2010 IENE International Conference
on Ecology and transportation

Improving Connections in a changing environment

27th September - 1st October, 2010
Velence, Hungary

Programme and Book of Abstracts
## Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organisation</td>
<td>4</td>
</tr>
<tr>
<td>About IENE</td>
<td>5</td>
</tr>
<tr>
<td>The 2010 IENE conference &quot;Improving connections in a changing environment&quot;</td>
<td>6</td>
</tr>
<tr>
<td>Welcome to IENE 2010</td>
<td>7</td>
</tr>
<tr>
<td>Children’s competition</td>
<td>8</td>
</tr>
<tr>
<td>General information</td>
<td>9</td>
</tr>
<tr>
<td>Sponsors</td>
<td>13</td>
</tr>
<tr>
<td>Exhibitors</td>
<td>13</td>
</tr>
<tr>
<td>Programme at a glance</td>
<td>14</td>
</tr>
<tr>
<td>Programme</td>
<td>17</td>
</tr>
<tr>
<td>Monday, 27 September</td>
<td>17</td>
</tr>
<tr>
<td>Tuesday, 28 September</td>
<td>17</td>
</tr>
<tr>
<td>Wednesday, 29 September</td>
<td>23</td>
</tr>
<tr>
<td>Thursday, 30 September</td>
<td>28</td>
</tr>
<tr>
<td>Friday, 1 October</td>
<td>28</td>
</tr>
<tr>
<td>Abstracts</td>
<td></td>
</tr>
<tr>
<td>Tuesday, 28 September</td>
<td>29</td>
</tr>
<tr>
<td>Wednesday, 29 September</td>
<td>63</td>
</tr>
<tr>
<td>Friday, 1 October</td>
<td>93</td>
</tr>
<tr>
<td>Index of authors</td>
<td>97</td>
</tr>
</tbody>
</table>
Organisation

Host
The conference is hosted by IENE in cooperation with Varangy Akciócsoport Egyesület with the help of the Hungarian Danube Research Station of the Institute of Ecology and Botany of the Hungarian Academy of Sciences.

Organising Committee
IENE Steering Committee conference organiser is Miklós Puhy. The conference is organised in cooperation with SCOPE Meetings Ltd.

Local members of the Organising Committee, Local Secretariat
Miklós Puhy; Head of the Conservation and Taxonomy Research Unit, Hungarian Danube Research Station of the IEB of the HAS
Éva Harman; Varangy Akciócsoport Egyesület
Zoltán Hegyi; Danube - Ipoly National Park Directorate
Miklós Heltai; Institute for Wildlife Conservation
Gusztáv Hencsey; SCOPE Meetings Ltd.
Miklós Hinfner; Hungarian Scientific Association for Transport
Béla Kalocsai; Baja Nature Conservation Society
László Kárpáti; Head of the Fertő - Hanság National Park Directorate
Balázs Kiss; Hungarian National State Railway Ltd.
Tibor Parrag; Danube - Dráva National Park Directorate
Zoltán Pásztor; Hungarian Roads Management Company
Benedek R. Sallai; Nimféa* Environment and Nature Conservation Association
Ildikó Söveg; GYESEV (Hungarian – Austrian Railway Company)

Foreign members of the Organising Committee
Andreas Seiler; Swedish Biodiversity Centre
Anna Maria Wremp; Swedish Biodiversity Centre

