintain or rebuild the network mesh of humid zones that was interrupted by the ILTS construction. A max distance of 500m between humid zones is required to ensure its ecological functioning. The RIZHU method is based on hydrological analysis using GIS layers. The topography, soil and land use are combined. In this work, it is first introduced the method of selection of GIS indicators. It is then evaluated the ability of the method to identify humid zones by comparing the predictions with existing wetland. An application on two test sites located along a high-speed train line, provides an initial operational evaluation of the method. First results indicate the method is able to find existing humid zones in a region which was not used to calibrate it. Second, a field trip revealed that the method can fail due to missing information in the present method. Third, another field trip revealed that the method was able to detect a small humid zone isolated in a drained agricultural plain.

## Talk- 3.4

### Ecological engineering

# Ecological importance and management measures for verges and embankments associated with transport infrastructure in Flanders (Belgium)

**Author(s):** Andy Van Kerckvoorde, Marleen Moelants

**Contact:** Andy Van Kerckvoorde, Flemish Government, Research Institute for Nature and Forest (INBO)

**E-mail:** andy.vankerckvoorde@inbo.be

In Europe the area of traditionally managed semi-natural grassland habitats has been reduced dramatically during 20th century. Main reasons are the agricultural intensification, urbanization and the abandonment of marginal land. Due to long co-evolution, those semi-natural grasslands are extreme species-rich habitats. To preserve these habitats management measures, based on the continuation of traditional agricultural practices like mowing or grazing, are essential. Verges and embankments of transport infrastructures don't have any direct input of artificial fertilizers or pesticides and are at least partly managed mainly because of traffic safety, slope stabilization and to facilitate transport function. As a consequence, these infrastructure habitats can function as a refuge for semi-natural grassland species, especially in highly fragmented landscapes with few or very small semi-natural habitats left. In this way, infrastructure verges and embankments can provide suitable habitat for many species, even for rare and declining species (red list species). Moreover, verges and embankments may serve as corridors or stepping stones for species thereby increasing the connectivity between habitat patches.Flanders is a highly urbanized region with a dense network of transport infrastructure.The area covered by infrastructure verges and embankments is estimated at approximately 2% of the total surface area. For comparison, 5.6% of Flanders surface are areas with ecological conservation measurements. In Flanders, much attention is paid to infrastructure habitats because of their ecological value and potential. Ecologically orientated management plans are (being) developed and implemented in field for verges and embankments of many navigable waterways, highways and regional roads.Major principles in these management plans are:

- Target to semi-natural grassland vegetation by the introduction or continuation of mowing or grazing measures;
- Adjust management measures in such way that rare and declining species can set seed or reproduce;
- Take into account the ecological and landscape values adjacent to the transport infrastructure;
- For wide verges, aim for a diverse vegetation structure by creating a mosaic of short herbaceous vegetation, tall-herbs, shrubs and trees;
- Vegetation management measures should be carried out in an ecological appropriate way during a long period of time.The basis of the management plans is an inventory of occurring ecological values along the verges and embankments. In a further step, ecological targets are assigned. With this information appropriate management measures are proposed.Expected results of the application of ecologically orientated management plans are the development or maintenance of flower-rich semi-natural grassland vegetation with rare or declining plant or animal species. Consequently, infrastructure verges and embankments should be seen as opportunities to strengthen green infrastructure and ecological networks.

# Talk- 3.4

## Ecological engineering

## Substrata on Wildlife Overpasses - Germany

**Author(s):** Udo Tegethof, Clemens Heidger

**Contact:** Udo Tegethof, Federal Highway Research Institute (BASt)

**E-mail:** tegethof@bast.de

**URL**: http://www.bast.de

In this research work soil construction and vegetation of existing wildlife overpasses were investigated. This was to get knowledge about which characteristics a substrate should have in order to establish certain plant communities, with focus on water/air balance. Examination of 12 several years old wildlife bridges was conducted from August 2012 until July 2014. The overpasses are located in different natural areas within the federal states of Baden-Wuerttemberg, Mecklenburg-West Pomerania, Lower Saxony, North-Rhine Westphalia and Thueringen. All locations showed an extensive anthropogenic modification of soil and stratification. Nevertheless essential conditions for the growth of woody plants are adequately met. Without connection to the natural soil, a thin layered composition of more than 80 cm of thickness was determined to always allow the establishment of a permanent bosk coverage. For the prevention of wooden plants, other substrates are necessary. Continuative investigations developed compositions of substrates determined for wildlife bridges without contact to natural soil. For this purpose, 15 vegetation substrates were developed and studied for their suitability. Results confirm that the majority of material components with open-pored grain structures made from recycled stone or natural stone are suitable. Practical tests with a material mixture were conducted as part of a bat bridge building project. With specific reference to the type of vegetation and its functional goal, finally five standard construction measures were formulated. These are for the vegetation types of heath and neglected grassland, open meadows, open meadows with bushes, bushes and bosks and, as a speciality, bridges for bats. Finally a specification profile for substrate use on wildlife overpasses soil is presented. This is strictly oriented on the physical soil characteristics.

## Talk- 3.4

### Ecological engineering

# The Untapped Potential of Retrofitting: Upgrading Existing Infrastructure to Reduce Fragmentation Impacts and Enhance Wildlife Passage

**Author(s):** Julia Kintsch, Sandra Jacobson, Barbara Charry, Kelly McAllister

**Contact:** Julia Kintsch, ECO-resolutions

**E-mail:** julia@eco-resolutions.com

**URL:** http://www.eco-resolutions.com

Roads and highways fragment natural habitats across much of the planet and have generally been constructed without consideration of how linear infrastructure affects wildlife permeability – the degree to which wildlife of all species are able to move freely across the landscape. Numerous existing culverts and bridges installed for drainage purposes have the potential to pass wildlife. With small modifications – known as retrofits – many of these structures could be enhanced to provide additional crossing opportunities for wildlife in a more timely and cost-effective manner than reconstructing new, greener and more permeable roadways. By retrofitting existing infrastructure where feasible, new crossing structure construction can be focused in high priority areas that are completely lacking suitable passages. A Passage Assessment System (PAS) was developed to facilitate the process of evaluating existing transportation infrastructure for its potential to pass terrestrial wildlife under or over a road. The PAS tool assists users in determining whether existing culverts, bridges, and right-of-way fencing can be modified to improve wildlife permeability, or if it is necessary to replace structures to pass the suites of species at that location. The PAS also guides users in determining which species groups can benefit from retrofitting and what type of retrofit solutions are possible.Since its initial development for the Washington State (USA) Department of Transportation, the PAS has been employed in multiple U.S. states and Israel to identify retrofit opportunities. For example, in the U.S. state of Maine, surveyors using the PAS found that over half of the 109 structures evaluated offered some retrofit opportunity, although the degree to which permeability could be improved varied among sites. In 2015, three U.S. state departments of transportation completed a pooled-fund project to develop the PAS as a free tablet app that is available to other users to improve survey efficiency.To date, there are only a few examples of where retrofits have been implemented, and their performance monitored. Yet, the monitoring data that are available indicate increased wildlife use following a retrofit. However, even where a structure may be retrofit, it cannot always be improved to provide passage for the full suite of wildlife present in a given area – for example, drainage culverts that are not suitably sized for large-bodied fauna with high visibility requirements or that lack a surface conducive to species with highly specialised habitat requirements through a structure, such as permeable-skinned amphibians that require consistent ambient conditions through a structures. Despite these limitations, we believe that targeted retrofits offer the greatest untapped opportunity to improve wildlife permeability across roads while maximising limited mitigation dollars.

## Talk- 3.4

## Ecological engineering

# A method to assess impacts of LTI projects on a territory and its biodiversity stakes

**Author(s):** Éric Guinard, Nicolas Gouix, Élodie Hamdi, Jocelyne Cambecèdes, Gérard Largier, Daniel Marc

**Contact:** Éric Guinard, CEREMA Sud-OuestRue Pierre Ramond - CS 60013 - F-33166 Saint-Médard-en-Jalles Cedex, France. Tel +33 5 56 70 66 73

**E-mail:** eric.guinard@cerema.fr

**URL**: http://www.cerema.fr/

Local and national administrations commonly make environmental impact assessment (EIA) on infrastructure projects like Linear Transport Infrastructure (LTI) to evaluate their potential impacts on biodiversity. This assessment hypothetically needs: i) a standardised and spatialised knowledge of biodiversity on their administrative area (depending on census effort on all the area) and ii) a good knowledge of impacts intensity of the different infrastructure types on all main taxonomic groups. Finally, iii) the main objective of this EIA is to assess the potential impacts of infrastructure projects against biodiversity. From knowledge about biodiversity stake of a study area, the goal is to obtain a threat index compared to a threat level of biodiversity sensitivity to the project. Such standardisation can limit heterogeneity in analysis and help instructors to carry out EIA. Study area and method In the Midi-Pyrénées region, we developed a new method for regional administration (DREAL) from 2012 to 2015. i) A grid of 2.5 km square units is applied on the regional area. Each square unit contains a list of (censused) flora and fauna species and natural habitats (DREAL, CBNPMP and CEN MP databases). This species (and habitats) list allows calculation in a square unit of a regional Stake index which is a sum of 3 indexes applied on each species: Responsibility, Rarity and Vulnerability indexes. ii) For each type of linear infrastructure (LTI, power lines, pipelines, but also wind plant and solar plant, urban project, dam, quarry...), the sum of sensitivity of the main natural habitats and taxonomic groups (Mammals, Birds, Reptiles, Amphibians, Fishes and Crustaceans, Molluscs, nocturnal Lepidopters, Odonates, other Arthropods, aquatic - semi-aquatic and other Flora and natural habitats) are detailed, towards all impacts that can potentially occur during construction and exploitation periods (= Sensitivity index). This analysis depends on literature review and on joint expertise. iii) To obtain a Threat index, a crossing analysis is made, in a square unit impacted by a linear infrastructure project, using comparison between the sum of Stake indexes of all species in the square unit multiplied by the taxonomic Sensitivity indexes towards this kind of project, and a regional Threat level towards an infrastructure project type. This Threat level has been defined as the interaction between the quartiles 3 of all Stake index (per square unit) in the region, of the species number of all square units in the region and of all taxonomic groups Sensitivity index towards linear infrastructure projects. Discussion Our work provides a normalised tool which can be a common basis for stakeholders, instructors and biodiversity administrative departments or offices, in biodiversity (environmental) impacts assessment of infrastructure (LTI) projects in a regional or national area ; this has been improved with real projects. We will discuss the strengths and weaknesses of this method and its future development.

# Workshop- 3.5

## The Green and Blue Infrastructure (la Trame verte et bleue): A French policy of ecological network

## A French policy of ecological network : the Green and Blue Infrastructure (la Trame verte et bleue)

**Author(s):** Romuald Loridan

**Contact:** Romuald Loridan,  Environment, Energy and Sea

**E-mail:** Romuald.Loridan@developpement-durable.gouv.fr

**URL:** http://www.trameverteetbleue.fr/

This session will introduce the Green and Blue Infrastructure policy in France, its principles and how it works.  Official State agents present how a national policy on green infrastructure is implemented on several coherent levels.  This policy is new (initiated in 2007 by the Environment Round Table) and unique in Europe as a national goal, but not well-known enough yet due to a lack of international communication.  The session shows a structural policy designated as an answer to fragmentation of natural landscape, aiming to preserve and restore functional networks. It is based on the "TVB" network: a green component (natural and semi-natural landscapes on land) and a blue component (water and wetland network).  French State has created a complete policy, which integrates local, regional and national frames, and developed initiatives. The Green and Blue Infrastructure is based on three interlocked levels: national guidelines (by decree), regional scheme of ecological coherence (regional council + state government), and planning documents, especially produced by local councils (land use, urban planning); they are meant to be articulated and consistent. Another innovative aspect is the Resource center on TVB: a group of experts from public partners, coordinated by the ministry of Environment, Energy and the Sea. This resource center mostly targets professional users, providing information, making available technical, methodological and scientific resources, and sharing experiences. Whilst still in its early stage, the study of TVB can inspire other countries as an example, and an integrated policy on a national level.

Speakers : Main speaker : Didier Labat, national project officer on the Green and Blue Infrastructure - Ministry on the policy itself - specialists (Centre de ressources) about the methods -  a local government about the regional scheme

## Workshop- 3.5

### The Green and Blue Infrastructure (la Trame verte et bleue): A French policy of ecological network

# Reconnection of Habitats and migration corridors across and along road networks – from national programs to European initiatives about needful improvements for the European Green Infrastructure

**Author(s):** Marita Böttcher

**Contact:** Marita Böttcher, Federal Agency for Nature Conservation Germany

**E-mail:** marita.boettcher@bfn.de

Defragmentation needs environmental information, strategy approaches and programs which comprise concepts for sustainable measures that altogether must regularly be adapted to new insights about ecosystems, dynamics of land use and landscape change and recognized societal needs as e. g. the need of a integrative green infrastructure (EU, COM 249 (2013)). Albeit European national states develop programs to reconnect habitats across and along their road networks since more than thirty years, hot spots for measures are often identified and located at accident areas with game or at intersections of planned or existing ecological corridors. But often fauna passages are not integrated into a corridor management or integrative concepts for green infrastructure. Especially for safeguarding international important migration corridors and needed international cross border activities plans and relevant information are missing or are vague (with some outstanding well-defined exceptions). Based on the pan-european activities in the past and in consideration of the experiences of the German Defragmentation Program (GDP) and its application in the federal states different developed tools and methods as a possible part for the improvement of a coherent European Green Infrastructure network in the context of traffic infrastructure are presented. These range from ecological models to describe nationwide habitat networks (Habitat-Net), the defragmentation of habitat networks for the whole country (Unfragmented functional areas (UFA)), the prioritization of defragmentation areas across the road network in combination with regional plans to interlink habitats, the systematic differentiation and valuation of determined bottlenecks in the habitat networks which are potentially endangered by urban settlement to legally binding rules.

## Talk- 3.6

### Wildlife monitoring and field studies - Part 3.3

# How to evaluate potential ecological effects of dredging operations in French navigated rivers ?

**Author(s):** Alexis Guilpart, Amélie Charnoz, Nicolas Huybrechts, Sylvie Nouvion-Dupray

**Contact:** Alexis Guilpart, Centre d'études et d'expertise sur les risques, l'environnement, la mobilité et l'aménagement (Cerema) Département Ville Durable/ Unité Qualité des Eaux et des Sols

**E-mail:** alexis.guilpart@cerema.fr

Inland waterway navigation can be considered as a sustainable transport solution because of reduced CO2 emissions and its effect on terrestrial roads traffic. Even though it offers a competitive cost, it remains largely under-exploited in Europe. However, inland water transport has also strong environmental impacts, starting with the impacts on the river itself due to engineering, waves and noises caused by navigation. A substancial part of inland waterways networks, especially around barrages and locks, need to be regularly dredged to avoid sediment accumulation in the channel. These operations induce various rates of sediment extraction and resuspension, depending on the volume of the intervention site and the dredging method. The sediment resuspension can affect the ecosystem through the release of polluting susbtances potentially trapped, but also through the release of nutrients, the increase of turbidity and the decrease of oxygen concentration. Moreover, the deposition of resuspended material can alter the viability of local habitats, both for the primary producers and for the fauna. Thus, dredging presents risks at the same time for organisms living in the sediment, the water column and connected benthic habitats. However, dredging operations often occur in heavily developed waterways with concentrated human activities, where the ecosystem is strongly modified by the engineering of the river bank and the river bed, the daily wave wash caused by barges and other anthropogenic perturbations which commonly take place in these watersheds. The local habitats and organisms communities might therefore be adapted to high level of pressure and be resilient to dredging episodes. Dredging operations in French rivers are regulated and controlled by authorities, especially in the WFD (EU Water Framework Directive) context and submitted to impact analysis. Surprisingly, the tangible effect of dredging operations on aquatic ecosystems is poorly documented. Whereas some physical and chemical parameters are clearly mentioned in monitoring programs, the "study of biological compartment" remains unclear and there is a need of precise methods and indicators to investigate this question. Moreover, the level of field survey campaign in time and space should be adapted to the dredging operation typology.We experimented a standard protocol of macroinvertebrate community sampling upstream and downstream a bucket dredging operation on the Oise river, located in Janville (Nord-Pas-de-Calais-Picardie Region). Uptsream and downstream sites were sampled before and after this operation, and combined to physical and chemical parameters (%O2, Suspended material, turbidity, conductivity, Nitrogen, pH, dissolved Fe2+) measured during the operation. In this study we discuss the relevance of various indicators and parameters to assess the environmental consequences of dredging operations. Our results suggest that the local benthic communities are lightly affected by dredging. We also highlight that ecological monitoring of such activities should keep having a flexible methodology to be adapted to local feature of the river and the dredging typology.

## Talk- 3.6

### Wildlife monitoring and field studies - Part 3.3

# Taking into account environmental benefits of urban infrastructural projects' vegetation in Life Cycle Assessment : state-of-the-art and prospective approaches

**Author(s):** Anne Cécile de Bortoli

**Contact:** Anne de Bortoli, École des Ponts ParisTech, Laboratoire Ville Mobilité Transport,Université Paris Est

**E-mail:** anne.de-bortoli@enpc.fr

Environmental assessment with a life cycle approach is an ever more popular method for construction project appraisal. For that purpose, Life Cycle Assessment (LCA) which is standardized (ISO 14040 and 14044) is a robust methodology, adopting a systemic position and calculating environmental potential impacts of a system on a set of quantitative indicators. As ecological prejudices are numerous and delay real advances towards environmental transition, LCA has the advantage to provide quantitative performance ratings and to detect transfer of impacts. In France, LCA may be used to assess the environmental performance of road infrastructure – several road eco-comparators like SEVE, ECORCE or Variways® have been developed in that purpose. Nevertheless, assessing complex systems by LCA entails methodological choices to make the studied object and phenomena simpler through modelling. Indeed, reality is so complex that modelling it entirely is not possible, because science is not advanced enough: scientific phenomena are not entirely well understood, computers are not powerful enough, etc. Road eco-comparators only consider pavement and earthworks in the system boundaries instead of assessing an entire transport project. In particular, despite the public appealing toward urban plantations that are ever more frequent in infrastructural development projects – green walls and roofs, urban kitchen gardens, miscellaneous green embellishment, the real environmental benefit is rarely calculated. Specifically, in an infrastructure project, LCA uniquely captures environmental burden due to construction, and potentially maintenance of green spaces, but does not take into consideration phenomena related to vegetation growth or end-of-life, namely carbon sequestration, ecosystem services, impact on biodiversity, land, resources consumption, etc. Whereas it is common belief that greening cities has positive effects on the environment, the objective of the article is to propose a state-of-the-art of knowledge toward an impartial quantitative consideration of the impacts of infrastructure project's greenery in urban context via LCA. Results show that if some effects related to few indicators would be relatively possible to intercept like climate change or resource consumption, others seem to be more delicate like biodiversity or land use. Moreover, LCA methodology, either attributional or consequential LCA, would consider different phenomena, with high repercussion on the results. The use of methods associated to consequential LCA such as system expansion allows integrating positive aspects of urban plantation such as additional energy resources provided by maintenance of green spaces (e.g. wood recovery). Even though all kind of effects are not methodologically taken into account in LCA – like local impacts (landscape, noise, odor, ambience) or even mind changes which are so important when it comes to environment, it may be valuable to take into account more phenomena related to vegetation in LCA of urban projects. The final aim would be to provide robust information to decision-makers in order to rationalize public and private choices.