Programme Committee
Andreas Seiler; Swedish Biodiversity Centre and Swedish university of Agricultural Sciences (Sweden)
Carme Rosell; Minuartia (Spain)
Marguerite Trocmé; Federal Road Office (Switzerland)
Marita Böttcher; Federal Agency for Nature Conservation (Germany)
Heinrich Reck; Kiel University (Germany)
Hans Bekker; Rijkswaterstaat (the Netherlands)
J-O Helldin; Swedish Biodiversity Centre (Sweden)
Antonio Mira; University of Évora (Portugal)
Anthony Clevenger; Western Transportation Institute, Montana State University (USA)
Marcel Huijser; Western Transportation Institute, Montana State University (USA)
Jochen Jaeger; Concordia University (Canada)
Edgar A. van der Grint; Alterra, Department of Landscape Ecology, Wageningen University and Research Centre (the Netherlands)
Miklós Puhy; Head of the Conservation and Taxonomy Research Unit, Hungarian Danube Research Station of the IEB of the HAS
Eugene Murray; Center for Transportation and the Environment (CTE), (USA)
Malin Andersson; Swedish Transport Administration (Sweden)
Anders Sjolund; Swedish Transport Administration (Sweden)
Dick van Straaten; Institute of Nature Conservation (Belgium)
Johan Lammerant; ARCADIS (Belgium)
About IENE

Infra Eco Network Europe (IENE) is a European network of authorities, institutes and experts working with the phenomena of habitat fragmentation caused by the construction and use of linear transport infrastructure, especially roads, railways and canals (waterways).

The network addresses decision makers, planners and researchers as well as the public, by providing an international and interdisciplinary arena to encourage and enable cross-boundary cooperation in research, mitigation and planning.

The general goal of IENE is to promote a safe and sustainable pan-European transport infrastructure through recommending measures and planning procedures to conserve biodiversity, counteract landscape fragmentation, and reduce vehicular accidents and wildlife casualties. Some focus areas are:

• Developing nature friendly infrastructure
• Conserving biodiversity
• Counteracting landscape fragmentation
• Connecting fragmented habitats
• Reducing wildlife casualties
• Promoting ecoducts and mitigation measures

Originally established in 1996, IENE was re-vitalized in 2008 and is currently expanding its network across Europe. IENE membership is cost-free and can be individual and/or tied to an organisation (governmental or non-governmental, research institution, private company, etc) that supports the overall goals of IENE. Regular international conferences, symposia, workshops and other arenas for interdisciplinary discourse is an essential part of the IENE activities. Welcome to the first international IENE conference since the re-establishment of IENE!

More information: www.iene.info
The 2010 IENE conference "Improving connections in a changing environment"

We live in a changing environment, we always have! But the pace of change is probably unprecedented and its cause can likely be attributed to a single species alone - us. We are quickly approaching our planetary boundaries, but at the brink of a global climate change and in the aftermath of extensive industrial pollution, habitat destruction and species extinctions, that characterized the past decennium, our concern for Nature has probably never been greater than now, during 2010, the International Year of Biodiversity.

The transport sector plays a significant role in this process! Besides the overwhelming CO2 emission and the gulpy consumption of non-renewable resources, traffic and transport facilities affect our environment to a much greater extent than what is obvious at first sight, and is dealt with in standard EIA procedures.

Every year, billions of animals are killed on roads and railways across Europe. Traffic noise and exhaust toxins pollute and degrade habitat quality far into the adjacent landscape, while the physical imprint disrupts ecological and cultural linkages and create division lines that disintegrate natural and human living spaces alike. However, we need to look at the broader picture to fully grasp the extent of the actual impact. It is then we see a growing fragmentation of entire landscapes into smaller and more isolated patches of often lesser quality. These patches may, eventually, no longer support viable populations of their own and wildlife will increasingly depend on its ability to move across the patchwork. To protect biodiversity, we must hence safeguard and improve connections in this changing environment.

This requires i) a large-scale development of ecological transportation and habitat networks, and ii) more permeable human transport corridors that provide safe passage for both animal and human travelers.

It is in this dualism, I believe, that the key lies to a successful defragmentation of landscapes. And it is this dualism that is in the focus of the 2010 IENE conference.

During the next days, we will learn about new approaches to integrate ecological concern into the plans and policies of the transport sector; how to work with defragmentation programs, and to assess and evaluate critical fragmentation levels. We will see extensive evidence for the actual barrier effect of roads and railroads on wildlife; the death toll of traffic and its disturbance effects, but also learn about the potential of verge habitats as a refuge to rare and endangered species. We will further see how ecological networks can be developed and used as a tool in defragmentation programs.

Yet, to accomplish defragmentation, we must employ adequate technical measures that effectively mitigate the physical severance, disturbance effect and mortality, all of which contribute to the barrier effect of transport infrastructure. We will learn from case studies around the globe about the significance of passage design, dimension and embedding in the surrounding landscape. We will hear how automated warning systems can be used to defuse accident hotspots and restore connectivity for wildlife.

Indeed, there is comprehensive practical experience and knowledge on such matters, but what does it help if it is not communicated and shared? The whole idea with IENE is to provide a forum for exchange and collaboration - not only among scientists, but rather between science and practice. As such, the conference hosts a number of open workshops, among which there is e.g. the meeting of the CEDR task force on Wildlife and Traffic.

In the name of IENE, I am very grateful for the broad interest that the conference has received so far. I am honored by the presence of our plenary speakers from Japan, Canada, and the US and heartily welcome all participants from outside Europe who help us show that improving ecological connections in our changing environment is a global responsibility.

On behalf of the 2010 IENE programme committee,
Andreas Seiler
Welcome to IENE 2010

On behalf of the Organizing Committee, I welcome you to the 2010 IENE Conference.

The need for the discussion of theoretical and practical issues of linear infrastructure and the environment resulted in several European conferences after the first meeting in Maastricht, in September, 1995. However, it is only the second Infra Eco Network Europe (IENE) conference, the first was held in Brussels, in 2003. As part of a new strategy of the IENE network, from now on these meetings are planned to be held more regularly in even years to avoid possible overlaps with ICOET meetings in North America.

It is a great honour to us, Hungarians, that following the successful organization of the Re-Start IENE workshop in Nyíregyháza in 2008, an event after five quiet years, we got the privilege to organize this important event as well. To me, whose work was appreciated by a poster prize in the first, 1995 event, it is an especially valuable development in my career.

The IENE 2010 conference is an important meeting in the general area of ecology and transportation. It has attracted biologists and engineers, researchers and practitioners, decision-makers and NGO representatives from four continents.

Besides discussing the state-of-the-art, new results, new perspectives and applications, main objectives of the conference are to provide an arena for information exchange, building bridges among different areas and experts, and trigger lively discussions on a topic which basically determines if we shall be able to meet our ambitions for halting the loss of biological diversity in Europe and elsewhere, in what is a fast changing environment in many respects.

The 2010 IENE conference features 5 plenary and 69 ordinary talks, 5 workshops and 53 posters. The credit for this rich response to our call should mainly go to the International Secretariat and the Steering Committee of IENE and the Programme Committee of the Conference. Their members did their best to invite specialists to this meeting from all over the world. I especially thank all members of the Programme Committee for the efforts made during the review process.

The 2010 IENE conference has two further characteristics worth mentioning even in a welcome address. It is the first ecology and transportation meeting that was preceded with an education campaign. One result, drawings and other items from a children’s competition will be exhibited during the meeting and winners have also been invited to the IENE conference to get their prizes here. The second important development is the chance for all presenters to publish in a special issue of a journal with an impact factor, an unprecedented outcome of ecology and transportation meetings.

Hungary is undoubtedly one of the world most favourite tourist destinations. Hungarians settled in the Carpathian Basin 1110 years ago. Their culture, music, art, architecture, spas, the largest Parliament of Europe, the continent’s first underground railway and many other miracles to discover together with the unique flora and fauna, national parks and UNESCO World Heritage Sites of the country, cuisine and wine attract millions of visitors every year. The language as well as Hungarian folk songs hardly bear resemblance to those of other nations in Europe; do not miss to listen to some of them.