## Talk- 3.6

### Wildlife monitoring and field studies - Part 3.3

# Restoring a viable population of lynx in the French Vosges Mountains: insights from a spatially explicit individual-based model

**Author(s):** Laetitia Blanc, Stephanie Kramer-Schadt, Cyril Bernard, Fridolin Zimmermann, Eric Marboutin, Estelle Germain, Olivier Gimenez

**Contact:** Laetitia Blanc, CEFE UMR 5175, CNRS - Université de Montpellier - Université Paul-Valéry Montpellier - EPHE

**E-mail:** laetitia.blanc@cefe.cnrs.fr

Habitat destruction and fragmentation are important threats to large carnivores as they are wide-ranging species and live in human-dominated landscapes. The road network is getting denser and acts as a barrier for these species as well as it increases the risk of collisions with vehicles. The creation of corridors is often advocated in these situations as a way to restore connectivity. Because of increasing conflicts with humans, large carnivores are also particularly vulnerable to poaching resulting in small and isolated populations. Reintroductions are often used as a reinforcement strategy in such situations. Here we compared these two conservation strategies, reintroduction and corridor settlement, in order to determine the optimal solution to halt the decline of the Eurasian lynx population in the Vosges Mountains (France). We developed Spatially Explicit Population Viability Analyses (SEPVA) to evaluate the efficiency of alternative conservation strategies. The SEPVA is particularly relevant in the context of species viability in fragmented landscapes as it combines a population dynamics model and a habitat model through explicit dispersal. We explored the efficiency of i) different reintroduction scenarios in the German Palatinate that is in continuity with the Vosges (a reintroduction is ongoing) and ii) a scenario involving a corridor between the stable lynx population in the Jura Mountains, shared between France and Switzerland, and the declining population of the Vosges Mountains. We found that performing reintroductions performed better than building corridors, and reduced significantly the extinction risk. Further work will focus on refining the corridor strategies. Overall, our approach has the potential to provide an efficient and relevant tool for setting up a management plan for the species.

## Talk- 3.6

### Wildlife monitoring and field studies - Part 3.3

# Individuals Matter: Predicting Koala Road Crossing Behaviour in South-east Queensland

**Author(s):** Cathryn Elizabeth Dexter

**Contact:** Cathryn Dexter, Griffith University Applied Road Ecology Group Environmental Futures Research Institute Nathan Campus Brisbane, Queensland, Australia

**E-mail:** c.dexter@griffith.edu.au

**URL:** http://www.griffith.edu.au/environment-planning-architecture/environmental-futures-researc

The ability to predict the conditions under which certain species of conservation concern cross linear infrastructure (i.e. roads, rail), is an important step toward instituting management approaches aimed at maintaining population viability and integrity. In south-east Queensland, Australia, rapid urban development and related consequences including habitat loss, fragmentation and increasing vehicle-related mortality has significantly contributed to a dramatic decline in local koala populations, which together has led to them being listed as a threatened species in Queensland. Research to determine the success of wildlife-road mitigation works has demonstrated clear benefits in enabling safe passage across roads for many species. However the construction costs of eco-infrastructure that can effectively meet the need for all species to move freely across impacted landscapes is usually both prohibitive and unrealistic at scales commensurate with the problem. Therefore, a better understanding of which individuals that are most likely to undertake crossings should allow resources to be focussed on locations that maximise benefits. This study attempted to do just that, by examining the probability of individual koalas within a set of sub-populations that actually crossed roads within a region. We modelled the number of individual koalas that crossed roads, and the frequency with which they did so, at six sites. We explored the influence of potential predictor variables in models including: age; sex; weight; and distance of first capture point from roads of interest. We grouped all road crossing events including those that occurred both over any major roads of interest or those involving the use of eco-structures. Our assumption was koalas that crossed using eco-structures may have also been inclined to cross roads if such structures were not available, providing an initial picture of road crossing risk. We found koalas were disproportionately more likely to cross roads if first captured within a distance of 100m of a road of interest. We also established that road crossing activity was limited to a relatively small subset of individuals, with only 18/51 (~35%) koalas studied determined to have ever crossed a road of interest. Our results are preliminary, but suggest that a better understanding road crossing behaviour of koalas will have significance for road agencies seeking to mitigate road strike for this species when designing, upgrading or building new roads.

## Talk- 3.7

### Roadkill and citizen science: examples from Africa, Europe and USA

# Driver knowledge and attitudes on animal vehicle collisions in Northern Tanzania

**Author(s):** John Kioko

**Contact:** John Kioko, school for field studies

**E-mail:** jkioko@fieldstudies.org

Roads are a major cause of wildlife mortality through animal-vehicle-collisions (AVCs). There is minimal understanding of driver knowledge and attitudes of drivers, yet there is increase in traffic in most wildlife range. We monitored the patterns and frequency of AVCs on two sections of a major highway in Northern Tanzania and compared these patterns to the knowledge and perceptions of drivers who frequently use the roads. While actual field survey showed that birds were mostly killed through AVCs; mammals were perceived by the drivers to be the most common AVC. Drivers were indifferent to whether AVCs were a major problem on the road, 67% strongly felt that AVCs were mainly accidental, either due to high vehicle speed or poor visibility at night. There was a negative correlation between the likelihood of a species being hit by vehicles and its average body mass. Only 35% of drivers said they had attended an educational program related to the impact of roads on wildlife. Our study highlights a need for collaborative efforts between the wildlife conservation and road department to educate vehicle drivers on the importance of driving responsibly and exercise due care for wildlife and human safety. This should be coupled with implementing effective mitigation structures so as to reduce the extent of AVCs.

## Talk- 3.7

### Roadkill and citizen science: examples from Africa, Europe and USA

# Using citizen science to survey roadkill over large spatio-temporal scales: the example of South Africa

**Author(s):** Stéphanie Périquet

**Contact:** Stéphanie Périquet, Department of Zoology and Entomology University of the Free State, Qwaqwa Campus

**E-mail:** stephanie.periquet@gmail.com

Roads affect wildlife through a range of mechanisms from habitat loss and degradation by decreasing landscape connectivity to direct mortality from collisions with vehicles (roadkill). It is challenging to estimate the direct impact of wildlife-vehicle collisions on wildlife populations, but this cause of mortality has been rated amongst the highest modern risks to our fauna. Repeated road surveys conducted by trained personnel are the ideal way of monitoring impacts of roadkill on wildlife, but are impractical over large areas. However, with the development of "citizen science" projects, in which members of the public participate in data collection, it is now possible to monitor this phenomenon over scales far beyond the limit of traditional field studies. This tool has far-reaching implications for ecologists, but has not yet been rigorously tested. In this study, we used social media and a simple smartphone app ("Road Watch") to mobilize citizen scientists to collect data on mammalian roadkill across South Africa (with an estimated road network length of 1.2 million km). From 1999 to 2015, a total of 2680 roadkill occurrences were reported by citizen scientists and stored in the Endangered Wildlife Trust's roadkill database. We identified two main types of reporters: those that conducted regular road patrols (each person reporting >50 roadkill) and those that submitted opportunistic data. Throughout this study, we compared data from regular and opportunistic reporters, and found few significant differences between these data sets. Based on regular reporter data, carnivores (44%), very small species (≤10kg, 25%) and nocturnal species (43%) were most often found killed on South African roads. The five species reported most frequently were scrub hares (Lepus saxatilis, 10%), various rabbit sp. (9%), bat-eared foxes (Otocyon megalotis, 8%), black-backed jackals (Canis mesomelas, 7%) and aardwolves (Proteles cristatus, 5%). Unidentified mammals represented 8% of the dataset. Mammalian roadkill were most often reported on national roads (32%) and paved roads in general (96%) compared to smaller and unpaved roads. We identified three major roadkill hotspots representing high-risk areas for wildlife, two located in the Northern Cape province and one in the Free State. They were all centered on heavily used national highways linking Johannesburg to two of the country's biggest cities: Cape Town and Durban. This study is the first to provide a nationwide survey of mammalian roadkill in South Africa. Some groups of mammals are reported more frequently as roadkill than others e.g. carnivore and nocturnal species. While this pattern may be partly due to observer bias, it confirms what has been described in smaller studies elsewhere in Africa. Our analysis demonstrates that citizen science surveys can be used to provide solid roadkill data, in determining trends across very large areas difficult for scientists to monitor. These trends can determine potential roadkill hotspots and species at risk, which in turn can become the focus of more detailed monitoring, ultimately leading to the implementation of roadkill-reduction-measures.

## Talk- 3.7

### Roadkill and citizen science: examples from Africa, Europe and USA

# AVC Report Application www.srazenazver.cz: Summary of Experience from the User and Administrator Points of Views

**Author(s):** Michal Bíl

**Contact:** Michal Bíl, CDV - Transport Research Centre

**E-mail:** michal.bil@cdv.cz

**URL:** http://www.srazenazver.cz

We summarize our experience with the animal-vehicle collision (AVC) report application www.srazenazver.cz. This tool was launched to cover as many AVC sources as possible in one place. This application is accessible through common web browsers and allows the user to input, edit and browse data accumulated by other users. The data is visualized in the form of a map or table. Each registered user can add data. Users have several authorizations which are based on their status. Hunter area administrators have higher rights than common users. They are allowed to edit data included within their custody. Data are continuously and automatically checked to prevent application misuse and determine duplicates. Suspicious records are also sent vie e-mail to the application administrators in an automatically generated weekly report. We have programmed an online module which utilizes the KDE+ approach to identify locales with AVC concentration (clusters). The clusters are dynamically re-calculated when a new entry comes into the database. The clusters consequently always represent the best option for identifying dangerous places on roads based on the available data. AVC density on road segments is also calculated at the same time. Both values are visualized on a second map view within the application. As many as 9,136 road kills were recorded over 2015. Only 4,449 (49 %) records had attributed species. The majority of the records belongs to roe deer (67 % of the identified species), followed by wild boar (13 %) and hare (7 %). The reason why 51 % of records had not species identified was caused by the fact that the majority of the records came directly from Police road information generally classified as "animal-vehicle collision". Only a smaller part of these records had additional information attributed where the species was specified. These data were data-mined by using a full-text analysis. The value of AVC data stored in the database will rise over time, however. This application is currently the only platform which stores data on AVC from various sources (Police, hunters, volunteers) for the entire Czech Republic. About 5 % of the hunter areas are responsibly administered. Spatial analyses and ecological models are possible to conduct, however, for these parts even at present when data are irregularly distributed throughout the country. We identified certain problems which limit the use of the application. Only several hundred hunters are registered and add data regularly. We have identified the three principal reasons why the application is not used by hunters more frequently: the majority of hunters are rather old with a negative view to informatics. They are also not motivated by the Ministry to report the road kills to this application. The current hunter law and associated system of shooting permissions penalizes those who report road kills. Their species shooting limits are lowered by the number of recorded road killed individuals.

## Talk- 3.7

### Roadkill and citizen science: examples from Africa, Europe and USA

# Putting the citizen in science: using volunteer-based data to determine the effect of vehicular traffic on endangered western leopard toad (Amietphrynus pantherinus) in Noordhoek, Cape Town

**Author(s):** Wendy Jane Collinson, Donnavan Kruger, Jeanne Tarrant, Alison Faraday, Richard Faraday, Louis H Du Preez

**Contact:** Wendy Collinson, The Endangered Wildlife Trust

**E-mail:** wendyc@ewt.org.za

**URL:** https://www.ewt.org.za/

Amphibians are one of the most impacted vertebrate groups at risk from roads during breeding migrations and feeding events, in particular wildlife-vehicle-collisions (WVCs). The last 20 years have seen a dramatic increase in efforts by volunteers and scientists to mitigate the negative effects of roads and traffic on wildlife globally, including fencing to prevent WVCs and wildlife crossing structures to facilitate landscape connectivity and reduce road mortality. WVCs have been identified as one of the main threats facing the endangered Western Leopard Toad (Amietophrynus pantherinus), found endemically in coastal suburbs in Cape Town, South Africa. Due to the desirability of coastal land for residential homes, there has been an increase in WVCs on A patherinus. In 2008, a volunteer group consisting of local residents Toad NUTS (Noordhoek's Unpaid Toad Savers), was established to rescue migrating toads off roads and to record observations and locations. A 'rescue and record' protocol was created whereby volunteers were trained to drive the roads bordering the breeding ponds and remove toads off the roads. A photograph of each toad was taken and size and sex recorded. Data are collated per season and used to track roadkill numbers, identify road hotspots and breeding ponds and to help motivate the volunteers. Our protocol identified A. pantherinus road mortality hotspots, prompting Toad NUTS to seek alternative methods to reduce the number of fatalities and to make the rescue process safer for the volunteers. As the first experiment of its type in South Africa, Toad NUTS in collaboration with The Endangered Wildlife Trust pioneered shade cloth drift fences and pitfall traps erected on the roadside verges to reduce road mortalities of A. pantherinus on their migration routes on a main road in Noordhoek, Western Cape. The design of these fences was based on recommended international practices, but also took into account developing world conditions such as: severe budget limitations, possibility of theft, potential for human interference, and erection and patrolling by non-scientifically trained volunteers. The road kill numbers reflect the success of the barrier erected for 900m along Noordhoek Main Rd. Before the barrier was in operation 29.5% of 105 toads collected were found dead on the road in 2011. Similar figures were noted in 2012 and 2013 with 29% of 155 toads followed by 27.1% of 70 toads collected on the road. The barrier was erected after the first week of the 2013 breeding season with 0% of 88 toads collected found dead on the road; further decreases in road mortalities were noted in 2014 (3.6% of 138 toads collected) and 2015 (1.9% of 106 toads collected). The Toad NUTS initiative has been a self-started, community-funded project involving ~100 local residents in nightly road patrols over eight breeding seasons (2008-2015). This has resulted in increased public and driver awareness of A. pantherinus as well as the successful adopting of a roadkill-reduction measure. The data collected over eight years of road patrols and for three years of barrier patrols, has been essential. These data further reflects the value that volunteers can contribute to citizen science. However, it is clear that a single strategy to conserve this species is not enough; conservation strategies need to be site-specific and community awareness and participation in the form of volunteerism and financial support is essential. Together, with appropriate levels of support provided by the scientific community, local volunteerism may be the most important and enduring strategy for an African country such as South Africa with limited financial resources available for continuous conservation projects.

# Talk- 3.7

## Roadkill and citizen science: examples from Africa, Europe and USA

## Maine Audubon Wildlife Road Watch Citizen Scientist Observations

**Author(s):** Barbara Charry, Fraser Shilling

**Contact:** Barbara Charry, Maine Audubon

**E-mail:** bcharry@maineaudubon.org

Maine Audubon Wildlife Road Watch (WRW) is a citizen science project developed in partnership with Maine Department of Inland Fisheries and Wildlife, Maine Department of Transportation, and University of California, Davis Road Ecology Center. Volunteers record their observations of wildlife crossing roads — both dead and alive — on the WRW website (wildlifecrossing.net/maine/).Wildlife need to move across the landscape to find food and water and areas to rest, breed, and raise their young. Roads and traffic can make it difficult or impossible for animals to move safely. Wildlife populations can be reduced or even go locally extinct due to collisions, as well as, the inability to move to necessary habitats. Wildlife movement has become even more important for population survival as habitats shift due to climate change and animals must adapt by moving to find more suitable habitat. Wildlife-vehicle collisions are also a serious safety issue for drivers. Understanding and identifying where animals are moving both successfully and unsuccessfully across roads can help wildlife and road managers, at both the Maine Department of Transportation and local town level, know where to implement wildlife crossings and road enhancements to help animals cross roads safely and protect driver safety. This can include wildlife crossing underpasses, overpasses, fencing and signs. Between July 2010 and December 31, 2014, over 460 volunteers have recorded over 4800 observations which includes 6000 individual animals recorded. The observations were used in a geographic information system (GIS) to find stretches of road where wildlife road–crossing attempts occur more frequently (high density locations) and places where there are statistically-significant clusters of wildlife road-crossing attempts (hotspots). Both high density locations and hotspots are important for understanding and planning for wildlife movement. Places where high density locations and hotspots overlap are especially important. The Wildlife Road Watch project structure, volunteer outreach and data analysis process and results, as well as, an interactive web map to view the results will be covered in this presentation

# Talk- 3.8

## Habitat and Conduit

# Absurdity or reality? Roadside verges are a premium habitat and act as a large-scale corridor, while even motorways are a minor barrier for the hazel dormouse (Muscardinus avellanarius)

**Author(s):** Juliane Kelm, Björn Schulz, Göttsche Matthias, Thomas Steffens, Heinrich Reck, Kathrin Friebe

**Contact:** Juliane Kelm, Zoological Institute, University of Kiel and Stiftung Naturschutz Schleswig - Holstein

**E-mail:** juliane.kelm@sn-sh.de

On the one hand roads and their impacts are recognized as one of the main factors threatening mammal biodiversity especially in the crowded areas of central Europe (Benítez-López et al. 2010). On the other hand, all kinds of roadsusually imply roadside habitats, which a) can be highly connected landscape elements, b) can cover a significant high proportion of land and c) are regularly managed by road administration. In the northern German federal state of Schleswig-Holstein, road verges must actually be managed as a component of the habitat system (§18a StrWG SH). So roadsides have the potential to play a noteworthy role in habitat and species conservation, but good examples, whereroadside habitat managements have led to an improvement of a species status are rare or amiss. The hazel dormouse is a strictly protected species in Europe (Habitats Directive annex IV, Bern Convention annex III), endangered in our study region in Northern Germany (Borkenhagen 2014) and missing in most neighbouring regions. It is known as a strictly arboreal species living in the canopy at the edge of forests and in shrubs (Juškaitis 2014). Movements onground are a rarely observed behaviour (Bright 1998) and movement studies show that even small pathways are a significant barrier (Bright et al. 2006). Only few studies have given proof, that the hazel dormouse can traverse longer distances on ground (Büchner 2008,Juškaitis 2014) and that roads are not a total barrier (Chanin & Gubert 2012).But recently we found more and more evidence of hazel dormouse living in Schleswig-Holsteins roadside habitats. Therefore we conducted several studies to answer these questions:

1. Do dormice regularly live in roadside habitats and on traffic islands?

2. Does road crossing take part and if yes, is it an exceptional behaviour or does it happen regularly? Is there a close genetic relationship between populationson either side of the road?

3. Do continuous roadside habitats over a longer distance function as migration corridors? Is this roadside habitat network as suitable as habitat networks in adjoining cultural landscapes? Capture-mark-recapture-study showed that hazel dormice reproduce at roadside verges habitats and 30 crossings overroads were proved. An additional telemetry-study proved 27 crossings over roads; so road crossing can be a relatively frequent behaviour. A large scale genetic study showed, that populations in habitats on both roadsides are genetically close related. Genetic differences via longer distances along roadsides were lower than via agricultural landscape. In summary a comparison of dormouse habitats

a) along roads,

b) in cultural landscapes and c) in forests show a high importance of roadside habitats for the both survival anddispersal of this species in Northern Germany. Road authorities are well aware of this responsibility and consider the species' need in management plans and management practice.

## Talk- 3.8

### Habitat and Conduit

# Constructed stormwater systems extended to provide biodiversity- neutral roads

**Author(s):** Zhenhua Sun, Sondre Meland, Ekaterina Sokolova, John E. Brittain, Svein Jakob Saltveit, Sebastien Rauch

**Contact:** Zhenhua Sun, Chalmers University of Technology

**E-mail:** zhenhua.sun@chalmers.se

Roads have significant effects on aquatic environment and ecosystems, leading to the loss of freshwater habitats and a decrease in aquatic biodiversity. In face of the degradation of freshwaters and the loss of ecosystem services, constructed ponds and wetlands can be established as potential options for compensating the adverse effects of roads. Constructed ponds and wetlands are known as sustainable urban drainage systems (SUDS) that provide multiple ecosystem services simultaneously, such as flooding and pollution control, as well as biodiversity services. Nowadays the concept of sustainability has become increasingly popular in road construction. Biodiversity has played a crucial role in the framework of recent policies and international conventions for promoting sustainable development. Several studies demonstrated that constructed ponds and wetlands are able to support wildlife and enhance biodiversity, providing new opportunities for species to resist disturbance. The adoption of constructed ponds and wetlands is in compliance with the main goal of the EU Water Framework Directive, which pinpoints a vital trend towards an ecosystem-based approach to achieve “good ecological and chemical status” for all surface waters and groundwater in Europe. However, due to the complex interaction between different ecosystem services, detailed studies are still needed to provide a solid basis for biodiversity protection and promotion. The paper will present the results from an on-going project aiming to determine the factors that control biodiversity in constructed ponds and wetlands along roads. Different biotic and abiotic factors that influence the aquatic biodiversity will be identified using the data collected during the sampling campaign in Norway. Biological data will be explored in combination with chemical data and physical features. The influence of hydroperiod, chemical pollutants, and physical aspects of water and sediment quality (e.g. pH, conductivity, and temperature) on the biodiversity (e.g. abundance of macroinvertebrates) will be analysed. The relationship between the cover of aquatic vegetation and the abundance of macroinvertebrates will also be explored due to the crucial role of aquatic vegetation in providing shelter, food resources, and habitat structural diversity. Mathematical models that can be used to simulate the influence of various factors are being reviewed. Such models play a crucial role in quantifying ecosystem services and bridging gaps between theoretical knowledge and practices.This study will disclose the factors that maintain and enhance biodiversity and at the same time provide flooding and pollution control in constructed ponds and wetlands along roads.