The 2010 IENE conference is held at Velence, 45 km from the centre Budapest. It is an excellent location along a lake to make a meeting, where everyone can concentrate on professional issues in a quiet environment. Two excursions along motorways and a lively social programme including a concert in the Brunswick Palace, where Beethoven worked for several years, an evening visit to Székesfehérvár, the city of Hungarian kings, wine tasting, gypsy and modern music enriches the meeting bringing an atmosphere, which triggers fruitful discussions.

I honestly hope that you will find the conference an unforgettable professional and cultural event and fully enjoy all aspects of the meeting.

Miklós Puky
Chair of the Organising Committee
Children’s competition

With the growing need for interaction between road ecologists, engineers, decision-makers and the general public, i.e. tax-payers covering the costs of all de-fragmentation measures, organisers of the 2010 IENE conference decided to launch a special education campaign related to the meeting.

The “On dangerous roads” campaign lasted for a year and had several forms. A related information campaign about linear infrastructure issues in the form of talks, special programmes (e.g. on the International Day of Biodiversity) and broadcasts were carried out in Hungary with the general public as the main target group. Parallel with those activities a competition was organised for children. They could express their opinion about these issues in the form of drawings, sculptures, etc. The best examples of their work are presented at the 2010 IENE conference to remind all participants what the future generation wants us to achieve.

More than 180 drawings and other items were sent in from 11 counties and the capital of Hungary. The winners and runners up were selected in three age categories at the end of August, 2010, and they were exhibited in the Institute of Ecology and Botany of the Hungarian Academy of Sciences for three weeks in September, 2010. Also, they are part of the IENE 2010 conference to help all participants remember how important their work is and that future generations are really interested in improving connections for wildlife over linear infrastructure.

The winners of the competition were invited to the IENE meeting where their prizes are presented during the morning session on 28th September by, among others, the chair of IENE, the chair of the Sustainable Development Committee of the Hungarian Parliament and a former secretary general of the Hungarian Academy of Sciences.

Children’s competition winners

• 4-6 years: Füzy Anna, Esztergom
• 7-10 years: Thalmeiner Virág, Göd
• 11-14 years: Telek Angelika, Budapest

First runners up

• 4-6 years: Vizy Vanda, Soltvadkert
• 7-10 years: Burján Hanna, Gödöllő; Stollár Szonja, Gödöllő
• 11-14 years: Gazdag Bálint, Salgótarján; Tihanyi Viktória - Darázs Csenge, Esztergom

Second runners up

• 4-6 years: Herenik Petra, Vác
• 7-10 years: Hegedűs Henrietta, Zákányszék
• 11-14 years: Nyúl Zsófia, Soltvadkert; Patyik Hanna, Rőszke

Special awards

• Balogh Blanka, Kocsis Rebeka, Menyhárt Maja, Kismarjai Márton, Lészkai Ádám Zsolt, Takács Dániel, Fót
• Csohány Roland, Hári Boglárka, Lits Ágoston, Csór
• Mika Zoltán, Abaújszántó
• Takács Márton, Abaújszántó
• Deák Bence, Nagy Veronika, Gora Evelin, Pasztuhov István, Kovács Mónika, Kolonics Fanni, Ásotthalom
General information

Venue

Hotel Juventus Velence
(H-2481 Velence, Kis köz 6.)

Ground floor:
- meeting rooms A, C, registration and information desk, poster area, exhibition, welcome reception, coffee breaks, lunch
1st floor:
- meeting room B, Speakers’ Ready room with Internet access

Registration and information desk

Opening hours

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
</tr>
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<tbody>
<tr>
<td>Monday, 27 September</td>
<td>13:30 – 19:00</td>
</tr>
<tr>
<td>Tuesday, 28 September</td>
<td>08:00 – 19:00</td>
</tr>
<tr>
<td>Wednesday, 29 September</td>
<td>08:00 – 19:00</td>
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<tr>
<td>Thursday, 30 September</td>
<td>08:00 – 09:30</td>
</tr>
<tr>
<td>Friday, 1 October</td>
<td>08:00 – 15:00</td>
</tr>
</tbody>
</table>

On-site payments can be settled in cash (EUR or HUF) only. The ATM closest to the conference venue is available in 2-3 minute walk (see the map in inner cover).

Speakers’ instructions

Oral presentations

Presenters will have access to a podium lectern with microphone, video projector, Windows PC laptop w/CD-ROM drive, and projection screen in each meeting room.

The room laptops are equipped with Windows XP Professional, Powerpoint, Adobe Reader, Windows Media Player and VLC Video Player. Bring your presentation files (MS Powerpoint 2003 compatible) on a USB flash-drive or CD-ROM to the conference and make sure to upload and check them before the start of your session. A Speakers’ Ready room with 4 computers equipped with the same softwares as the room laptops will be available at the conference venue, where you can check your slides.

We intend to include audio recordings of all oral presentations in the proceedings. In case you do not wish to have your presentation recorded, please indicate this in advance to your session chair.

Wireless Internet will be available in the whole building.

Posters

Posters will be presented during two separate poster sessions on 28 and 29 September. Please locate your particular session in the poster session programme.

Poster set-up should be completed before 11.30 on the day of the respective session. Posters will be on display during the whole day before the respective evening poster session and can thus be viewed during coffee and lunch breaks. During the poster session 18:00-19:00, all authors should be present at their poster and available for questions and discussions. Authors are kindly asked to remove their posters right after the end of the respective session. Removed posters can be stored at the registration desk.
Exhibition
The exhibition is held in the registration area (ground floor) during the conference hours.

Internet access
Free wireless Internet access is available in the building. Public Internet access is available in the Speakers' Ready room (1st floor).

Badges
Please, make sure that you wear your badge in every event you participate, including coffee breaks, lunch and the social events.

Social events
Pre-conference programme: Conservation highlights of the M7 motorway
   Monday, 27 September, 14:30 – 19:00
   All registered participants are welcome.

The 4,5 hour trip visits the conservation highlights of the M7 motorway (This road connects Budapest, the almost 2 million Hungarian capital, with Lake Velence, Lake Balaton, Slovenia and Croatia.).

The tour focuses on mitigation measures in the Balaton area including a 1,872 m and a 300 m bridge providing terrestrial as well as aquatic connections between the two sides of the motorway. The latter is also a good locality for the introduction of another critical conservation element, the runoff water treatment system, as its structure is clearly visible at that site. Other stops are also planned at different mitigation measures such as game bridges and amphibian tunnel systems.

Besides the professional programme, this tour also gives a good overview on the southern Transdanubian landscape along Lake Balaton. Participants will come back to Velence, the meeting venue, from their appr. 230 km journey before the welcome reception starts in the evening.

Welcome Reception
   Monday, 27 September, 20:00 – 21:00
   Conference venue, ground floor
   All registered participants are welcome.
   Special bus is provided to Budapest after the reception.

Opening speech by academician Tamás Németh, Secretary General of the Hungarian Academy of Sciences, who greets the participants of the IENE conference.

Social event
   Tuesday, 28 September, 19:30 – 22:00
   Agricultural Research Institute of the Hungarian Academy of Sciences – Brunswick Castle
   (H-2462 Martonvásár, Brunszvik u. 2.)
   All registered participants are welcome.

Special buses are provided from the venue and back to Velence and Budapest. Departure from the conference venue: from 19:00

Visit a famous place in music history: come with us to the Brunswick Palace. Situated near Velence, this former home of nobilities (now place for an academic institute) is world-famous due to the years Ludwig van Beethoven spent here. A 40 minute concert given by renowned musicians, Kossuth Prize winning György Geiger and Liszt Prize winning Éva Maros, will be a very special and memorable event not only for those who love classical music. After the concert there will be a reception and you will also have a chance to visit the local Beethoven museum.
**Conference dinner (optional)**