## Talk- 3.8

### Habitat and Conduit

# The Function Deterioration or Loss of Deer-Vehicle Collision Prevention Facilities Caused by Snow Accumulation

**Author(s):** Misako Noro, Takane Shikano, Masato Sato, Fumihiro Hara

**Contact:** Misako Noro, Hokkaido Development Engineering Center

**E-mail:** noro@decnet.or.jp

Hokkaido, the 2nd largest island of Japan, is quite snowy with annual snowfall of approx. 700 cm and the max. 200 cm cumulative snow. The tremendous snow accumulation due to such heavy snowfall causes in winter the function deterioration or loss of deer-vehicle collision prevention facilities including deer-proof fences, jump-outs, one-way gates, underpasses, overpasses, and warning signs. Especially, deer-proof fences are sometimes even broken by deep snow accumulation. This study outlines how snow accumulation hinders the function of deer-vehicle collision prevention facilities and seeks measures to minimize the snow troubles. The types of the facility function deterioration or loss caused by snow accumulation are broadly classified into two: one is the trouble without physical break and another is the one caused by physical facility damage. The facility function deterioration or loss without physical damage of facilities include cases such as: deer fences whose heights are lowered by snow accumulation cannot prevent deer from entering the roadway, or deer cannot use an underpass because its entrance is blocked with snow. The facility function deterioration or loss due to physical damage of facilities may occur because of a part of or complete damage on fence posts, mesh fences, one-way gates' bars and warning sign poles. This study focuses on troubles caused by snow on deer fences. In winter, the deer fence height is lowered due to snow accumulation, which enables deer to overleap the fence to enter the roadway. This problem becomes serious when deer fences are located in the area that is within or close to a deer wintering place. In such an area, in the thawing season, the repetition of thawing and freezing of snow hardens accumulated snow, which facilitates deer to overleap deer fences so as to enter the roadway. As a countermeasure against such problems, the height of the fences is increased to prevent deer from entering the roadway in the snowy season. The state of the facility function deterioration or loss due to physical damage of facilities including fence posts and mesh fences may vary depending on the level of snow accumulation, topography, cut slope structures, weight pressures of removed snow and the location where they exist. To minimize the problems caused by broken deer fences by snow, facility maintenance or repair works are conducted to strengthen or replace damaged parts. More information on the function deterioration or loss of deer accident prevention facilities caused by snow need to be collected to keep the facilities to function properly in winter in snowy areas, seeking for solutions to minimize the snow troubles.

# Talk- 3.8

## Habitat and Conduit

# The Influence of Roads, Land Use, Fire and Flood on Movement, Home Range and Habitat Use of Florida Box Turtle and Gopher Tortoise in the Ocala National Forest Ecosystem, Florida, USA

**Author(s):** Daniel J Smith

**Contact:** Daniel Smith, Department of Biology, University of Central Florida, Orlando, FL, USA

**E-mail:** daniel.smith@ucf.edu

The Ocala National Forest ecosystem (2,000 km2) is a diverse mosaic of wetland and upland plant communities, but increasingly threatened by urbanization along existing roads. One example is Highway 40, a busy two-lane road carrying over 15,000 vehicles/day that bisects the forest. We used radio-telemetry to examine effects of the road, fire management and variation in water levels in floodplain forests on movements, home range and habitat use by gopher tortoise and Florida box turtle. Candidate animals were captured within 500 m of the road corridor. Locations were recorded 1-2 times per week; data recorded included date, time, weather, activity and micro-habitat. Twelve tortoises were tracked from 2012 to 2013, six in pineland (with fire) and six in scrub habitat (without fire). Tortoise home range was on average 1.0 ha (with fire) and 0.73 ha (without fire). Where fire was absent, tortoises used trails, powerlines and roadsides for foraging. Dense shrub layers altered movement pathways, home range size and shape. Sixteen box turtles were tracked from 2012 to 2014. Average home range was 7.21 ha (males) and 22.3 ha (females). There was significant overlap among individuals; in particular, multiple males overlapped individual female home ranges. Maximum straight-line distance traveled was 2 km. There were 10 habitat types represented in box turtle home ranges; 50% or more of the proportion of habitat was mixed pine-hardwood forest, pinelands represented 15%, and remaining habitat types represented 10% or less. The mixed pine-hardwood forest and pinelands consisted of areas that experienced seasonal flooding and box turtle movements mimicked the ebb and flow of the river floodplain. Tortoises and box turtles consistently used roadside areas and 9 road-kills were recorded during the study period. Prescribed fire management in neglected scrub habitat and installation of wildlife passages and fencing along the road will improve population sustainability.

## Talk- 3.9

### Integration with Landscape plans - Part 2/2

# Impact of linear transport infrastructures on ecological continuities and landscapes: comparison and connection of tools and methods

**Author(s):** Alexandra Joyce Locquet

**Contact**: Alexandra Locquet, Paris 1 Panthéon-Sorbonne University - UMR 7533 Ladyss

**E-mail:** locquetalex@gmail.com

Linear transport infrastructures (high-voltage power lines, motorways) impact the landscapes and fragment the natural environment, which influence the circulation of species and requires facilities or management measures to restore ecological continuities. To this end, while studying the territory of the Regional Natural Park of the Ardennes in France, we considered the different tools and methods for analysing, on several scales, the impact of transport infrastructures on the landscape and ecological continuities. Thank to those researches we succeeded to identify spaces where ecological continuities should be restored or created. The issue here is to compare two different methods, a habitat-centred approach and another centred on species, to obtain a complete reading of the whole territory. The “habitat” method is based on an evaluation and a rating of all environments in the territory. The rating is assigned according to several criteria that evaluate the ecological quality of elements. These criteria vary according to the type of element studied (linear or surface). The ratings are added to obtain the final score of the element studied, which makes it possible to assess its quality (proven, strong, weak ecological potential) and to prioritize the various elements which constitute a landscape. The “species dispersal” method simulates the potential displacement of indicator species starting from the reservoirs of biodiversity. This method is based on the maximum cost a given species can incur when moving, depending on the types of environment crossed. These are modelled in the form of a grid in which each cell corresponds to a type of environment to which a resistance coefficient is assigned: the harder it is to cross over, the higher the coefficient will be. These methods were developed using bibliographic searches and a GIS tool which was completed by the creation of data sets (field information and picture interpretation). We show the advantages and limits of each approach. The “habitat” method makes it possible to prioritize natural elements and to see if high ecological quality areas are impacted by infrastructures, which provides a fairly accurate reading of the landscape. The “species dispersal” approach provides an analysis adapted to the animal being studied and a dynamic reading of the ecological network. It emphasizes the impact of infrastructures on the movement of species. However, this method does not integrate one-off elements, and crossing linear and surface data is not obvious under GIS. Both methods are dependent on the data quality, which can lead to bias.We also reveal that these two methods can effectively be used complementarily to assess the impact of infrastructures on both habitats and species. We have used it on several scales (municipal and multi-municipal) with certain limits because on too large a scale the first method is no longer readable.They can also be used to evaluate the effectiveness of actions intended to restore ecological continuity and to integrate transport infrastructures with the landscape (wildlife passages, hedges and groves under power lines...). They can be implemented on any territory.

## Talk- 3.9

### Integration with Landscape plans - Part 2/2

# Method to secure fulfilment of environmental goals in road and rail infrastructure planning. Part I

**Author(s):** Annika K. Jägerbrand, Hans Antonson, Charlotta Faith-Ell, Sara Janhäll

**Contact:** Annika Jägerbrand, Swedish National Road and Transport Research Institute

**E-mail:** annika.jagerbrand@vti.se

This project aims at developing a method to increase the compliance of realized road and rail infrastructure investments with Swedish national environmental objectives, the national transport policy, project goals, project requirements and agreed environmental adaptation measures. The study is directed towards the environmental aspects of the so-called impact objective of the overall objective of the Swedish transport policy and on four of the national environmental objectives where the transport sector has an especially large role: Reduced climate impact, Clean air, A good built environment and A rich diversity of plant and animal life. The project focuses on the location and physical characteristics of the infrastructure but takes also the traffic into account. The project does not include aspects of economics. Case studies of four recently finalized infrastructure projects forms a central component of the project. Results from the first part of the project will be reported and is focused on the handling of the four environmental objectives throughout the environmental assessment, residual impacts and potential for improvements. The results from the first part of the project are based on a systematic literature search and is complemented by real case examples from infrastructure projects in Sweden. Preliminary findings in the literature show heterogeneity with regard to considerations of different environmental goals throughout the planning process research literature.

## Talk- 3.9

### Integration with Landscape plans - Part 2/2

# A model for inclusion of biodiversity in a Swedish system for sustainability assessment of transport infrastructure

**Author(s):** Charlotta Faith-Ell

**Contact:** Charlotta Faith-Ell, WSP Sweden

**E-mail:** charlotta.faith-ell@wspgroup.se

During the last couple ofyears, several systems for sustainability assessment of infrastructure, housingand communities have been developed. However, the aspect of biodiversity hasnot always been integrated into these systems in a satisfactory way. Therefore,the Swedish Transport Administration has initiated a research project aimingdeveloping a system for integrating, assessing and classifying biodiversity intransport infrastructure projects. Furthermore, the project aims at testing themodel in road and rail projects through case study methodology. The model thathas been developed in the research project is based on six impact categories:barrier effects, mortality, disturbance, habitat loss, new nature values andinvasive species. The aim of the model is that it will be used in order toquantitatively describe impacts on biodiversity in Environmental Product Declarations(EPD). Also, the model aims at functioning as a practical tool for planning andsteering infrastructure projects in order to reduce negative impacts onbio-diversity. The model is based on a set of questions and indicators forbiodiversity. The model is focusing on specific infrastructure projects. Also,the model covers all planning stages from feasibility studies, detailed designto construction and links up with the EIA process. This paper aims atdescribing the initial results of the research project, the model that has beendeveloped. Based on the preliminary results, the project shows that models forsustainability assessment have a potential to further the practice of includingbiodiversity in planning of transport infrastructure.

## Talk- 3.9

### Integration with Landscape plans - Part 2/2

# Tunnel Euralpin Lyon Turin: a big railway infrastructure in alpine environment. The challenge of respecting biodiversity

**Author(s):** Elena Luchetti

**Contact:** Elena Luchetti, TELT

**E-mail:** elena.luchetti@telt-sas.com

The international railway project between Lyon and Turin has an ambitious purpose: to limit the environmental impact across the Alps, while enabling the development of international exchanges, particularly for circulation of high capacity freight trains. The cross-border section of this project, between Saint-Jean-de-Maurienne in Savoie (France) and Susa in Piedmont (Italy) is already under construction from the building site of Saint-Martin-la-Porte. To fully meet the main environmental objective, the building sites, necessary for the construction of the line, must cause the least amount of damage to the natural environment, in the greatest respect for the Alpine biodiversity. Thus, the Contracting Authority, the French-Italian company Tunnel Euralpin Lyon Turin (TELT), implements concrete actions during the current construction phase in Maurienne, at Saint-Martin-la-Porte. The current building site covers an area of approximately 25 ha spread over four sites, which have been chosen because already anthropised and highly reworked. However, fauna and flora inventories, realized on a total of 144 ha, have identified some sensitive issues for the natural environment, and in particular: ü Regarding wildlife, these include the presence of protected species Natterjack toad (Bufo calamita), who had once some breeding sites in the areas of the building sites; ü Concerning the flora, the challenge lies in the presence of Early tulip (Tulipa raddii) and Rocambole Garlic (Allium scorodoprasum) inside and close to construction areas. Avoidance, reduction and compensation measures have been implemented, including: ü For Natterjack Toads, several campaigns to capture individuals, during the breeding period, and before earthworks on building site platforms, have been realized by a specialized consulting firm in ecology (Biotope); the amphibian populations concerned have been evacuated and transported to safe areas, on which compensation pools (6 in total, distributed across a network along the Arc river) had previously been realized. Construction site areas have been appropriately closed to prevent recolonization by amphibians, and the puddles have been refilled. ü About Tulips and Garlic, adjustments of the perimeters of site areas have been possible to avoid the destruction of a few plants. For groups of plants located in the middle of the grip of the site, a transplantation campaign has been conducted in partnership with the Alpine Botanical Conservatory who provided scientific guidance. In total, about 3500 Tulip's bulbs and 650 Garlic's bulbs have been transplanted to host parcels situated inside an area of 5 ha subject to restoration, maintenance and conservation of open natural habitats and typical shrub of Maurienne Valley. On building sites, the respect for biodiversity depends also by the incessant fight against invasive exotic plant species (including Summer lilac and Himalayan fleece vine) and the maintenance of ecological corridors.

# Workshop- 3.10

## IENE Railway-Wildlife working group

## IENE Railway-Ecology working group

**Author(s):** Andreas Seiler, Anders Sjölund, Elke Hahn

**Contact:** Andreas Seiler, Swedish University of Agricultural Sciences, Dep. of Ecology, Grimsö Wildlife Research Station

**E-mail:** andreas.seiler@slu.se

**URL:** http://www.slu.se

Wildlife and railway conflicts have so far received relatively little attention across Europe, however, with growing investments in rail infrastructure and the development of high-speed railways, the is also a growing demand for ecologically adapted solutions in rail facilities and train traffic. Due to a lack of knowledge and experience, railway - wildlife issues are often dealt with in the same way as issues related to roads, although there are some relevant differences in design, operation, maintenance and traffic that require special attention and tailored solutions. For example, railway infrastructure is often owned and managed by private companies with clear economic interests rather than by governmental agencies. Train-animal collisions cannot be addressed by reducing vehicle speed or increasing driver awareness; local adjustments in railway level and curve-radius are strongly limited; and options to physically integrate railways in the landscape are fewer than in roads. On the other hand, railways may provide better opportunities to install fauna measures or adjust verge habitats for plant and animal wildlife than what is possible in roads. During the IENE 2014 international conference, a workshop on Rail and Wildlife was held with a specific focus on animal-train collisions. Participants pointed out that the problem may have been considerably underestimated so far. The participants expressed strong interest to collaborate, share knowledge and data and to create a special IENE Working Group for promotion of railway related questions. Now, in the IENE 2016 conference, we activate this working group and intend to initiate concrete collaboration with rail authorities and develop an action plan for joint activities. The workshop is open for anyone interested in the topic.

Participants of the IENE 2014 workshop:

andreas.seiler@slu.se,
mattias.olsson@enviroplanning.se,
par.soderstrom@sj.se,
anders.sjolund@trafikverket.se,
ulrika.lundin@trafikverket.se,
michael.below@bahn.de,
stamar@jbv.no,
je.malo@uam.es,
jsolina@gencat.cat,
d.emond@buwa.nl,
rdornas@outlook.com,
herzog@forst.tu-dresden.de,
jiri.jedlicka@cdv.cz,
Rolle@eba.bund.de,
mfc@grontmij.dk,
maris_kruuse@yahoo.com,
juliana-ribeiro.rocha@ibama.gov.br,
vincenf@tin.it,
eric.guinard@cerema.fr,
lifeimpactoceroadif@gmail.com,
thomas.schuh2@oebb.at,
tone.israelsen@jbv.no,
puky.miklos@okologia.mta.hu,
sep.wedrowny@gmail.com,
jiri.jedlicka@cdv.cz, liga_lieplapa@inbox.lv

## Talk- 3.11

### Wildlife-vehicle accidents

# On the identification of high mortality rate hotspots

**Author(s):** Luis Borda-de-Agua, Fernando Ascensão, Rafael Barrientos, Henrique Miguel Pereira

**Contact:** Luis Borda-de-Agua, Infraestruturas de Portugal Biodiversity ChairCIBIO - Research Center in Biodiversity and Genetic Resources, Universidade do PortoISA - Universidade de Lisboa

**E-mail:** lbagua@gmail.com

One of the main tasks in road ecology is to identify hotspots of high mortality so that one can devise and implement mitigation measures. A common strategy to identify hotspots is to divide a road into several segments and determine when the number of collisions is above a given threshold, reflecting a desired significance level obtained assuming a probability distribution (often the Poisson). The problem of this approach when applied to each segment individually is that the probability of identifying false hotspots is very high, i.e., the probability of making a type I error is very high. For instance, if we establish the threshold based as the top of a 95% confidence interval, then one should expect to incorrectly identify just by chance five false hotspots in every 100 segments. Although one may argue that such overly cautionary approach may be beneficial from a biological conservation perspective, it may lead to the waste of resources and, probably worse, it may raise doubts on the methodology adopted and the credibility of those suggesting it. The problem of multiple comparison occurs in several scientific areas and several corrections have been suggested. Here, we apply three different approaches to the identification of hotspots: a method similar to that of the Bonferroni correction; the false discovery rate (FDR); and a a Bayesian approach that consists of a hierarchical Poisson model. The Bonferroni approach reduces the probability of type I errors, yet the probability of type II errors (rejecting a true hotspot), is very high and thus this procedure has low power. FDR method increases the power of the test while keeping the probability of identifying false hotspots low. The Bayesian approach uses the information obtained from all segments to infer the probability of a segment being a hotspot and avoids some of the problems inherent to the two previous approaches. We discuss the application of these three methods and give recommendations to the identification of hotspots with a view to providing a wide range of practitioners' procedures that are reliable and simple to use in real situations.

## Talk- 3.11

### Wildlife-vehicle accidents

# Spatial patterns of road mortality in medium- to large-sized mammals of the Cerrado and Pantanal

**Author(s):** Fernando Ascensão, Emília Patrícia Medici, Arnaud L.J. Desbiez

**Contact:** Fernando Ascensão, CIBIO/InBio, Centro de Investigação em Biodiversidade e Recursos Genéticos, Universidade do Porto. Campus Agrário de Vairão, Vairão, Portugal.CEABN/InBio, Centro de Ecologia Aplicada “Professor Baeta Neves”, Instituto Superior de Agronomi

**E-mail:** fernandoascensao@gmail.com

Brazil has one of the richest biodiversity and one of the most extensive road networks in the world. Several negative impacts emerge from this interaction, including wildlife-vehicle collisions (WVC).We analyzed the spatial patterns of WVC from medium-large sized mammals (>1 kg) collected along three transects (920 km), fortnightly over one year. We aimed to i) evaluate the relative influence of land cover patterns on the distribution of WVC; ii) assess if WVCs are clustered forming hotspots of mortality, and if so iii) evaluate the benefits of mitigating only hotspot sections. We studied the seven most represented species: lowland tapir (Tapirus terrestris), capybara (Hydrochoerus hydrochaeris), giant anteater (Myrmecophaga tridactyla), southern tamandua (Tamandua tetradactyla), crab-eating fox (Cerdocyon thous), six-banded armadillo (Euphractus sexcinctus) and nine-banded armadillo (Dasypus novemcinctus) (n=924, 92% of records).We found a strong association between WVC probability and road sections with high overall mortality for all focal species. Distance to riparian areas, tree cover, terrain ruggedness and distance to urban areas were also important predictors. We detected several hotspots of mortality, though they overlapped little.Our results suggest that road mitigation solely focused on hotspots may fail to significantly reduce overall roadkill. The results support focusing more on habitat quality and landscape connectivity for a better assessment of road mortality. At the local scale, a larger number and improved road passages with exclusionary fencing of appropriate mesh in riparian areas may provide safe crossings for many species and constitute a promising mitigation measure.

# Talk- 3.11

## Wildlife-vehicle accidents

# Road-kill hot spots can change over the time, variables explaining them do not

**Author(s):** Rafael Barrientos, Mireia Plaza

**Contact:** Rafael Barrientos, Infraestruturas de Portugal Biodiversity ChairCIBIO - Research Center in Biodiversity and Genetic ResourcesCampus Agrário de Vairão R. Padre Armando Quintas 4485-661 Vairão, Portugal

**E-mail**: barrientos@cibio.up.pt

Road-kill studies are often carried out in a limited timescale. The assumption that their results (hot-spots and variables determining them) are maintained over time is then applied. To check the reliability of this premise, in 2014-2016 we repeated a study that we conducted in 2002-2004 in the center of Spain on the factors explaining polecat (Mustela putorious) road-kills, a species very prone to them. We found 63 polecats in 2014-2016 (ongoing) compared with 107 in 2002-2004; we used the same 104 random points in both periods. Our results show that both in 2002-2004 and in 2014-2016 the presence of rabbits (Oryctolagus cuniculus), polecat's main prey, in the road verges was the main factor differentiating between points with casualties and random points. However, the spatial distribution of road-kills has changed in these 12 years. In the sectors where most casualties were recorded in 2002-2004, they have practically disappeared today, coinciding with a reduction in rabbit abundance there. By contrast, the road-kills have increased in sectors where prey species have increased. This has important implications for studies of road casualties as hot spots should be periodically evaluated, especially if it is suspected that variables determining them have changed.

## Talk- 3.11

### Wildlife-vehicle accidents

# A Comparison of Certain Methods for Spatial Analysis of Animal-vehicle Collisions

**Author(s):** Michal Bíl

**Contact**: Michal Bíl, CDV - Transport Research Centre

**E-mail:** michal.bil@cdv.cz

We present a comparison of the most commonly used methods for traffic accident hotspots identification. There are in general three types of methods for hotspots identification. The most straightforward approach is based on aggregated counting of records. The sums are either used directly to rank the segments of roads, or the local spatial autocorrelation statistic (local Getis Ord statistic) is computed. The latter option seems better because it allows for setting an objective threshold for distinguishing significantly dangerous locations. These methods have, however, several drawbacks: segmentation of roads, not considering the regression to the mean and aggregation when the exact positions of animal-vehicle collisions are known. Additionally, various regression models are often built to analyse crash-frequency data. They express the number of animal-vehicle collisions by the use of explanatory variables. There are a number of methodological issues which have to be addressed prior to the application of this approach (e. g. time-varying explanatory variables, under-reporting, the low sample mean and sample size, omitted variables, disunity in the choice of the functional form, segmentation of roads). Hence, regression analyses are time-consuming in the case of crash-frequency data and often produce biased results. The empirical Bayes method uses the results from a regression model as the prior estimate of crash-frequency counts. Afterwards, the prior information is combined with the actual data and a posterior estimate is produced. Although this is a brilliant idea, the accuracy of the empirical Bayes method depends on prior estimates produced by a regression model. Furthermore, this approach provides no objective threshold for distinguishing significantly dangerous locations. Finally, clustering analysis can be used to find locations where animal-vehicle collisions occur more frequently than expected. Clustering methods can either testify to a general clustering tendency or identify the exact positions of hotspots (clusters). In our previous research, we introduced the KDE+ method which is based on kernel density estimation. The KDE+ method is able to objectively determine significant clusters and allows for the ranking of the clusters.We compared the methods for spatial analysis of animal-vehicle collisions from both a theoretical and practical view. Based on our results, we recommend the use of clustering techniques, particularly the KDE+ method, because they are effective, robust and capable of distinguishing whether an animal-vehicle collision occurred due to local factors (clusters) or global factors (random distribution along a network).

## Talk- 3.11

### Wildlife-vehicle accidents

# Are animal-vehicle collisions a random event? – Analysis of the spatial distribution of accident data

**Author(s):** Andreas Seiler, Magnus Sjölund, Richard Andrasik, Carme Rosell, Marina Torrellas, Jiri Sedonik, Michal Bíl, Annika Jägerbrand

**Contact:** Andreas Seiler, Swedish University of Agricultural Sciences, SLU

**E-mail:** Andreas.seiler@slu.se

Ungulate-vehicle collisions (UVC) in Sweden, Catalonia (NE Spain), the Czech republic as well as in many other European countries are an increasing traffic safety issue, causing an escalating loss in wildlife and a growing socio-economic burden. Conventional prevention methods appear as little cost-effective and both Transport and Wildlife administrations call for better targeted mitigation strategies. An essential requisite for this is a good understanding of how accidents are distributed and where they aggregate. Since 2010, in Sweden car drivers are legally obliged to report any UVC to the police and a majority of these reports is followed-up by contracted hunters who take care of the wounded or dead animal and report the exact accident location. In Catalonia and Czech republic, UVC are registered by traffic police and road management teams as drivers and not obliged to report the data. We present a thorough analysis of these reports, using a modified kernel density estimation technique (KDE+) to identify significant clusters in accident frequencies and compare their spatial coherence between ungulate species and between years. During the 5-year period of 2010 to 2014, some 79000 accidents with roe deer (Capreolus capreolus), 19000 with moose (Alces alces), 11000 with wild boar (Sus scrofa) and 7000 with fallow deer (Dama dama) or red deer (Cervus elaphus) have been reported by hunters in Sweden. Of these, 30% to 45% were distributed in a significantly aggregated pattern. UVC clusters covered less than 3% of the entire road network. Within these clusters, accident densities were on average 45 times higher than elsewhere on the roads. In Catalonia during 2007 to 2011, the analyses were performed on 2110 UVC of which 1987 were with wild boar. About 20% of these accidents were included in the significant clusters, covering less than 0,3% of the entire road network. In the Czech Republic, 2009 – 2013, 16 612 UVC (not species specific) were recorded by the police during 2009 – 2013. Of these, 33,2% were significantly aggregated in 2060 clusters covering 0,71 % (267 km) of the Czech road network. There were important differences in aggregation and in cluster locations between species and some differences between time periods as well. Factors associated with clustering can be generalize as providing increased attractiveness and increased openness of the road to wildlife. We conclude that, despite species specific and temporal differences in clusters, only a small portion of the road network needs to be mitigated by physical mitigation measures such as fences or fauna passages to affect a substantial part of UVC. Yet, for the remaining part of UVC that are not aggregated, a different mitigation approach is needed that corresponds to regional or global factors such as wildlife population densities or driver behaviour. Note: The study is stillon-going and will produce further results before the conference that shall be included in an updated version of the abstract.

## Talk- 3.12

### Vision 2050: Ecologically Sustainable Transport System

# Optimal settlement and road network configurations for habitat connectivity - results from modelling coupled habitat and human networks

**Author(s):** Maarten Jan van Strien, Adrienne Grêt-Regamey

**Contact:** Maarten van Strien, Planning of Landscape and Urban Systems, PLUS Institute for Spatial and Landscape Development ETH Zürich, Switzerland

**E-mail:** vanstrien@ethz.ch

**URL:** http://www.irl.ethz.ch/plus/people/vmaarten

For their survival, animal species depend on networks of habitat patches between which they can easily move (i.e. habitat networks). Similarly, human well-being also in part depends on networks of settlements that are well-connected by roads and traffic (i.e. human networks). However, human networks often pose a threat to the connectivity in habitat networks. This threat is two-fold; animal habitats and settlements usually are mutually exclusive (i.e. settlements and natural habitats rarely occur at the same location) and in most cases traffic intensity negatively influences the movement of animals between habitats. Due to the interactions between these coupled spatial networks, it is difficult to determine how the configuration of the human network affects connectivity in the habitat networks. For instance, changes to the settlement configuration may not only directly influence habitat connectivity, but also indirectly via changes in traffic flows. Although such knowledge is important for sustainable landscape and transport planning, few studies have assessed how habitat connectivity is influenced by settlement and road network configuration in coupled human and habitat networks. In this study, we have developed a model with which habitat connectivity is simulated at a regional scale in landscapes with variable settlement and road network configurations. In binary landscapes, we independently varied the number of settlements, the size of the largest settlement patch as well as the total proportion of settlement. The settlements were embedded in a matrix of continuous habitat. Settlements were connected with either dense or sparse road networks. On each road, expected traffic volumes were calculated with novel radiation models. Similar to the road network, the habitat network was constructed by connecting neighbouring habitat cells. With an animal dispersal model, we calculated the probability that an organism would successfully move between cells, which depended on the distance and traffic volumes between cells. Such habitat networks were parameterised for a range of species with different dispersal abilities and sensitivity to traffic (i.e. tree frog, hedgehog and badger). With this setup, the topology of a habitat network and the strengths of its links were influenced by settlement configuration and traffic volumes, respectively. From the habitat networks, we calculated overall habitat connectivity with two commonly used connectivity measures. In general, we found a negative correlation between the number of settlements and the habitat connectivity. Furthermore, for landscapes with a high proportion of settlement, it was more beneficial for habitat connectivity to have one very large settlement patch surrounded by smaller ones. Surprisingly, for some simulations, we found that habitat connectivity was higher with dense road networks than with sparse networks. In addition to new insights in the ecological processes governing habitat connectivity, the results from this study can provide valuable information for the planning of new settlement and transport networks as well as for the improvement of existing networks. Whereas the current study was based on a simplified simulation model, in a follow-up project we aim to add more realism to our models by coupling empirically derived habitat connectivity networks with land-use transport interaction models.

## Talk- 3.12

### Vision 2050: Ecologically Sustainable Transport System

# Nature 2050 is a long-term action program to restore biodiversity and adapt territories to climate change

**Author(s):** Jean Clinckemaillie

**Contact:** Jean Clinckemaillie, CDC Biodiversité

**E-mail:** jean.clinckemaillie@cdc-biodiversite.fr

Nature 2050 is a long-term action program to restore biodiversity and adapt natural, agricultural and forest spaces to climate change. It is also part of the conclusions of the COP 21, aiming to adapt the French territories (including overseas territories), then European, to climate change through natural solutions and improve their ability to capture Carbon. The program has several features which make its originality: - Its long-term commitment (2050) - Its partnership approach involving economic actors, scientists and associations, public and private, - An integrated approach to climate and biodiversity issues, - The use of natural solutions ...

## Talk- 3.12

### Vision 2050: Ecologically Sustainable Transport System

# Developing natural habitats under overhead electric lines: a win-win strategy for biodiversity and society

**Author(s):** Simon de Voghel, Jean-François Godeau

**Contact:** Simon de Voghel, LIFE Elia-RTE project

**E-mail:** devoghel.simon@gmail.com

Transmission System Operators (TSO) have to integrate energy from green sources into the grid. Indeed, electricity produced on an offshore wind farm has to be brought to the consumers. To achieve this, TSO have either to create new high-tension lines or to reinforce existing ones on the grid. Both on existing lines or new high-tension lines, vegetation management is a key issue when dealing with electrical safety of these lines crossing forest areas. In order to avoid any problem, most TSO's proceed to regular vegetation cuttings. The main idea of the LIFE Elia-RTE project is to test 7 alternative methods to manage vegetation. These methods are both promoting biodiversity and ensuring electrical safety : planting structured forest edges, planting conservatory orchards, restoring natural habitats, digging ponds, fighting against invasive plants, mowing or pasturing, or sowing flowering meadows. During 6,5 years, this project is implemented in Belgium (along 155 km of lines) and France (7 sites) to combine electrical safety and biodiversity. The project is financed by the European Commission, Elia (Belgian Transmission System Operator), RTE (French Transmission System Operator), and the Walloon Region. The easement under overhead high-tension lines does never belong to the TSO. Therefore, actions had to be carried out locally, with the involvement of local stakeholders by finding win-win situations. The main idea is to find the most appropriate action that could benefit landowners and land managers. The methodology developed in the LIFE Elia-RTE encompasses the following steps : initial mapping to identify potentialities, agreements with local stakeholders, works achieved by subcontractors (planting, cutting, soil scrapping…), and writing of a long-term management plan. Besides, biological and economical indicators are also monitored. Results obtained within the ongoing project are encouraging : planting structured forest edges (171 ha), planting conservatory orchards (16,5 ha), restoring natural habitats (37 ha), digging ponds (118 ponds), fighting against invasive plants (29 ha), mowing or pasturing (40 ha), or sowing flowering meadows (24 ha). By finding win-win solutions to manage vegetation, the project proves that local stakeholders could also benefit from a high-tension line. Furthermore, public acceptance on actions carried out will ensure their sustainability on a larger timescale. Results obtained concerned partnerships in Belgium and France with 48 municipalities in Belgium, 43 local districts of the Public Forest and Nature Department, 25 high-tension lines patroller, around 340 private owners, 5 main public landowners, around 70 local farmers/hunters/subcontractors, and 3 Regional Nature Park in France. A cost-benefit analysis showed that these alternative methods were cheaper (1.4 to 3.9 times on 30 years) than the ongoing vegetation management, with a return on investment from 3 to 9 years. Other benefits such as a better social acceptance, landscape improvement, or better relation with authorities - much more hard to assess – have also to be taken into account.

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## Talk- 3.12

### Vision 2050: Ecologically Sustainable Transport System

# Developing natural habitats under overhead electric lines: a win-win strategy for biodiversity and society

**Author(s):** Simon de Voghel, Jean-François Godeau

**Contact:** Simon de Voghel, LIFE Elia-RTE project

**E-mail:** devoghel.simon@gmail.com

.../...

These findings can be of great importance for European TSO, and for other linear infrastructures. In order to promote a wide network to implement these techniques, the project has launched a networking campaign towards national Transmission System Operators (TSO). The LIFE Elia-RTE team is in contact with 17 TSO and has organized a two-day event in Belgium that gathered 40 people for all over Europe. Partnership with this TSO leads to exchanges of vegetation management best practices and to the creation of pilot sites to test LIFE Elia-RTE methods.

# Talk- 3.12

## Vision 2050: Ecologically Sustainable Transport System

# Environmental potential of urban gondolas

**Author(s):** Delphine Giney

**Contact**: Delphine Giney, PhD studentUMR 7533 LADYSS, «Paris 1 Pantheon-Sorbonne University»

**E-mail:** giney.delphine@gmail.com

In order to provide future transport infrastructures, sustainable cities plan urban gondolas as a new means of public transit. This aerial transport system is installed in urban and peri-urban areas, especially to cross over natural or urban obstacles (river, forest, railway, road...). Non-existent in France, urban gondolas are mostly developed in South America and in North Africa. Due to the recent development of such infrastructures, there is really little scientific literature on the subject, as shown in this contribution. To introduce urban gondolas as a new sustainable means of transport, we present its environmental impacts and its potential for renaturing cities, using two different methodologies providing results afterwards compared with another linear transport infrastructure: the tramway. Few environmental impact assessments have been conducted so far. In order to assist government services in urban gondola appropriation and to upgrade scientific research, we introduce a methodology inspired by the French Environmental impact assessment (French Environmental Code, article R122-2 and the next) and leading to a decision support tool. The methodology, which includes evaluation of negative and positive impacts and compensatory measures, reveals very low impacts on the environment (biodiversity, air quality, greenhouse gas emissions, noise, energy consumption). We also observe opportunities offered by this new public means of transport for city renaturation through ecological landscaping. Renaturation takes place on the gondola infrastructure (gondola stations, towers) but also beneath the line and its approaches, when country planning allows it. Using a series of criteria and evaluation indicators, we observe that urban gondolas offer a real potential for ecosystem services. We expect this study to widen the scope of possibilities to provide sustainable urban mobility, challenged by the improvement of the environmental quality of cities and residents' quality of life.

## Talk- 3.12

### Vision 2050: Ecologically Sustainable Transport System

# Procedures for the Design of Roads in Harmony with Wildlife

**Author(s):** Eugene J OBrien, András Weiperth, Dennis Wansink, Georg Tschan

**Contact:** Eugene OBrien, Roughan ; O'Donovan Innovative Solutions

**E-mail:** eugene.obrien@ucd.ie

'Procedures for the Design of Roads in Harmony with Wildlife' or 'Harmony' is a project that aims to develop sustainable solutions to road transport challenges that are in harmony with wildlife. This paper is divided into two main parts, covering the areas of (a) Environmental Legislation and Guidelines and (b) Procurement Practices. The project focuses on eight reference countries consisting of Ireland, the United Kingdom, Belgium, the Netherlands, Hungary, Austria, Sweden and Denmark. A review of Environmental Impact Assessment and Appropriate Assessment is carried out for the European reference countries. As part of this review a database of over 80 Environmental Impact Statements (EIS) and AA reports is analysed to identify the similarities and differences between countries in the implementation of the duties required by EU Environmental Legislation. As well as comparing approaches between countries, an audit is carried out to identify the degree of implementation on a 5 point scale under the headings Screening; Scoping; Identification of Habitats; Impact Assessment Methodologies; Mitigation Measures and Monitoring. In relation to this audit, it is found that the degree of implementation under the headings considered varies greatly between countries. A general trend is seen that most countries appear to carry out little or no monitoring. Furthermore, the review shows that cumulative impacts are not suitably addressed in a significant proportion of the EIS's examined. The EIA and AA guidelines of each country are also reviewed and best practice guidelines provided in a simple and easy-to-read format. Additionally, this paper reviews project appraisal guidelines in the eight reference countries. The project appraisal process needs a set of tools to enable rational and sensible route choice decisions to be made that strike a balance between the requirement to protect wildlife and other factors such as economy, safety and societal objectives. The project appraisal methodologies used in the reference countries are compared and a project appraisal framework for use throughout Europe is developed based on the findings of this review. Environmental Protection is incorporated into a holistic project assessment process that balances competing demands. Procurement methods for road construction projects vary widely, including for example: (a) traditional road owner designed and operated; (b) contractor designed but road owner maintained and (c) contractor designed and operated. Increasingly, clients strive for performance-based contracts instead of traditional contract forms. This paper reviews existing approaches to the procurement of road constructions, ecological mitigation measures and maintenance, mostly in the eight reference countries, via interviews with key persons in road/transport administrations. The interviews are also used to identify best-practice experience on the influence of the procurement method on the output delivered and the effectiveness of the service procured.

## Talk- 3.13

### Evidence of efficacy

# Efficiency of compensating measures for the Annex IV-species Common spade-foot toad Pelobates fuscus at a highway between Kliplev and Sønderborg in southern Denmark

**Author(s):** Marianne Lund Ujvári, Per Klit Christensen

**Contact:** Marianne Ujvári, Danish Road Agency

**E-mail:** mu@vd.dk

The aim of the study was to monitor the efficiency of compensation measures for Pelobates fuscus at a new 26 km 4-laned highway opening for traffic in 2012. 141 new breeding ponds were created and 69 existing ponds restored to compensate for the negative effects of the road. 37 of the new ponds and 9 of the restored were supposed to compensate for negative effects on Pelobates fuscus. These ponds were situated in 4 areas with populations of Pelobates fuscus. 8 amphibian tunnels with amphibian fence were constructed to connect Pelobates fuscus habitats. The distribution and population size of Pelobates fuscus was monitored in 2014. The use of the tunnels was monitored in 2012. Distribution and population size of Pelobates fuscus and other amphibians was studied before the construction work in 2001-2 and 2007. The method used in 2001-2 and 2007 was counting male calls in spring and looking for juveniles during summer. In 2014 an underwater hydrophone was used to register male Pelobates fuscus in April. The use of tunnels was studied by an expert walking through the tunnel and the openings in August-September 2012 in warm and humid weather (6 times each tunnel). At Søgårdsmark the Pelobates fuscus population in 2014 was around 201 males in 21 ponds. In 2007 only 55 males were found in 7 ponds. It seems as if the species has had a high breeding success in several ponds and that a large number of ponds had been colonized. In 2001-2 and 2007 only 3 and 1 pond north of the highway respectively was a Pelobates fuscus habitat. After construction of the highway Pelobates fuscus was found in 9 ponds north of the highway and 12 ponds south of the highway. The population size of Pelobates fuscus north and south of the highway respectively at Søgårdsmark was higher in 2014 after construction than the total population size in the overall area before the highway was constructed. 5 amphibian tunnels connect the habitats north and south of the highway. Pelobates fuscus was not found inside any of the tunnels but in the very proximity of one tunnel opening to the south. The tunnel opening was situated very close to a Pelobates fuscus breeding pond south of the highway. Other amphibians, badger and hare used the tunnels. At Potterhus the population size in 2014 was 24 males in 3 ponds all situated north of the highway where Pelobates fuscus was also present in 2001-2 and 2007. No new ponds were colonized. The population size seems to be at the same level as before the highway. 3 amphibian tunnels connect the habitats north and south of the highway. 2 of these were not constructed correctly and are not functional fauna tunnels. The third tunnel was well constructed. Pelobates fuscus was not found inside the tunnel but in the very proximity of the tunnel opening to the south. This is interesting as we did not find any breeding Pelobates fuscus in the ponds south of the highway.