Wednesday, 29 September, 19:30 – 22:00  
Restaurant "Szárcsa Csárda" (H-8000 Székesfehérvár, Szárcsa u. 1.)  
Optional event, price: EUR 55

There will be bus transportation to the event and back to Velence and Budapest.  
Departure from the conference venue: from 19:00

The conference dinner evening will take us to the county capital Székesfehérvár, the coronation place of Hungarian kings back in early medieval times. Leaving early evening we begin with a tour in the historic city centre and stroll the old streets where we can see medieval houses, the bishop’s palace, memorials of kings, heroes, and Kati néni (Aunt Kati), the statue of an old woman famous for selling goods from her trolley in the streets for many years. You can even touch her nose, it is said to bring good luck! After the refreshing tour we are heading for the best restaurant in town to have dinner with gypsy music and Hungarian dances.

Join us for an evening in a relaxed and casual atmosphere while tasting traditional Hungarian and special international meals and drinks.

**Field trip**

Thursday, 30 September, 09:30 – 19.00  
Restaurant "Szárcsa Csárda" (H-8000 Székesfehérvár, Szárcsa u. 1.)  
Optional event, price: EUR 55

Departure: 09:30 from the conference venue  
Special bus is provided to Budapest after the trip.

The 350 km mid-conference excursion takes participants to the newest motorway of Europe. M6 (E73) is part of a planned international corridor connecting the Baltic and the Adriatic Sea. The visited stretch spans over a landscape dominated by the River Danube. Practical measures, e.g. deer grids, wildlife warning reflectors, an amphibian tunnel as well as game bridges are shown during the tour.  
A special visit is planned to the locality, where the motorway crosses a Natura 2000 site. NG0 and national park activities are introduced during a visit of an abandoned Danube arm surrounded by roads and railroads. In the afternoon short presentations are given on the planning, construction and functioning of the motorway. The whole day excursion finishes with a touch of local traditions in an internationally renowned winery.

**Personal insurance**

The Organisers of the conference do not provide insurance and do not take responsibility for any loss, accident or illness that might occur during the Congress or in the course of travel to or from the meeting site.

**Useful telephone numbers (can be dialed without using a card or coins)**

Ambulance: 104  
Fire Brigade: 105  
Police: 107  
Overall Emergency: 112

**24-hour Tourinform hotline**

Telephone numbers: +36 60 550 044 from abroad, +80 66 00 44 in Hungary.
Sponsors

**The Swedish Transport Administration**

**The Swedish Research Council for Agricultural Sciences and Spatial Planning**

**ACO Wildlife**

**ARCADIS**

Exhibitors

**ACO Wildlife**

Working in conjunction with environmental specialists, ACO has utilized its extensive knowledge of surface drainage to develop a proven amphibian tunnel and guide wall system.

At ACO Wildlife we are constantly working to develop new ideas for improvements.

ACO symbolizes top class products and system solutions around the world for drainage technology and construction elements in the construction, civil engineering and building services sectors.

www.aco-wildlife.com

**MAIBACH VuL GmbH**

Manufacturer of amphibian protection systems for temporary and permanent installations: Fences, tunnels and accessories. Maibach products are based on advice of herpetologists. The materials are in accordance with European standards. Maibach amphibian fences are produced since more than 20 years and are installed in many European countries.

MAIBACH VuL GmbH
Bannholzstrasse 4
D- 73037 Göppingen / Germany
## Programme at a glance

| Monday  
27 September | Tuesday  
28 September |
|----------------|----------------|
| **Opening ceremony**  
Plenary session I.  
Children’s competition awards giving ceremony | 08:30 |
| 09:00 | 09:30 |
| 10:00 | 10:30 |
| 11:00 | 11:30 |
| **Coffee break** | 12:00 |
| 12:30 | 13:00 |
| 13:30 | Lunch |
| 13:30 | 14:00 |
| **13:30**  
Registration opens | 14:30 |
| 15:00 | 15:30 |
| **Coffee break** | 16:00 |
| 16:30 | 17:00 |
| 17:30 | 18:00 |
| **Tuesday poster session** | 18:30 |
| 19:00 | 19:30 |
| **Welcome reception** | 20:00 |
| 20:30 | 21:00 |
| 21:30 | Social event |
# Programme at a glance