# Talk- 3.13

## Evidence of efficacy

# Use by large mammals of wildlife crossing structure on an overpass in western France. Results of the first three years of camera-trap surveys

**Author(s):** Cédric Heurtebise

**Contact:** Cédric Heurtebise, VINCI Autoroutes, réseau ASF. Direction Technique de l'Infrastructure

**E-mail:** cedric.heurtebise@vinci-autoroutes.com

In 1981, the A10 highway was going through the Lande forest, making a nearly impossible to cross barrier for large wildlife. Back then, a «wild game passage» had been set up in the town of St Ciers du Taillon. Despite its appropriate location, the bridge with its narrow operational width of 4.50 meters was little to not frequented. In 2012, aware of this problem, ASF widened the deck of this former passage by building an overpass (landscape bridge) with an operational width of 18.50 meters. Functional since July 5, 2012 the Fédération des Chasseurs de Charente-Maritime is in charge of monitoring the large fauna use of this facility. This monitoring is ensured by the installation of two «camera trap» devices. One score unit corresponds to an animal's complete crossing of the facility which, depending on its behaviour, may result in one shot or hundreds, in case of feeding behaviour for example. Over the three-year monitoring of 4180 crossings, close to 100 000 shots have been processed. These concerned the sole species of deer (Cervus elaphus), roe (Capreolus capreolus) and boar (Sus scrofa) and permitted the gathering of highly instructive data. Based on these information, we were able to compile an accurate and significant analysis of parameters for each species, like the importance and direction of movements, monthly variations, schedules... The number of recorded crossings for the roe increased steadily by 245% over the three-year period (from 101 to 248 crossings). Concerning boars, the yearly average of 191 crossings fluctuates according to the population level. For the deer, the most represented with a yearly average of 1021 crossings, the results are unmatched in the records and enable a finer analysis by gender and year-class: decrease in the annual crossing frequency for does and youngsters while we note a strong increase for stags. Globally, all species combined, the analysis of crossing numbers by time window shows that animals tend to go over the passage earlier. The exchanges for the three species are relatively balanced between both sides with now one and only deer population on the whole massif and a genetic diversity broader than ever. The cross-checking of data with light counting, as well as the continuous monitoring has enabled to reassure local hunters, originally reluctant before the overpass construction. Indeed this «landscape bridge» contributes to a rational population management. These data confirm the intensive use of the facility and its critical importance when it comes to crossing highways for large-range species (1111 crossings for the deer in the first year). The building of an overpass such as this one also contributes to diminish the penetration of fauna on the network.

# Talk- 3.13

## Evidence of efficacy

# Effectiveness of bat mitigation on roads

**Author(s):** Morten Elmeros, Jasja Dekker, Inazio Garin, Hans Jørgen Baagøe, Morten Christensen

**Contact:** Morten Elmeros, Department of Bioscience, Wildlife Ecology Group, Aarhus University

**E-mail:** elm@bios.au.dk

Roads may have detrimental impact on bat populations by increasing mortality rates, fragmentation and habitat degradation. To comply with the legislative obligation to maintain favourable conservation status of bats it is essential for road and nature authorities to include effective mitigation strategies for bats when expanding or upgrading road infrastructures. A range of mitigation measures has been installed on roads across Europe to function as road safe crossing structures for bats (e.g. culverts, bat gantries, hop-overs and green bridges) or to compensate for habitat destruction (e.g. artificial roost sites). These measures have been developed on the basis of general knowledge on bat ecology and landscape use, and observations of bats' flight behaviour near roads. Intuitively the implemented measures will help bats to cross roads safely, and several studies have described bats using the structures to cross the roads. However, observations of bats flying along a structure do not imply that the structure effectively contributes to maintaining landscape permeability for bats or that the impact of the road has been mitigated and off-set on population levels. The proportion of bats that cross a road safely using the mitigation measures, i.e. documenting their effectiveness, has rarely been evaluated in quantitative terms, and the studies show inconsistent results, e.g. recent studies in UK and Poland have documented that gantries are inefficient to guide bats safely across roads. Only a couple of high profile studies in Wales and Germany have monitored and assessed the impact of road schemes and mitigation strategies on population levels. The 53 European bat species have different flight patterns and show a high plasticity in their spatial and temporal behaviour, i.e. the effectiveness of a mitigation strategy may depend on species composition and landscapes structure. Furthermore, documentation of the effectiveness of bat mitigation structures and the overall mitigation strategy for a road scheme is often hampered because survey methodology in pre-construction assessments and post-construction monitoring projects differs (e.g. timing of year, equipment and location). As a consequence of the limitation and inconsistency in the knowledge of the effectiveness of bat mitigation measures, road agencies may currently implement measures which are inefficient. To improve the understanding of the effectiveness of bat mitigation strategies on roads and advance on the developing cost-effective methods to mitigate road impact on bat conservation, we compiled up-to-date information on constructed bat mitigation measures and published studies on the efficiency of bat mitigation strategies on roads in Europe. The presentation will present: - An overview of bat mitigation on roads in European countries. - An evaluation of the effectiveness of different types of mitigation measures, and - Recommendations for research needed to develop effective mitigation strategies for bats on roads.

## Talk- 3.13

### Evidence of efficacy

# Roadkill: Are mitigation measures effective for small and medium-sized mammals?

**Author(s):** Judith Plante, Jochen A.G. Jaeger

**Contact:** Judith Plante, Concordia University

**E-mail:** judith.plante@hotmail.com

Roads are now widely considered as a major source of disturbance to wildlife. In addition to decreasing the quantity and quality of habitat, they often create a barrier to wildlife movements. However, the most observable effect on a daily basis is the wildlife mortality associated with road crossing attempts. To try to reduce road mortality, mitigation measures such as wildlife passages have been developed. These mitigation measures allow animals to cross the road without having to go across the road pavement. However, most of these mitigation measures were specially designed for large fauna because large mammals represent a potentially deadly danger for drivers. Even though road mortality could also endanger populations of smaller fauna, little work has been done to reduce collisions with them. During the widening of Quebec's Highway 175 from two to four lanes, 33 wildlife passages designed specifically for small and medium mammals were added under the road. Small fauna fences were also built for 100 meters on each side of every passage to direct animals through the passage entrance. They are among the first wildlife passages built in the province of Quebec. Our study examines the effectiveness of these passages and exclusion fences to reduce road mortality of small and medium mammals while controlling for the potential confounding effects of landscape variables. To do so, we analyse the spatial distribution of road mortalities along Highway 175. Daily mortality surveys were conducted by car during summers 2012 to 2015. During these four years, 895 mortalities were found comprising 14 different species or taxonomic groups. The North American Porcupine was the mammal most often found. We examined the relationship between roadkill locations and distance to various landscape and road features such as forest cover, water bodies, and road sinuosity and the mitigation measures. Detection probability was also considered during statistical analysis. Mortalities were lower within the fenced sections than the unfenced sections. Mortalities were the highest at the ends of the fenced sections. The results may indicate a displacement of roadkills to the ends of the fences. To resolve this issue, the fence design should be revised to prevent animals from going around the fence ends. Furthermore, the presence of shrubby vegetation in the median strip separating the two directions of the highway also increased the number of roadkill.

## Talk- 3.14

### Habitat and Conduit: Effects on pollinators

# The habitat value of power line rights-of-way for pollinators (bees and butterflies) in agricultural landscapes

**Author(s):** Violette Le Féon, Héloïse Blanchard, David Martinière, Jean-François Bretaud, Eric Guinard, Mickaël Henry, Christophe Pineau, Bernard E. Vaissière, Denis François

**Contact:** Violette Le Féon, Equipe «Pollinisation et Ecologie des Abeilles» UR 406 «Abeilles et Environnement» INRA Centre de Recherche PACA 228 route de l'Aérodrome CS 40509 Domaine Saint Paul - Site Agroparc 84914 AVIGNON Cedex 9 FRANCE

**E-mail:** violette.lefeon@gmail.com

To ensure safe transport of electricity, the vegetation in power line rights-of-way (ROWs) must be maintained low. In wooded areas, the construction and maintenance of power line ROWs thus require regular clearings that can have negative ecological effects on forest species through the fragmentation of continuous forest habitats. However, this also creates open areas that may be suitable to plant and animal species associated with open habitats such as grasslands or moors. The value of these open areas for biodiversity has rarely been studied, especially for insect pollinators. Maintaining suitable pollinator habitats in agricultural landscapes is an important issue due to their vital role in pollinating many crops and wild plants. Here we assessed the value of power line ROWs as habitat for pollinators by comparing assemblages of bees (Hymenoptera, Apoidea) and butterflies (Lepidoptera, Rhopalocera) with those found in typical pollinator habitats in neighbouring agricultural landscapes, i.e. semi-natural (extensively managed) grasslands. We also surveyed the availability of food and nesting resources to better understand the drivers of bee and butterfly abundance, species richness and assemblage composition in ROWs. The study was carried out in central France, near Limoges (45°51'N, 1°15'E), in 31 power line ROW sites and 25 grassland sites. Bees and butterflies were surveyed by sweep netting in suitable weather conditions during 40-min transect walks. Regarding the availability of food and nesting resources, the following variables were considered: flowering plant cover and species richness, shrub cover, vegetation height, bare ground cover, and presence of dead wood. A total of 109 and 78 bee species were collected in the power line ROW and grassland sites, respectively. Bee abundance and species richness were higher in power line ROW sites than in grassland ones. A total of 59 and 50 butterfly species were found in the power line and grassland sites, respectively. The mean number of butterfly species was not significantly different between the two groups of sites. We also identified key environmental factors affecting bee and butterfly assemblages in power line ROWs. The cover and species richness of flowering plants and the availability of nesting sites for both above ground and below ground nesting bees positively affected bee species richness and abundance. On the contrary, shrub cover (especially ferns) negatively affected bee species richness and abundance as well as butterfly species richness. The composition of bee and butterfly assemblages in power line ROW and grassland sites will also be analysed from both taxonomic and functional approaches, and considering species status (rare vs. common species). Overall, our study indicates that power line ROWs are valuable habitats for pollinator conservation in agricultural landscapes. As management recommendations, we suggest to maintain patches of bare ground and not to remove dead wood resulting from management interventions, at least small branches. Moreover limiting fern cover could enhance flower abundance and diversity.

## Talk- 3.14

### Habitat and Conduit: Effects on pollinators

# Motorway edges as refugee for butterflies – preliminary results of case study from the Czech Republic

**Author(s):** Vladimír Hula, Jana Niedobová

**Contact:** Vladimír Hula, Department of Zoology, Faculty of Agronomy, Mendel University in Brno

**E-mail:** hula@mendelu.cz

Motorways and other roads are usually considered as threat for most of the nature. They make barriers for migratory species, fragmented homogenous habitats, cause roadkills etc. There is also another point of view on roads. Mainly in Western Europe and United States there is a pressure to use the edges of roads (and also railways and river dikes) as a habitat source for different invertebrates, mainly for butterflies. The usual way of management on these habitats is planting of bushes and on some places mowing of grass turf. This turf is composed mainly from different grass species, herb are generally sparse. Our aim is to use motorways as a migratory corridor for different thermophilous butterfly species and as a connection between particular Protected Areas across whole Czech Republic. In year 2015 we established 10 sites across the country where we placed 10 Moericke traps per site in 100 m long transect for collecting of butterflies to state initial stadium of local butterfly community. Traps were emptied 6 times during season (altogether 600 samples per season). We collected 27 species (363 specimens). Amon common ubiquitous species we found also some rare and endangered species (Polyommatus bellargus, P. thersites, Coenonympha arcania, Brinthesia circe, Colias alfacariensis) or typically xerophilous common species (Plebejus spp., Zygaena loti). Most these butterflies prefer as a food plant different species of family Fabacae or grasses. But all need special structure, they cannot survive in dense turf which is usually present on our localities. On the other hand localities have potential to host interesting butterfly species and possibly they could be used as stepping stone for future migrations. At year 2015 we start with future management of sites – we sowed half of all sites by seeds of hemiparasitic plant Rhinanthus alectorolophus to control grass population and bring space for herbal species into the turf. The whole study will continue until the year 2019, when we will observe the impact of population of R. alectorolophus on vegetation composition and via this way also on butterflies populations (via food plants). We expect, that due the decreasing mass of grass species, herbal species will expanse to the space within the turf and these plants will host butterflies. We suggest that reduction of grass will lead to decreasing management cost of motorway edges thanks to lower vegetation productivity.

## Talk- 3.14

### Habitat and Conduit: Effects on pollinators

# Greening highway corridors to support butterfly metapopulations in protected areas: new technology for restoration of semi-natural vegetation using root hemiparasites

**Author(s):** Jan Mladek, Tomas Sikula

**Contact**: Jan Mladek, Palacky University

**E-mail:** jan.mladek@upol.cz

Highway corridors are usually fringed with wide safety verges that are often maintained as grasslands by mulching several times a year. Improperly grassed verges represent a significant threat to native flora and fauna, but verges hosting semi-natural vegetation might serve as new habitats for many endangered butterflies and connect their last isolated metapopulations in neighbouring protected areas. Semi-natural vegetation can be established either by seeding regional grass-forbs mixtures, which is quite expansive and feasible only on new road constructions, or by ecological restoration of contemporary vegetation. In the past, commercial seed mixtures for highway verges in the Czech Republic consisted mainly of the cheapest forage varieties of cultivated grasses (Festuca rubra, F. arundinacea, Lolium perenne, Poa pratensis) which are typical by high biomass production. Thus, current vegetation is usually dominated by these competitive species or by quickly expanding grass Arrhenatherum elatius. Here, new technology using native root hemiparasitic plants is described. This should support butterfly food plants (mostly competitively weak dicotyledonous forbs) without complicated technical reclamation. Hemiparasites from genus Rhinanthus are green plants sucking water and nutrients from host roots. In last two decades Rhinanthus was locally used in Western Europe to increase diversity of meadows as well as road verges. However, technology has not spread up possibly due to high cost of seeds and poor establishment of selected Rhinanthus species. Five years ago our research team discovered that Rhinanthus alectorolophus, species native to Central Europe and formerly common weed of cereals, is able to establish viable population almost at all grassland habitats and eradicate most grasses in 1–2 vegetation seasons. Dicotyledonous forbs are usually well protected against Rhinanthus parasitism and quickly spread on site at the expense of grasses. As an annual species Rhinanthus is completely dependent on its host plants (i.e. grasses) and after their suppression also Rhinanthus disappears from vegetation opening space in canopy and releasing nutrients for other species. Moreover, R. alectorolophus is a vigorous plant and its seeds are easily multiplied, thus species has the potential for commercial production. Four-year project connecting biological and agricultural universities with the Czech project office planning construction of highways and supra-national seed-producing company was started in spring 2015. In close interdisciplinary collaboration 10 model sites were selected, highway verges having 1000 m2 in size, which are situated nearby protected areas and their vegetation is dominated by grasses. At first, botanists recorded initial plant species composition and species dominance while entomologists monitored seasonal occurrence of butterflies. After collection of this baseline data Rhinanthus was sown in a density 500 seeds per 1 m2 on one randomly selected half of each site, in order to verify the effect of hemiparasites on vegetation and butterflies in situ experimentally. At IENE conference 2016 results from the first year will be presented and road maintenance specialists will have the chance to assess whether this technology suppressing productive grasses is also able to decrease the necessity of frequent mulching.

## Talk- 3.14

### Habitat and Conduit: Effects on pollinators

# TRANSFER project - railways ecological transparency

**Author(s):** Anne Guerrero, Michel Baguette, Sébastien ROUE, Romain Sordello, Jean Carsignol, Virginie Stevens

**Contact**: Anne Guerrero, SNCF Réseau

**E-mail:** anne.guerrero@reseau.sncf.fr

SNCF Réseau is one of the major transport infrastructures manager in France. It is in charge of 30 000 Km of railway lines, their development and their upgrading. Within the framework of the green and blue belts, the transport infrastructures are identified as one of the main causes of the fragmentation of ecological continuities. Specific construction works have been made during the last thirty years to secure crossing of wild animals. Their efficiency is monitored through surveys but protocols are not yet standardized and they focus on big mammals, carnivores and amphibians. In addition to the eco-bridges built on new railway tracks, there is an increasing demand to restore the ecological continuity on the existing network. The main problem is that we really know little about the transparency of the infrastructures and the global efficiency of these specific engineering works. In this context, an assessment of the transparency of railway infrastructures has been engaged with the assistance of the Ministry of the Environment. The aim is to assess the role of various crossing works existing on the national network and to define a first list of measures aiming at restoring the ecological continuities and their surroundings. The chosen methodology involves studying four railway sections, each one about twenty kilometre-long : two of them within totally enclosed TGV railways, the others within conventional railway tracks. All are located in the North-East of France, and cross a huge proportion of mixed forest and agricultural landscapes. Standard survey methods were used : camera traps for many terrestrial mammal species and ultrasonic sound recorders. The analysis of events on the different types of crossing works (almost 480,000 photos and 68,000 ultrasonic recordings) has been carried out in order to treat all data globally according to different criteria (human frequentation, size of crossing works, seasonal variations…). Thus, it provides reliable information on the regular mobility of individual animals on each side of infrastructures. In parallel, landscape genetic was used via molecular technologies. Analysis on DNA samples from individuals of many populations located on both sides of the sections enabled to measure the degree of fragmentation of tracks and the genetics flows of 3 species: an amphibian (Salamandra salamandra), a butterfly (Maniola jurtina) and a beetle (Feronia nigrita). Genetical distance measured between populations enabled a rigorous diagnosis of the permeability thanks to a specific focus on the functional connectivity, integrating landscape effects. Whatever the survey methodologies used, the results of this project indicate that railway tracks do not generate any impassible barrier for the studied species. As a matter of fact, they play a filter function: for instance, they create local difficulties for the ungulates when the tracks are enclosed.

# Index of authors

# Index of authors

| Country | Last Name | First Name | Affiliation |
|---|---|---|---|
| AT | **Banko** | **Gebhard** | Umweltbundesamt GmbH |
| AT | **Bauer** | **Thomas** | Institute of Surveying, Remote Sensing and Land Information, University of Natural Resources and Life Sciences, Vienna |
| AT | **Grillmayer** | **Roland** | Umweltbundesamt GmbH |
| AT | **Hahn** | **Elke** | |
| AT | **Heigl** | **Florian** | Citizen Science Working Group, Institute of Zoology, University of Natural Resources and Life Sciences, Vienna |
| AT | **Horvath** | **Kathrin** | |
| AT | **Laaha** | **Gregor** | Institute of Applied Statistics and Computing, University of Natural Resources and Life Sciences, Vienna |
| AT | **Leissing** | **Daniel** | Büro für Wildökologie und Forstwirtschaft |
| AT | **Leitner** | **Horst** | Büro für Wildökologie und Forstwirtschaft |
| AT | **Pascher** | **Kathrin** | University of Vienna, Department of Botany and Biodiversity Research, Division of Conservation Biology, Vegetation- and Landscape Ecology, Rennweg 14, A-1030 Vienna, Austria |
| AT | **Schuh** | **Thomas** | ÖBB-Infrastructure Inc. Praterstern 3 1020 Vienna Austria |
| AT | **Steiner** | **Wolfgang** | Institute of Wildlife Biology and Game Management, University of Natural Resources and Life Sciences, Vienna |
| AT | **Stretz** | **Carina** | Citizen Science Working Group, Institute of Zoology, University of Natural Resources and Life Sciences, Vienna |
| AT | **Suppan** | **Franz** | Institute of Surveying, Remote Sensing and Land Information, University of Natural Resources and Life Sciences, Vienna |
| AT | **Umgeher** | **Lukas** | REVITALIntegrative Naturraumplanung GmbH |

| Country | Last Name | First Name | Affiliation |
|---|---|---|---|
| AU | **Bhardwaj** | **Manisha** | Australian Research Centre for Urban Ecology (Royal Botanic Garden Victoria) and the University of Melbourne. |
| AU | **Dexter** | **Cathryn** | Griffith University Applied Road Ecology Group Environmental Futures Research Institute Nathan Campus Brisbane, Queensland, Australia |
| AU | **Jones** | **Darryl** | Griffith university |
| AU | **Lahoz-Monfort** | **Jose** | University of Melbourne |
| AU | **Laurance** | **William** | Centre for Tropical Environmental and Sustainability Science, James Cook University, Cairns, Queensland, Australia ALERT—the Alliance of Leading Environmental Researchers ; Thinkers |
| AU | **Lumsden** | **Lindy** | Arthur Rylah Institute - Department of Environment, Land, Water Planning |
| AU | **Newman** | **Kate** | WWF |
| AU | **Soanes** | **Kylie** | Australian Research Centre for Urban Ecology (ARCUE) c/o School of BioSciences, University of Melbourne Parkville Victoria 3010 Australia |
| AU | **Spooner** | **Peter** | Charles Sturt University |
| AU | **Van der Ree** | **Rodney** | Royal Botanic Gardens Victoria and University of Melbourne |
| BE | **Claus** | **Katja** | Flemish Government - Environment, Nature and Energy Department |
| BE | **De Voghel** | **Simon** | LIFE Elia-RTE project |
| BE | **Engelen** | **Guy** | Flemish Institute for Technological Research (VITO) |
| BE | **Everaert** | **Joris** | Research Institute for Nature and Forest (INBO) |
| BE | **Godeau** | **Jean-François** | LIFE Elia-RTE project |
| BE | **Janssens** | **Luc** | Environment, Nature ; Energy administration (LNE) in Flanders |

| Country | Last Name | First Name | Affiliation |
|---|---|---|---|
| BE | Michaux | Johan | Université de Liège |
| BE | Moelants | Marleen | Flemish Government Agency for Roads and Traffic |
| BE | Uljee | Inge | Flemish Institute for Technological Research (VITO) |
| BE | Van Kerckvoorde | Andy | Flemish Government, Research Institute for Nature and Forest (INBO) |
| BE | Van Laer | Liesbet | Nature administration (ANB) in Flanders |
| BE | Van Leirsberghe | Hilde | Vlaamse Landmaatschappij |
| BE | Vanonckelen | Steven | Agency of Nature and Forests (ANB), Belgium |
| BG | Kachamakova | Maria | Sofia University "St. Kliment Ohridski" |
| BG | Zlatanova | Diana | Sofia University “St. Kliment Ohridski” |
| BR | Aguiar | Ludmilla | University of Brasilia |
| BR | Dale | Paul | São Paulo Environmental State Secretariat |
| BR | De Freitas | Carlos | University Center of Araxá - Minas Gerais |
| BR | Desbiez | Arnaud | Royal Zoological Society of Scotland, Edinburgh, Scotland, United Kingdom. |
| BR | Ferreira | Flávio | Centro Brasileiro de Estudos em Ecologia de Estradas, Programa de Pós-graduação Ecologia Aplicada, Universidade Federal de Lavras, 37200-000, Lavras, Minas Gerais, Brazil |
| BR | Figueiredo | Almir | University of Brasilia - UnB |
| BR | Giorgi | Camilo | CETESB - São Paulo Environmental Agency |

| Country | Last Name | First Name | Affiliation |
| --- | --- | --- | --- |
| BR | Grilo | Clara | Centro Brasileiro de Estudos em Ecologia de Estradas/Programa de Pós-graduação Ecologia Aplicada, Universidade Federal de Lavras, 37200-000, Lavras, Minas Gerais, Brazil |
| BR | Medici | Emília | IUCN/SSC Tapir Specialist Group (TSG), Gland, Switzerland. Lowland Tapir Conservation Initiative, IPÊ–Institute for Ecological Research, Nazaré Paulista, São Paulo, Brazil. |
| BR | Pina | Juliana | CETESB - São Paulo Environmental Agency |
| BR | Santos | Rodrigo Augusto | Universidade de Brasília - UnB IBRAM - Instituto Brasília Ambiental |
| BR | Setz | Eleonore | University of Campinas - São Paulo |
| CA | Bywater | Nicola | MMM Group Limited / WSP |
| CA | Harrison | Kristen | MMM Group Limited / WSP |
| CA | Jaeger | Jochen | Concordia University Montreal, Quebec |
| CA | Plante | Judith | Concordia University |
| CH | Grêt-Regamey | Adrienne | Planning of Landscape and Urban Systems, PLUS Institute for Spatial and Landscape Development ETH Zürich, Switzerland |
| CH | Krause | Kim | Kaden ; Partner AG, Bahnhofstrasse 43, CH-8500 Frauenfeld |
| CH | Righetti | Antonio | B+S AG, Bern |
| CH | Trocmé | Marguerite | Federal Roads Office (FEDRO), Mrs Marguerite Trocmé, Director of Environment, Department, Federal department of environment, transportation, energy and communication, DETEC |
| CH | Van Strien | Maarten | Planning of Landscape and Urban Systems, PLUS Institute for Spatial and Landscape Development ETH Zürich, Switzerland |
| CH | Zimmermann | Fridolin | KORA |
| CI | Vroh | Bi Tra Aimé | University Félix Houphouët-Boigny, Abidjan, Côte d'Ivoire |

| Country | Last Name | First Name | Affiliation |
|---|---|---|---|
| CM | Chamagne | Juliette | CIRAD |
| CM | Dessard | Hélène | CIRAD |
| CM | Feintrenie | Laurène | CIRAD |
| CM | Jepang | Camille | IUCN |
| CN | Wang | Yun | China Academy of Transportation Sciences |
| CZ | Anděl | Petr | EVERNIA, s.r.o., Liberec |
| CZ | Andrášik | Richard | CDV Transport Research Centre |
| CZ | Bíl | Michal | CDV - Transport Research Centre |
| CZ | Dostál | Ivo | Transport Research Centre Division of Infrastructure and Environment Líšeňská 33a636 00 Brno Czech Republic |
| CZ | Ernst | Martin | researcher |
| CZ | Hlavac | Vaclav | Nature Conservatin Agency of the Czech Republic |
| CZ | Hula | Vladimír | Department of Zoology, Faculty of Agronomy, Mendel University in Brno |
| CZ | Jedlička | Jiří | Transport Research Centre Division of Infrastructure and Environment Líšeňská 33a636 00 Brno Czech Republic |
| CZ | Kolařík | Jaroslav | SAFE TREES, Ltd.Arboricultural Academy (NGO) |
| CZ | Kutal | Miroslav | researcher |
| CZ | Libosvár | Tomáš | |

| Country | Last Name | First Name | Affiliation |
|---|---|---|---|
| CZ | **Mladek** | **Jan** | Palacky University |
| CZ | **Niedobová** | **Jana** | Department of Zoology, Faculty of Agronomy, Mendel University in Brno |
| CZ | **Romportl** | **Dusan** | researcher |
| CZ | **Sedonik** | **Jiri** | CDV |
| CZ | **Sedoník** | **Jiří** | CDV Transport Research Centre |
| CZ | **Sikula** | **Tomas** | HBH Project |
| CZ | **Svoboda** | **Josef** | Transport Research CentreDivision of Infrastructure and EnvironmentLíšeňská 33a636 00 Brno Czech Republic |
| CZ | **Zýka** | **Vladimír** | researcher |
| DE | **Benten** | **Anke** | Georg-August-University Göttingen |
| DE | **Böttcher** | **Marita** | Federal Agency for Nature Conservation Germany |
| DE | **Brückmann** | **Katharina** | Bund für Umwelt und Naturschutz Deutschland (BUND, Friends of the Earth Germany), Landesverband Mecklenburg-Vorpommern e.V. |
| DE | **Friebe** | **Kathrin** | Zoological Institute, University of Kiel |
| DE | **Heidger** | **Clemens** | |
| DE | **Herzog** | **Sven** | Technische Universität Dresden |

| Country | Last Name | First Name | Affiliation |
|---|---|---|---|
| DE | **Kelm** | **Juliane** | Zoological Institute, University of Kiel and Stiftung Naturschutz Schleswig - Holstein |
| DE | **Kramer-Schadt** | **Stephanie** | UFZ, Helmholtz Centre for Environmental Research-UFZ and Leibniz Institute for Zoo and Wildlife Research |
| DE | **Göttsche** | **Matthias** | Institute for Natural Resource Conservation, University of Kiel |
| DE | **Müller** | **Kerrin** | Christian-Albrechts-University Kiel |
| DE | **Orthlieb** | **Xavier** | Transport Technologie-Consult Karlsruhe GmbH (Transport consultancy) |
| DE | **Pereira** | **Henrique** | German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig Institute of Biology, Martin Luther University Halle-Wittenberg Infraestruturas de Portugal Biodiversity Chair-CIBIO - Resea |
| DE | **Polster** | **Jens-Ulrich** | Technische Universität Dresden |
| DE | **Puechmaille** | **Sébastien** | Ernst-Moritz-Arndt-University of Greifswald |
| DE | **Reck** | **Heinrich** | Institute for Natural Resource Conservation, Dept. of Landscape Ecology at Kiel University, Germany |
| DE | **Riegler** | **Armin** | NGO "Callisto" - Wildlife and Nature Conservation Society, 123 Mitropoleos st., 54621 Thessaloniki, Greece |
| DE | **Riegler** | **Sussane** | NGO "Callisto" - Wildlife and Nature Conservation Society, 123 Mitropoleos st., 54621 Thessaloniki, Greece |
| DE | **Schulz** | **Björn** | Schleswig-Holstein State Foundation for Nature Conservation |
| DE | **Steffens** | **Thomas** | Zoological Institute, University of Kiel |
| DE | **Tegethof** | **Udo** | Federal Highway Research Institute (BASt) |
| DE | **Tetzlaff** | **Alica** | Planungsbüro Mahnel |
| DK | **Baagøe** | **Hans** | Natural History Museum of Denmark and Flagermus Forskning ; Rådgivning, Svalmstrupvej 10, DK-4174 Jystrup, Denmark |

| Country | Last Name | First Name | Affiliation |
|---|---|---|---|
| DK | Christensen | Morten | Sweco Denmark A/S, Granskoven 8, DK-2600 Glostrup |
| DK | Christensen | Per | Amphi Consult |
| DK | Elmeros | Morten | Aarhus University, Dept. of Bioscience, Grenåvej 14, DK-8410 Rønde, Aarhus, Denmark |
| DK | Fjederholt | Esben | Sweco A/S, Skibhusvej 52A, DK-5000 Odense C, Denmark |
| DK | Møller | Julie | Aarhus University, Dept. Bioscience, Grenåvej 14, DK-8410 Rønde, Aarhus, Denmark |
| DK | Ujvári | Marianne | Danish Road Agency |
| DZ | Bouzar | Hayet | University of Sciences and Technology Houari Boumediene (USTHB) Algiers |
| EE | Kruuse | Maris | University of Tartu / Estonian Naturalists` Society |
| ES | Bas | Maria | Museu Ciències Naturals Granollers |
| ES | Colomer | Joana | Minuartia wildlife consultancy |
| ES | Fernández-Bou | Marc | Minuartia wildlife consultancy, Avda Diagonal 523, 08029 Barcelona |
| ES | Flaquer | Carles | Museu de Ciències Naturals Granollers |
| ES | Garcia de la Morena | Eladio | SECIM, Servicios Especializados de Consultoria de Investigacion Medioambiental |
| ES | Garin | Inazio | University of the Basque Country, Sarriena auzoa z/g, Leioa E-48940, Bilbao |
| ES | Griell | Ramon | |
| ES | Herranz | Jesus | Terrestrial Ecology Group. Department of Ecology. Universidad Autonoma de Madrid |

| Country | Last Name | First Name | Affiliation |
|---|---|---|---|
| ES | **Hervas** | **Israel** | Terrestrial Ecology Group. Department of Ecology. Universidad Autonoma de Madrid |
| ES | **Laje** | **Mònica** | Infrastructures.cat |
| ES | **Malo** | **Juan** | Terrestrial Ecology Group, Departamento de Ecología, Universidad Autónoma de Madrid, C. Darwin 2, 28049 Madrid, Spain |
| ES | **Mata** | **Cristina** | Terrestrial Ecology Group. Department of Ecology. Universidad Autonoma de Madrid |
| ES | **Mohmed Sanz** | **Adrián** | Creando Redes (Company). Co-Founder. |
| ES | **Navàs** | **Ferran** | Minuartia wildlife consultancy |
| ES | **Pindado** | **Miguel Ángel** | |
| ES | **Plaza** | **Mireia** | Department of Evolutionary EcologyNational History Museum of Natural Science (CSIC)c/José Gutiérrez Abascal 2; 28006, Madrid |
| ES | **Rodà** | **Ferran** | Universitat Autònoma de Barcelona |
| ES | **Rosell** | **Carme** | Minuartia wildlife consultancy Department of Animal Biology-University of Barcelona |
| ES | **Solina Angelet** | **Jordi** | Ministry of Territory and Sustainability. Government of Catalonia (Generalitat de Caatalunya) |
| ES | **Torrellas** | **Marina** | Minuartia wildlife consultancy, Avda Diagonal 523, 08029 Barcelona |
| FI | **Kivimäki** | **Ilkka** | |
| FR | **Alard** | **Didier** | |
| FR | **Allegrini** | **Benjamin** | Naturalia-Environnement |
| FR | **Guerrero** | **Anne** | SNCF réseaux |

| Country | Last Name | First Name | Affiliation |
|---|---|---|---|
| FR | **Apheceix** | **Fabien** | Waynote startup French Tech Côte d'Azur - Sophia Antipolis French Tech Culture - Avignon Telecom Valley - Sophia Antipolis PRIMI Pôle Transmédia Méditerranée - Marseille |
| FR | **Aujoulat** | **Michel** | |
| FR | **Autret** | **Yannick** | Environment, Energy and Sea |
| FR | **Baguette** | **Michel** | MNHN |
| FR | **Balbi** | **Manon** | Université de Lorraine |
| FR | **Barlet** | **Eric** | ATLANDES |
| FR | **Bas** | **Yves** | Muséum national d'Histoire naturelle |
| FR | **Bassama** | **Charles** | IUCN |
| FR | **Batista** | **Manon** | GREGE |
| FR | **Bernard** | **Cyril** | CEFE UMR 5175, CNRS - Université de Montpellier - Université Paul-Valéry Montpellier - EPHE |
| FR | **Bertheau** | **Yves** | Centre d'Ecologie et de Sciences de la COnservation (CESCO), Muséum national d'Histoire naturelle (MNHN), 75005 Paris, France Inra (Institut national de la recherche agronomique), SPE, route de Saint Cyr, 78026 Versailles cedex, France |
| FR | **Depigny** | **Bertrand** | Cerema / Dtec TV |
| FR | **Biaunier** | **Joris** | Research engineer, CEREMA, l'Isle d'Abeau. |
| FR | **Bigot** | **Alain** | APAVE |
| FR | **Billon** | **Lucille** | National Museum of Natural History of Paris |
| FR | **Billon** | **Virginie** | CEREMA Sud-Est |

| Country | Last Name | First Name | Affiliation |
|---|---|---|---|
| FR | Blanc | Laetitia | CEFE UMR 5175, CNRS - Université de Montpellier - Université Paul-Valéry Montpellier - EPHE |
| FR | Blanchard | Héloïse | |
| FR | Blatrix | Cécile | AgroParisTech |
| FR | Bocognano | Jean-Michel | Grand Port Maritime de Marseille Port of Marseilles Authority |
| FR | Bonthoux | Sébastien | INSA CVL, ENP |
| FR | Borgniet | Laurent | Ph.D, IRSTEA (National Research Institute of Science and Technology for Environment and Agriculture), Grenoble. |
| FR | Boulnois | Rénald | Biotope 22 Bld Foch 34140 Mèze France |
| FR | Bourbon | Christine | VNF |
| FR | Bout | Catherine | GREGE |
| FR | Breil | Pascal | Irstea Hydrology-Hydraulics research unit, Hydrological Processes ; Spatial Modelling Team IRSTEA, 5 rue de la Doua, CS 70977, 69626 Villeurbanne |
| FR | Bretaud | Jean-Francois | Cerema Ouest Centre for studies and expertise on risks, environment, mobility, and urban and country planning - Territorial division for the western regions |
| FR | Breton | Vincent | Research engineer, IRSTEA (National Research Institute of Science and Technology for Environment and Agriculture), Grenoble. |
| FR | Cambecèdes | Jocelyne | Conservatoire botanique national des Pyrénées et de Midi-Pyrénées (CBNPMP) |
| FR | Carsignol | Jean | CEREMA Est |

| Country | Last Name | First Name | Affiliation |
|---|---|---|---|
| FR | Charlemagne | Thierry | LISEA |
| FR | Charnoz | Amélie | Centre d'études et d'expertise sur les risques, l'environnement, la mobilité et l'aménagement (Cerema) Département Ville Durable/ Unité Qualité des Eaux et des Sols |
| FR | Chaudron | Clémence | UMR CNRS 7324 CITERES, Université François Rabelais de Tours |
| FR | Chavaren | Philippe | Head of the Nature, Landscape and Green Constructions Division ASF network Direction Technique de l'Infrastructure74, allée de Beauport – CS 90304 – 84278 Vedène Cedex; France |
| FR | Chazelle | Blandine | SNCF – INFRA, PROJETS SYSTEME INGENIERIE - Département Lignes Voie Environnement (PSIGT.LVE), 6, avenue François Mitterrand - 93574 LA PLAINE SAINT DENIS CEDEX |
| FR | Chelkoff | Grégoire | CRESSON-ENSAG |
| FR | Claireau | Fabien | Naturalia environnement, National Museum of Natural History of Paris ; Zoological Institute and Museum of the Ernst-Moritz-Arndt-University of Greifswald |
| FR | Clauzel | Céline | LADYSS UMR 7533 Université Paris 7 CNRS |
| FR | Clinckemaillie | Jean | CDC Biodiversité |
| FR | Coulon | Aurélie | Centre d'Ecologie et de Sciences de la COnservation (CESCO), Muséum national d'Histoire naturelle (MNHN), 75005 Paris, FranceCEFE UMR 5175, CNRS - Université de Montpellier - Université Paul-Valéry Montpellier - EPHE – laboratoire Biogé |
| FR | Croyal | Anne-Sophie | Coordinatrice des continuités écologiques Département de l'Isère Service Développement Durable - Direction de l'Aménagement 7 rue Fantin Latour BP 1096 - 38022 Grenoble Cedex 1 Tel.: +33 (0) 4 76 00 64 30 |
| FR | Daumergue | Nathan | Technician, IRSTEA (National Research Institute of Science and Technology for Environment and Agriculture), Grenoble. |
| FR | Dauriat | Cécile | BIOTEC biologie appliquée |
| FR | De Bortoli | Anne | École des Ponts ParisTech, Laboratoire Ville Mobilité Transport, Université Paris Est |
| FR | De Vergnette | Antoine | |

| Country | Last Name | First Name | Affiliation |
|---|---|---|---|
| FR | **Degret** | **Viviane** | RTE |
| FR | **Dejeant-Pons** | **Maguelone** | COE - European Landscape Convention |
| FR | **Deniaud** | **Nadine** | Service du Patrimoine Naturel (SPN), Muséum national d'Histoire naturelle (MNHN), 75005 Paris, France |
| FR | **Deshaies** | **Michel** | LOTERR |
| FR | **Di Pietro** | **Francesca** | UMR CNRS 7324 CITERES, Université François Rabelais de Tours |
| FR | **Di Stefano** | **Jérémy** | |
| FR | **Dommanget** | **Fanny** | Ph.D, IRSTEA (National Research Institute of Science and Technology for Environment and Agriculture), Grenoble. |
| FR | **Doreau** | **Auréline** | Chaire Energie et Paysage - ENSP |
| FR | **Labarraque** | **Dorothee** | Egis Structures et Environnement |
| FR | **Douay-Bertrand** | **Cécile** | Cerema Est |
| FR | **Dupire** | **Nélia** | Chargée de mission - Centre de ressources sur la biodiversité Service observation et valorisation des données Délégation du développement urbain ; cadre de vie/Direction de la planification |
| FR | **Evette** | **André** | Ph.D, IRSTEA (National Research Institute of Science and Technology for Environment and Agriculture), Grenoble. |
| FR | **Fernandez** | **Quentin** | ECOLAB, Laboratoire d'Ecologie fonctionnelle et Environnement, CNRS, Université de Toulouse, Institut National Polytechnique |
| FR | **Fillon** | **Romain** | Université Paris 1 Laboratoire LADYSS |
| FR | **Flamerie** | **Frédérique** | Université Paris 6 Pierre et Marie Curie (UPMC), 75005 Paris, France |

| Country | Last Name | First Name | Affiliation |
|---|---|---|---|
| FR | Foltête | Jean-Christophe | Laboratoire ThéMA UMR 6049 Université de Franche-Comté CNRS |
| FR | Foures | Jean-Marc | Paris 1 Pantheon Sorbonne University Ladyss - UMR CNRS 7533 |
| FR | Fournier | Pascal | GREGE |
| FR | Fournier-Chambrillon | Christine | GREGE |
| FR | François | Denis | IFSTTAR |
| FR | Fressignac | Camille | Irstea Hydrology-Hydraulics research unit, Hydrological Processes ; Spatial Modelling Team IRSTEA, 5 rue de la Doua, CS 70977, 69626 Villeurbanne |
| FR | Gabillon | Antoine | |
| FR | Gady | Alexandre | Société pour la Protection des Paysages et de l'Esthétique de la France (SPPEF) |
| FR | Germain | Estelle | CROC – Centre de Recherche et d'Observation sur les Carnivores |
| FR | Habasque | Gilles | Egis Structures et Environnement |
| FR | Gillet | François | GREGE ; Université de Liège |
| FR | Giney | Delphine | PhD student UMR 7533 LADYSS, "Paris 1 Pantheon-Sorbonne University" |
| FR | Gippet | Jérôme | LEHNA UMR 5023 Université Claude Bernard Lyon 1 FRANCE |
| FR | Girardet | Xavier | Laboratoire ThéMA UMR 6049 Université de Franche-Comté CNRS |
| FR | Godart | Angelique | Cerema Est |

| Country | Last Name | First Name | Affiliation |
|---|---|---|---|
| FR | **Goettelmann** | **Grégoire** | Biotope 22 Bld Foch 34140 Mèze France |
| FR | **Gouix** | **Nicolas** | Conservatoire d'Espaces Naturels de Midi-Pyrénées (CEN MP) 75 voie du Toe |
| FR | **Grisard** | **Gilles** | CDPNE |
| FR | **Guérin** | **Maxime** | Plante ; Cité |
| FR | **Guerrero** | **Anne** | SNCF Réseau |
| FR | **Guilpart** | **Alexis** | Centre d'études et d'expertise sur les risques, l'environnement, la mobilité et l'aménagement (Cerema) Département Ville Durable/ Unité Qualité des Eaux et des Sols |
| FR | **Guinard** | **Eric** | Centre d'études et d'Expertises sur les Risques, l'Environnement, la Mobilité et l'Aménagement (Cerema), Cerema Sud Ouest DAIT GBMN, 33160 Saint-Médard-en-Jalles, France |
| FR | **Hamdi** | **Élodie** | Conservatoire botanique national des Pyrénées et de Midi-Pyrénées (CBNPMP) |
| FR | **Handrich** | **Yves** | Université de Strasbourg, IPHC, 23 rue Becquerel, 67087 Strasbourg, FranceCNRS, UMR 7178, 23 rue Becquerel, 67087 Strasbourg, France |
| FR | **Happert** | **Solène** | CIRAD |
| FR | **Henry** | **Mickaël** | INRA |
| FR | **Hervé** | **Marc** | Université de Lorraine |
| FR | **Heurtebise** | **Cédric** | VINCI Autoroutes, réseau ASF. Direction Technique de l'Infrastructure |
| FR | **Pouchelle** | **Hippolyte** | Egis Structures et Environnement |

| Country | Last Name | First Name | Affiliation |
|---|---|---|---|
| FR | Honnegger | Anne | PhD., Ecole Normale Supérieure, Lyon. |
| FR | Hota-Lacueva | Quentin | Faculty of Earth and Environmental Sciences, University of Burgundy, France |
| FR | Hubert | Severine | CEREMADirection Territoriale Sud Est |
| FR | Hugues | Romuald | GIE A63 |
| FR | Huybrechts | Nicolas | |
| FR | Jaslier | Emmanuel | Université Paris 6 Pierre et Marie Curie (UPMC), 75005 Paris, France |
| FR | Jeusset | Arzhvael | Service du Patrimoine Naturel Muséum national d'Histoire naturelle 36 rue Geoffroy Saint-Hilaire - CP 41 75231 Paris cedex 05 |
| FR | Jorcin | Pierre | Naturalia-Environnement |
| FR | Josserand | Clothilde | |
| FR | Jumeau | Jonathan | Université de Strasbourg, IPHC, 23 rue Becquerel, 67087 Strasbourg, France CNRS, UMR 7178, 23 rue Becquerel, 67087 Strasbourg, France Conseil Départemental du Bas-Rhin, place du Quartier Blanc, 67964 Strasbourg, France |
| FR | Kerbiriou | Christian | National Museum of Natural History of Paris |
| FR | Lagadec | Lilly-Rose | SNCF ; Irstea |
| FR | Laoue | Estelle | GREGE |

| Country | Last Name | First Name | Affiliation |
|---|---|---|---|
| FR | Largier | Gérard | Conservatoire botanique national des Pyrénées et de Midi-Pyrénées (CBNPMP) |
| FR | Le bris | Charlotte | Cerema / Dtec TV |
| FR | Le Féon | Violette | Equipe "Pollinisation et Ecologie des Abeilles" UR 406 "Abeilles et Environnement" INRA Centre de Recherche PACA 228 route de l'Aérodrome CS 40509 Domaine Saint Paul - Site Agroparc 84914 AVIGNON Cedex 9 FRANCE |
| FR | Le Mitouard | Eric | Centre d'études et d'Expertises sur les Risques, l'Environnement, la Mobilité et l'Aménagement (Cerema), Cerema Sud-Ouest DAIT GBMN, 33160 Saint-Médard-en-Jalles, France |
| FR | Lecaillon | Gilles | ECOCEAN |
| FR | Leduc | Vinciane | SEPANT |
| FR | Lenfant | Philippe | UNIVERSITE DE PERPIGNAN Prof., CEFREM |
| FR | Lesigne | Jean-Francois | RTE |
| FR | Linglart | Marine | Urban-éco |
| FR | Livoreil | Barbara | Fondation pour la Recherche sur la Biodiversité |
| FR | Locquet | Alexandra | Paris 1 Panthéon-Sorbonne University - UMR 7533 Ladyss |
| FR | Loridan | Romuald | Ministry of ecology, sustainable development and energy |
| FR | Luchetti | Elena | TELT |

| Country | Last Name | First Name | Affiliation |
|---|---|---|---|
| FR | **Luginbühl** | **Yves** | CNRS - Université Paris 1 |
| FR | **Machon** | **Nathalie** | National Museum of Natural History of Paris |
| FR | **Maillet** | **Grégory** | Conservationist The Natura 2000 de la Tourbière du Grand Lemps National Nature Reserve and Site Conservatoire d'espaces naturels de l'Isère Maison Borel 2 rue des Mails 38120 Saint-Egrève Tel: +33(0) 9.84.36.01.52. |
| FR | **Marboutin** | **Eric** | Office National de la Chasse et de la Faune Sauvage – CNERA Prédateurs-Animaux Déprédateurs |
| FR | **Marc** | **Daniel** | Conservatoire d'Espaces Naturels de Midi-Pyrénées (CEN MP) 75 voie du Toe |
| FR | **Martin** | **François-Marie** | Ph.D Student, IRSTEA (National Research Institute of Science and Technology for Environment and Agriculture), Grenoble. |
| FR | **Martinière** | **David** | |
| FR | **Matillon** | **Yannick** | SNCF Réseau, Direction Ingénierie ; Projet Sud-Est, Pôle Régional Ingénierie de Lyon, Groupe Etudes Générales, Le Premium - 133, boulevard Stalingrad, CS 80034, 69626 Villeurbanne Cedex, France |
| FR | **Maurie** | **Vanessa** | GREGE |
| FR | **Menut** | **Thomas** | Biotope 22 Bld Foch 34140 Mèze France |
| FR | **Michel** | **Nadia** | Université de Lorraine Laboratoire Agronomie et Environnement |
| FR | **Michelin** | **Gabriel** | CDPNE |
| FR | **Mimet** | **Anne** | ThéMA, CNRS, University Bourgogne Franche-Comté |
| FR | **Morand** | **Alain** | Cerema - Dt Est 1, boulevard Solidarité - BP 85230 - 57076 Metz Cedex 03 |

| Country | Last Name | First Name | Affiliation |
|---|---|---|---|
| FR | Morcrette | Annabelle | Biotope |
| FR | Moulherat | Sylvain | TerrOïko |
| FR | Noiret | Sophie | Cerema / Dter Est |
| FR | Nouvion-Dupray | Sylvie | Unité Risques, Sols Urbains et Eaux souterraines CEREMA-Direction territoriale Ile-de-Fra |
| FR | Nowicki | François | DTRest Cerema |
| FR | Nullans | Andréa | SNCF Reseau Direction Generale Idf Direction Des Projets Franciliens Departement Etudes / Groupe Etudes Generales / Pôle Sud Paris 4-14 Rue Ferrus 75683 Paris Cedex 14 |
| FR | Obretenova | Iva | COE - Bern Convention |
| FR | Pacevicius | Patrick | Centre d'études et d'Expertises sur les Risques, l'Environnement, la Mobilité et l'Aménagement (Cerema), Cerema Sud Ouest DAIT GBMN, 33160 Saint-Médard-en-Jalles, France |
| FR | Pallier | Dominique | Voiron Inter-municipal authority Directeur Général adjoint 40, rue Mainssieurx – CS 80363 38 516 VOIRON cedex Tél : +33 (0)4 76 93 17 30 GSM : +33(0)6 82 83 39 19 |
| FR | Palussiere | Laurent | SEPANT |
| FR | Paris | Magali | CRESSON-ENSAG |
| FR | Pech | Pierre | Paris 1 Pantheon-Sorbonne University, Ladyss UMR-CNRS 7533 |
| FR | Peguet | Julien | |
| FR | Perronne | Rémi | Le Moulon, INRA, Univ Paris-Sud, CNRS, AgroParisTech, Université Paris-Saclay, F-91190, Gif-sur-Yvette |

| Country | Last Name | First Name | Affiliation |
|---|---|---|---|
| FR | Perrot | Martin | EGIS |
| FR | Peyre | Olivier | Naturalia-Environnement |
| FR | Pihouee | Etienne | Société du Grand Paris - Etablissement public sous tutelle de ministères, dont Ecologie |
| FR | Pineau | Christophe | CEREMA |
| FR | Pistoni | Roberta | école nationale supérieure de paysage de Versailles |
| FR | Planty-Tabacchi | Anne-Marie | |
| FR | Poumailloux | Aurélie | CDPNE |
| FR | Pradines | Chantal | Cabinet All(i)ée |
| FR | Quesnel | Gaëtan | GRT Gaz |
| FR | Quetier | Fabien | Biotope 22 Bld Foch 34140 Mèze France |
| FR | Quintard | Delphine | LISEA |
| FR | Quivet | Sandra | Major Projects Leader Groupe APRR - APRR \| AREA Direction de l'innovation, de la construction et du développement 42 boulevard Eugène Deruelle 69432 LYON Cedex 03 Tél. +33 (0)4 72 60 11 06 GSM +33 |
| FR | Raffin | Fabrice | Université de Picardie Jules Verne Amiens - Paris 3 Sorbonne NouvelleSEA EUROPE Paris |
| FR | Rauel | Vanessa | Centre d'études et d'Expertises sur les Risques, l'Environnement, la Mobilité et l'Aménagement (Cerema), Cerema Sud-Ouest DAIT GBMN, 33160 Saint-Médard-en-Jalles, France |

| Country | Last Name | First Name | Affiliation |
|---|---|---|---|
| FR | **Remon** | **Jonathan** | TerrOïko ; SEEM-CNRS |
| FR | **Ritan** | **Carine** | Appel d'Air Consultants |
| FR | **Roemer** | **Charlotte** | Muséum national d'Histoire naturelle |
| FR | **Rossot Darmet** | **Agnès** | Cerema / Dter Méditerranée |
| FR | **ROUE** | **Sébastien** | Ecosphère |
| FR | **Roy** | **Véronique** | Service du Patrimoine Naturel (SPN), Muséum national d'Histoire naturelle (MNHN), 75005 Paris, France |
| FR | **Rufray** | **Xavier** | Biotope 22 Bld Foch 34140 Mèze France |
| FR | **Russier** | **Elodie** | IUCN FRANCE |
| FR | **Sordello** | **Romain** | Service du Patrimoine Naturel Muséum national d'Histoire naturelle 36 rue Geoffroy Saint-Hilaire - CP 41 75231 Paris cedex 05 |
| FR | **Spiegelberger** | **Thomas** | Ph.D, IRSTEA (National Research Institute of Science and Technology for Environment and Agriculture), Grenoble. |
| FR | **Stevens** | **Virginie** | CNRS |
| FR | **Fagart** | **Sylvain** | Ligue pour la Protection des Oiseaux |
| FR | **Tabacchi** | **Eric** | ECOLAB, Laboratoire d'Ecologie fonctionnelle et Environnement, CNRS, Université de Toulouse, Institut National Polytechnique |
| FR | **Tassone** | **Marc** | Environment, Energy and sea |
| FR | **Tatoni** | **Thierry** | IMBE Institut Méditerranéen de Biodiversité et d'Ecologie Marine et Continentale Campus Etoile - Faculté St Jérôme Av. Escadrille Normandie Niémen F-13397 Marseille cedex 20, France |

| Country | Last Name | First Name | Affiliation |
|---|---|---|---|
| FR | Thievent | Philippe | Manager of CDC BIODIVERSITE |
| FR | Touroult | Julien | Service du Patrimoine Naturel (SPN), Muséum national d'Histoire naturelle (MNHN), 75005 Paris, France |
| FR | Touzard | Blaise | |
| FR | Urbain | Yves | |
| FR | Uyttenhoven | Charles | Université de Lorraine |
| FR | Vaissiere | Bernard | INRA |
| FR | Van Reeth | Colin | Université de Lorraine |
| FR | Vanpeene | Sylvie | Irstea, centre Aix en Provence 3275 route de Cézanne CS 40061 13182 Aix-en-Provence cedex 5 |
| FR | Vargac | Marianne | Service du Patrimoine Naturel Muséum national d'Histoire naturelle 36 rue Geoffroy Saint-Hilaire - CP 41 75231 Paris cedex 05 |
| FR | Vermeersch | Perrine | Centre d'étude et d'expertise sur les risques, l'environnement, la mobilité et l'aménagement |
| FR | Vignon | Vincent | O.G.E. - Office de Génie Ecologique 5 boulevard de Créteil 94100 Saint-Maur-des-Fossés |
| FR | Villalba | Bruno | ITTECOP |
| FR | Villers | Alexandre | CEBC-CNRS, Université de la Rochelle UMR7372, 79360 Villiers en Bois;Groupe Ornithologique des Deux Sèvres 46 rue Rouget de Lisle 79000 Niort |
| FR | Wattebled | Elisabeth | Direction interdépartementale des routes Centre-Est |

| Country | Last Name | First Name | Affiliation |
|---|---|---|---|
| FR | Witté | Isabelle | Service du Patrimoine Naturel (SPN), Muséum national d'Histoire naturelle (MNHN), 75005 Paris, France |
| FR | Yang | Qixuan | |
| FR | Zanchi | Olivia | |
| GA | De Wachter | Pauwel | WWF Central African Regional Programme |
| GB | Altringham | John | University of Leeds, UK |
| GB | Berthinussen | Anna | University of Leeds, UK |
| GB | Hartup | Michael | Froglife Trsut |
| GB | Petrovan | Silviu | Froglife Trust and University of Hull, UK |
| GR | Aravidis | Elias | Development Agency of Thessaloniki Prefecture, 27 Ploutonos st., 54655 Thessaloniki, Greece |
| GR | Athanasiadis | Ioannis | Democritus University of Thrace – Electrical engineering and Computer engineering dept – Panepistimioupoli Kimerion – 67100 - Xanthi - Greece |
| GR | Examilioti | Georgina | Democritus University of Thrace – Electrical engineering and Computer engineering dept – Panepistimioupoli Kimerion – 67100 - Xanthi - Greece |
| GR | Georgiadis | Lazaros | IENE |
| GR | Giannakopoulos | Alexios | University of Thessaly, School of Veterinary Sciences, Trikalon 224, 43100 Karditsa , Greece |
| GR | Iliopoulos | Yorgos | NGO “Callisto” - Wildlife and Nature Conservation Society, 123 Mitropoleos st., 54621 Thessaloniki, Greece |
| GR | Kouris | Paris | Prisma Electronics SA. – Alexandroupoli, Greece |

| Country | Last Name | First Name | Affiliation |
|---|---|---|---|
| GR | Lazarou | Yorgos | NGO “Callisto” - Wildlife and Nature Conservation Society, 123 Mitropoleos st., 54621 Thessaloniki, Greece |
| GR | Mertzanis | Yorgos | NGO “Callisto” - Wildlife and Nature Conservation Society, 123 Mitropoleos st., 54621 Thessaloniki, Greece |
| GR | Patsinakidis | Nikolaos | NGO “Callisto” - Wildlife and Nature Conservation Society, 123 Mitropoleos st., 54621 Thessaloniki, Greece |
| GR | Petridou | Maria | NGO “Callisto” - Wildlife and Nature Conservation Society, 123 Mitropoleos st., 54621 Thessaloniki, Greece |
| GR | Psaralexi | Maria | Department of Ecology, School of Biology, Aristotle University of Thessaloniki, Greece |
| GR | Tragos | Athanasios | NGO “Callisto” - Wildlife and Nature Conservation Society, 123 Mitropoleos st., 54621 Thessaloniki, Greece |
| GR | Tsaknakis | Ioannis | NGO “Callisto” - Wildlife and Nature Conservation Society, 123 Mitropoleos st., 54621 Thessaloniki, Greece |
| GR | Vezynias | Thomas | Link Technologies S.A. – 9 km Thessaloniki-Thermi , Thessaloniki, Greece |
| GY | Bernard | Curtis | Conservation International Guyana |
| GY | Paemelaere | Evi | Panthera |
| GY | Payán | Esteban | Panthera |
| GY | Singh | David | Conservation International Guyana |
| HU | Farkas | János | Department of Systematic Zoology and Ecology, Eötvös Loránd University, 1117 Budapest, Pázmány Péter sétány 1/C |
| HU | Gál | Blanka | Doctoral School of Environmental Sciences, Eötvös Loránd University, 1117 Budapest, Pázmány Péter sétány 1/C |
| HU | Gelencsér | Géza | H-2100 Gödöllő, Páter Károly u. 1. |

| Country | Last Name | First Name | Affiliation |
|---|---|---|---|
| HU | Kádár | Ferenc | MTA Centre for Agricultural Research, Plant Protection Institute, 1022 Budapest, Herman Ottó út 15. |
| HU | Balázs | Kiss | Plant Protection Institute, Centre for Agricultural Research, Hungarian Academy of Sciences |
| HU | Koczor | Sándor | Plant Protection Institute, Centre for Agricultural Research, Hungarian Academy of Sciences |
| HU | Puky† | Miklós | MTA Centre for Ecological Research, Danube Research Institute, 1113 Budapest, Karolin út 29. |
| HU | Szita | Éva | MTA Centre for Ecological Research, Danube Research Institute |
| HU | Weiperth | András | MTA Centre for Ecological Research, Danube Research Institute, 1113 Budapest, Karolin út 29. |
| IE | Finnerty | Eugene | UCC |
| IE | Kennedy | Brendan | Transport Infrastructure Ireland |
| IE | O'Malley | Vincent | Transport Infrastructure Ireland |
| IE | OBrien | Eugene | Roughan ; O'Donovan Innovative Solutions |
| IE | Phelan | Sarah-Jane | Transport Infrastructure Ireland |
| IT | De Bortoli | Isidoro | EURAC Research |
| IT | Favilli | Filippo | EURAC Research |
| IT | Mazzei | Roberta | Regione Umbria |
| IT | Mertens | Annette | Regione Umbria |
| IT | Ricci | Simone | Regione Umbria |

| Country | Last Name | First Name | Affiliation |
|---|---|---|---|
| IT | Sergiacomi | Umberto | Regione Umbria |
| IT | Sgaramella | Gaia | University of Trento |
| JP | Asari | Yushin | Chodai co., ltd. |
| JP | Hara | Fumihiro | Hokkaido Development Engineering Center |
| JP | Kurihara | Masao | National Institute for Land and Infrastructure Management, Ministry of Land, Infrastructure and Transport |
| JP | Matsue | Masahiko | Ministry of Land, Infrastructure and Transport |
| JP | Nakamura | Masatoshi | IDEA Consultants, inc. |
| JP | Noro | Misako | Hokkaido Development Engineering Center |
| JP | Sato | Masato | Hokkaido Development Engineering Center |
| JP | Shikano | Takane | Hokkaido Development Engineering Center |
| JP | Shimura | Minoru | Railway Technical Research Institute |
| JP | Shusaku | Minato | "Dormouse Museum" and "Kwansei Gakuin University" |
| JP | Sonoda | Yoichi | Regional Environmental Planning inc. |
| JP | Tanizaki | Miyuki | |
| JP | Ueno | Yusuke | National Institute for Land and Infrastructure Management, Ministry of Land, Infrastructure and Transport |
| JP | Yamada | Yoshiki | |

| Country | Last Name | First Name | Affiliation |
|---|---|---|---|
| JP | Yanagawa | Hisashi | |
| KR | Choi | Taeyoung | National Institute of Ecology, Korea |
| KR | Woo | Donggul | National Institute of Ecology, Korea |
| LT | Balčiauskas | Linas | Nature Research Centre |
| LT | Balčiauskienė | Laima | Nature Research Centre |
| MM | Brooks | Ashley | WWF Tigers Alive Initiative |
| MM | Helsingen | Hanna | Green Economy Team Leader, World Wide Fund for Nature (WWF) Myanmar |
| NL | Brandjes | Jeroen | Bureau Waardenburg |
| NL | Dekker | Jasja | JD Dierecologie, Enkhuizenstraat 26, NL-6843 WZ Arnhem, the Netherlands |
| NL | Emond | Dimitri | Bureau Waardenburg |
| NL | Hamberg | Gert | Manufacturer and contractor for Prowild wildlife mitigation equipment. |
| NL | Jonkhof | Jos | J.O.S consultancy |
| NL | Kruidering | Anne Martine | Ecology Consultant at the company Arcadis. Specialized in the design, construction and maintanance of wildlife crossings. |
| NL | Loehr | Victor | Rijkswaterstaat Netherlands |
| NL | Meijneken | Camiel | ProRail |

| Country | Last Name | First Name | Affiliation |
|---|---|---|---|
| NL | Ottburg | Fabrice | Wageningen University ; Research Centre, Alterra Environmental Science Group Team Animal Ecology |
| NL | Schippers | Peter | Alterra |
| NL | Smit | Gerard | Bureau Waardenburg |
| NL | Van der Grift | Edgar | Alterra Wageningen URP.O. Box 476700 AA Wageningen-Netherlands |
| NL | Van Heukelum | Mark | Ecology Consultant at the company Arcadis. Specialized in the design, inspection and monitoring of wildlife crossings and road safety |
| NL | Wansink | Dennis | Bureau Waardenburg |
| NO | Auestad | Inger | Sogn og Fjordane University College, Norway |
| NO | Austad | Ingvild | Professor at Department of Engineering and Science |
| NO | Bischof | Richard | Norwegian University of Life Sciences Department of Ecology and Natural Resource Management |
| NO | Brittain | John | University of Oslo: Natural History Museum |
| NO | Drageset | Ola-Mattis | Norwegian Public Roads Administration |
| NO | Eldegard | Katrine | Norwegian University of Life Sciences |
| NO | Grung | Merete | |
| NO | Hagen | Dagmar | Norwegian Institute for Nature Research |
| NO | Hanslin | Hans Martin | Urban greening and environmental engineering, Norwegian institute of bioeconomy research |

| Country | Last Name | First Name | Affiliation |
|---|---|---|---|
| NO | **Heier** | **Lene** | Norwegian Public Roads Administration |
| NO | **Meland** | **Sondre** | Norwegian Public Roads Administration, Environmental Assessment Section and Norwegian University of Life Sciences, Dep. of Environmental Sciences |
| NO | **Panzacchi** | **Manuela** | |
| NO | **Ranneklev** | **Sissel** | Norwegian Institute for Water Research (NIVA) |
| NO | **Roer** | **Ole** | Faun Naturforvaltning AS |
| NO | **Rolandsen** | **Christer** | Norwegian Institute for Nature Research - NINA |
| NO | **Rydgren** | **Knut** | Sogn og Fjordane University College, Norway |
| NO | **Saltveit** | **Svein** | University of Oslo: Natural History Museum |
| NO | **Skrindo** | **Astrid** | |
| NO | **Sydenham** | **Markus** | Norwegian University of Life Sciences |
| NO | **Van Moorter** | **Bram** | Norwegian Institute for Nature Research |
| PK | **Akbar** | **Khalid** | Prof (Retd). of Botany Govt. Post-graduate College Sahiwal Pakistan |
| PL | **Jasińska** | **Karolina** | Warsaw University of Life Sciences - SGGW Faculty of Forestry Department of Forest Zoology and Wildlife Management |
| PL | **Krauze-Gryz** | **Dagny** | Warsaw University of Life Sciences - SGGW Faculty of Forestry Department of Forest Zoology and Wildlife Management |
| PL | **Nabielec** | **Joanna** | EKKOM Ltd. Zawiła 65 E Street, 30-390 Kraków, Poland |
| PL | **Tokarz** | **Wojciech** | Institute of Environmental Sciences, Jagiellonian Univeristy,ul. Gronostajowa 7, 30-387 Kraków |

| Country | Last Name | First Name | Affiliation |
|---|---|---|---|
| PL | Werka | Joanna | Warsaw University of Life Sciences - SGGW Faculty of Forestry Department of Forest Zoology and Wildlife Management |
| PT | Ascensão | Fernando | Infraestruturas de Portugal Biodiversity ChairCIBIO - Research Center in Biodiversity and Genetic Resources, Universidade do PortoISA - Universidade de Lisboa |
| PT | Barbosa | Ana Márcia | CIBIO-UE – Research Centre in Biodiversity and Genetic Resources. Pole of Évora / InBIO – Research Network in Biodiversity and Evolutionary Biology, University of Évora. Mitra, 7002-554 – Évora, Portugal |
| PT | Barrientos | Rafael | Infraestruturas de Portugal Biodiversity ChairCIBIO - Research Center in Biodiversity and Genetic Resources Campus Agrário de Vairão R. Padre Armando Quintas 4485-661 Vairão, Portugal |
| PT | Beja | Pedro | EDP Biodiversity Chair, CIBIO - Research Center in Biodiversity and Genetic Resources, Universidade do Porto, Campus Agrário de Vairão, Rua Padre Armando Quintas, 4485-6 |
| PT | Borda-de-Água | Luis | CIBIO-Inbio Infraestruturas de Portugal Biodiversity Chair/ CIBIO - Research Center in Biodiversity and Genetic Resources Campus Agrário de Vairão R. Padre Armando Quintas 4485-661 Vairão, Portugal/Instituto Superior de Agronomia, Universidade de Li |
| PT | Costa | Pedro | CIBIO/UE - Research Center in Biodiversity and Genetic Resources, Pólo de Évora, Universidade de Évora, Departamento de Biologia, Mitra, 7002-554 Évora, PortugalUBC – Conservation Biology Unit, Universidade de Évora, De |
| PT | Franch | Marc | CICGE, Centro de Investigação em Ciências Geo-Espaciais / Faculdade de Ciências da Universidade do Porto |
| PT | Guimarães | Nuno | Department of biology and ecology, faculty of natural sciences Matej Bel University - Banská Bystrica - Slovakia |
| PT | Lopes | Gil | School of Engineering of the University of Minho – Algoritmi Research Center. Guimaraes |
| PT | Marques | João Tiago | UBC – Conservation Biology Lab, Department of Biology, University of Évora. Mitra, 7002-554 – Évora, Portugal |
| PT | Medinas | Denis | CIBIO/UE - Research Center in Biodiversity and Genetic Resources, Pólo de Évora, Universidade de Évora, Departamento de Biologia, Mitra, 7002-554 Évora, Portugal UBC – Conservation Biology Unit, Universidade de Évora, De |
| PT | Mira | António | CIBIO-UE – Research Centre in Biodiversity and Genetic Resources. Pole of Évora / InBIO – Research Network in Biodiversity and Evolutionary Biology, University of Évora. Mitra, 7002-554 – Évora, Prtugal and UBC – Conservation Biology Lab, Depa |
| PT | Rebelo | Hugo | CIBIO-UP – Research Centre in Biodiversity and Genetic Resources. InBIO – Research Network in Biodiversity and Evolutionary Biology, University of Porto. Porto, Portugal |

| Country | Last Name | First Name | Affiliation |
|---|---|---|---|
| PT | Ribeiro | Fernando | School of Engineering of the University of Minho – Algoritmi Research Center. Guimaraes |
| PT | Ribeiro | Vera | UBC – Conservation Biology Lab, Department of Biology, University of Évora. Mitra, 7002-554 – Évora, Portugal |
| PT | Salgueiro | Pedro | CIBIO/UE - Research Center in Biodiversity and Genetic Resources, Pólo de Évora, Universidade de Évora, Departamento de Biologia, Mitra, 7002-554 Évora, Portugal UBC – Conservation Biology Unit, Universidade de Évora, De |
| PT | Santos | Sarah | CIBIO-UE – Research Centre in Biodiversity and Genetic Resources. Pole of Évora, Research Group in Applied Ecology, University of Évora, Évora, Portugal UBC – Conservation Biology Lab, Department of Biology, University of Évora, Évora, |
| PT | Sillero | Neftali | CICGE, Centro de Investigação em Ciências Geo-Espaciais / Faculdade de Ciências da Universidade do Porto |
| PT | Silva | Cristiano | |
| PT | Trigueiros | Paulo | School of Engineering of the University of Minho – Algoritmi Research Center. Guimaraes |
| RU | Koroleva | Elena | Department of Biogeography Moscow State Lomonosov University Russia |
| SE | Adelsköld | Tove | Calluna AB |
| SE | Andersson | Leif | Pro Natura |
| SE | Antonson | Hans | Swedish National Road and Transport Research Institute |
| SE | Bohman | Petter | Naturcentrum AB |
| SE | Chapron | Guillaume | Swedish University of Agricultural Sciences, Dep. of Ecology, Grimsö Wildlife Research Station |
| SE | De Jong | Johnny | Swedish Biodiversity Centre |
| SE | Delvenne | Malin | Swedish Transport Administration |

| Country | Last Name | First Name | Affiliation |
|---|---|---|---|
| SE | **Faith-Ell** | **Charlotta** | WSP Group |
| SE | **Helldin** | **Jan Olof** | Calluna AB, Gothenburg |
| SE | **Hipkiss** | **Tim** | EnviroPlanning AB |
| SE | **Jägerbrand** | **Annika** | Swedish National Road and Transport Research Institute |
| SE | **Janhäll** | **Sara** | Swedish National Road and Transport Research Institute |
| SE | **Jondelius** | **Erik** | Traffic Administration, City of Stockholm |
| SE | **Karlberg** | **Åsa** | Tyréns AB |
| SE | **Kjellander** | **Cecilia** | |
| SE | **Klein** | **Julian** | Swedish University of Agricultural Sciences, Dep. of Ecology, Grimsö Wildlife Research Station |
| SE | **Koffman** | **Anna** | Calluna AB |
| SE | **Lennartsson** | **Tommy** | Swedish Biodiversity Centre, Swedish University of Agricultural Sciences ; Uppsala University |
| SE | **Lindqvist** | **Mats** | Swedish Transport Administration |
| SE | **Nilsson** | **Kajsa** | |
| SE | **Nilsson** | **Torbjörn** | Swedish Transport Administration |
| SE | **Norlin** | **Karin** | Ecocom AB, Sweden |
| SE | **Öckinger** | **Erik** | Swedish University of Agricultural Sciences |

| Country | Last Name | First Name | Affiliation |
|---|---|---|---|
| SE | **Olsson** | **Mattias** | |
| SE | **Persson** | **Torbjörn** | Swedish Transport Administration |
| SE | **Pettersson** | **Maria** | |
| SE | **Rauch** | **Sebastien** | Chalmers University of Technology |
| SE | **Rolander** | **John** | |
| SE | **Röstell** | **Åsa** | Tyréns AB |
| SE | **Schönfeldt** | **Ida** | Swedish Transport Administration |
| SE | **Seiler** | **Andreas** | Swedish University of Agricultural Sciences, Dep. of Ecology, Grimsö Wildlife Research Station |
| SE | **Sjölund** | **Anders** | Swedish Transport Administration |
| SE | **Sjölund** | **Lisa** | GIS Consultant |
| SE | **Sjölund** | **Magnus** | Swedish University of Agricultural Sciences, Dep. of Ecology, Grimsö Wildlife Research Station |
| SE | **Söderström** | **Pär** | Swedish Rail, SJ AB |
| SE | **Söderström-Lööf** | **Christina** | Traffic Administration, City of Stockholm |
| SE | **Sokolova** | **Ekaterina** | Chalmers University of Technology |
| SE | **Sun** | **Zhenhua** | Chalmers University of Technology |
| SE | **Tschan** | **Georg** | Swedish National Road and Transport Research Institute (VTI) |

| Country | Last Name | First Name | Affiliation |
|---|---|---|---|
| SI | **Adamič** | **Marjana** | LUTRA, Institute for Conservation of Natural Heritage. |
| SI | **Gregorc** | **Tatjana** | LUTRA, Institute for Conservation of Natural Heritage. |
| SK | **Ligasova** | **Gabriela** | Transport Research Institute, JSC. - Žilina - Slovakia |
| SK | **Tesák** | **Jerguš** | Department of biology and ecology, faculty of natural sciences Matej Bel University - Banská Bystrica - Slovakia |
| SK | **Urban** | **Peter** | Department of biology and ecology, faculty of natural sciences Matej Bel University - Banská Bystrica - Slovakia |
| TZ | **Kioko** | **John** | school for field studies |
| US | **Adams** | **Joshua** | Copperhead Environmental Consulting |
| US | **Andrews** | **Kimberly** | University of Georgia and Jekyll Island Authority |
| US | **Baer** | **L.** | Copperhead Environmental Consulting |
| US | **Baer** | **Zachary** | Copperhead Environmental Consulting |
| US | **Beier** | **Paul** | Northern Arizona University |
| US | **Blank** | **Matt** | Western Transportation Institute (WTI), Montana State University, Bozeman, MT, USA |
| US | **Charry** | **Barbara** | Maine Audubon |
| US | **Cramer** | **Patricia** | Utah State University |
| US | **Cushman** | **Samuel** | USDA Forest Service |
| US | **Dickson** | **Brett** | Northern Arizona UniversityConservation Science Partners, Inc. |

| Country | Last Name | First Name | Affiliation |
|---|---|---|---|
| US | Gagne | Sarah | Department of Geography and Earth Sciences, University of North Carolina at Charlotte 9201 University City Blvd., Charlotte, NC 28223, USA |
| US | Grace | Molly | University of Central Florida |
| US | Gumbert | Mark | Copperhead Environmental Consulting |
| US | Harrold | Kathryn | Road Ecology Center, University of California, Davis |
| US | Huijser | Marcel | Western Transportation Institute - Montana State University |
| US | Jacobson | Sandra | USDA Forest SErvice |
| US | Jarvis | Karl | Northern Arizona University |
| US | Kintsch | Julia | ECO-resolutions |
| US | Landguth | Erin | University of Montana |
| US | McAllister | Kelly | Washington State Department of Transportation |
| US | McFall | Valarie | The Transportation Corridor Agencies |
| US | Nanjappa | Priya | Association of Fish and Wildlife Agencies, Amphibian ; Reptile and Invasive Species Coordinator PARC, National PARC States' Coordinator |
| US | Noss | Reed | University of Central Florida |
| US | Riley | Seth | Wildlife Ecologist, National Park Service |
| US | Roberts | Thomas | Esciences, Inc., Orlando, FL, USA |
| US | Roby | Piper | Copperhead Environmental Consulting |

| Country | Last Name | First Name | Affiliation |
|---|---|---|---|
| US | **Sewell** | **Price** | Copperhead Environmental Consulting |
| US | **Shilling** | **Fraser** | University of California, Davis Road Ecology Center |
| US | **Sloan** | **Brice** | Sloan Security Technologies, Inc. |
| US | **Smith** | **Daniel** | Department of Biology, University of Central Florida, Orlando, FL, USA |
| US | **Tonjes** | **Stephen** | Esciences, Inc., Orlando, FL, USA and BMA Consulting Engineering, Doral, FL, USA |
| US | **Waetjen** | **David** | Road Ecology Center, University of California, Davis |
| US | **Wagner** | **Paul** | Environmental Services OfficeWashington State Department of TransportationUnited States |
| US | **Wilder** | **Jason** | Northern Arizona University |
| ZA | **Collinson** | **Wendy** | The Endangered Wildlife Trust |
| ZA | **Davies-Mostert** | **Harriet** | The Endangered Wildlife Trust |
| ZA | **Davies-Mostert** | **Warwick** | De Beers Group of Companies |
| ZA | **Du Preez** | **Louis** | Unit for Environmental Sciences and Managment, North-West University, Potchefstroom |
| ZA | **Faraday** | **Alison** | Toad NUTS Volunteer Group |
| ZA | **Faraday** | **Richard** | Toad NUTS Volunteer Group |
| ZA | **Gaiger** | **Ian** | Lajuma Research Centre |
| ZA | **Goodman** | **Laura** | The Endangered Wildlife Trust |

| Country | Last Name | First Name | Affiliation |
|---|---|---|---|
| ZA | Halajian | Ali | Department of Biodiversity, University of Limpopo, Private Bag X1106, Sovenga 0727, South Africa |
| ZA | Kruger | Donnavan | Unit for Environmental Sciences and Management, North-West University, Potchefstroom |
| ZA | Kunutu | Katlego | Department of Biodiversity, University of Limpopo, Private Bag X1106, Sovenga 0727, South Africa |
| ZA | Le Roux | Aliza | Department of Zoology and Entomology, University of the Free State, Qwaqwa, Private Bag X13, Phuthaditjihaba, 9866 Republic of South Africa |
| ZA | Le Roux | Miles | N3 Toll Concession |
| ZA | Linden | Birthe | Department of Zollogy, University of VendaLajuma Research Centre |
| ZA | Luus-Powell | Wilmien | Department of Biodiversity, University of Limpopo, Private Bag X1106, Sovenga 0727, South Africa |
| ZA | Mokgawa | Makubu | Department of Biodiversity, University of Limpopo, Private Bag X1106, Sovenga 0727, South Africa |
| ZA | Nuttall-Smith | Gareth | Rhodes University |
| ZA | Parker | Daniel | Rhodes University |
| ZA | Patterson-Abrolat | Claire | The Endangered Wildlife Trust |
| ZA | Périquet | Stéphanie | Department of Zoology and Entomology University of the Free State, Qwaqwa Campus |
| ZA | Rakale | Thandiwe | N3 Toll Concession |
| ZA | Roxburgh | Lizanne | The Endangered Wildlife Trust |
| ZA | Tarrant | Jeanne | The Endangered Wildlife Trust |

| Country | Last Name | First Name | Affiliation |
|---|---|---|---|
| ZA | **Tavakol** | **Sareh** | Department of Biodiversity, University of Limpopo, Private Bag X1106, Sovenga 0727, South Africa |
| ZA | **Van Wyk** | **Charmaine** | Bakwena Toll Concession |

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