<table>
<thead>
<tr>
<th>Wednesday 29 September</th>
<th>Thursday 30 September</th>
<th>Friday 1 October</th>
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<tbody>
<tr>
<td><strong>Plenary session II.</strong></td>
<td>Field trip introduction</td>
<td><strong>Plenary session III.</strong></td>
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</table>
| Parallel sessions:  
  • Ecological networks and corridors as tools for defragmentation I.  
  • Transport corridors as habitat  
  • Case studies: Mitigation and monitoring | | Parallel sessions:  
  • Trans European wildlife network  
  • Workshop: IENE project: Geographic interactive  
  • Workshop: Ecological connectivity - towards a framework for ... |
| **Coffee break** | | **Coffee break** |
| Parallel sessions:  
  • Ecological networks and corridors as tools for defragmentation II.  
  • Defragmentation approaches for existing transport networks  
  • Fences and animal detection | | **Plenary session IV.** |
| **Lunch & luncheon (IENE awards)** | Field trip | Lunch |
| Parallel sessions:  
  • Workshop: Fragmentation measures  
  • Workshop: CEDR task 7 - Wildlife and traffic  
  • Workshop: Rail and road | | **IENE General Assembly 2010** |
| Coffee break | | |
| Parallel sessions:  
  • Workshop: Fragmentation measures  
  • Workshop: CEDR task 7 - Wildlife and traffic  
  • Workshop: Rail and road | | |
| Wednesday poster session | | |
| **Conference dinner** | | |
# Programme

**Monday, 27 September**

13:30-19:00  
Registration

14:30-19:00  
**Pre-conference programme: Conservation highlights of the M7 motorway**

20:00-21:00  
**Welcome reception**  
Welcome address: Tamás Németh, Secretary General of the Hungarian Academy of Sciences

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**Tuesday, 28 September**

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<tr>
<th>Time</th>
<th>Event</th>
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<tr>
<td>09:00-09:30</td>
<td><strong>Opening ceremony</strong></td>
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<td>Chair: István Láng, Honorary Chair of the National Council for Environmental Protection, Hungary</td>
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<td></td>
<td><strong>Opening addresses</strong></td>
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<td></td>
<td>Benedek Jávor, Chair of the Sustainable Development Committee of the Hungarian Parliament</td>
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<td>09:30-11:00</td>
<td><strong>Plenary session I.</strong></td>
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<td></td>
<td><strong>Mitigating road effects on wildlife populations: why we know less than we think we know</strong></td>
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<td></td>
<td>Lenore Fahrig</td>
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<td>11:00-11:30</td>
<td><strong>Children’s competition awards giving ceremony</strong></td>
<td>A</td>
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<td>11:30-12:00</td>
<td><strong>Coffee break</strong></td>
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<td>12:00-13:30</td>
<td><strong>Road mortality and barrier impacts I.</strong></td>
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<td>Chair: Antonio Mira (PT), Marco Dinetti (IT), Marguerite Trocmé Maillard (CH)</td>
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<td><strong>Spatial wildlife-vehicle collision models: A review of current work and recommendations for their application to transportation mitigation projects</strong></td>
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<td>Kari E. Gunson, Giorgos Mountrakis</td>
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<td><strong>The factors implied in bird casualty distribution on motorways</strong></td>
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<td>Eric Guinard, Romain Julliard, Christophe Barbaud</td>
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<td><strong>Behavioural responses of barn owls and stone martens to highways: Do ecological or highway features explain the differences?</strong></td>
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<td>Clara Grilo, Joana Sousa, Hugo Matos, Inês Leitão, Paula Pinheiro, João Bernardo, Mónica Costa, Filipe Silva, Dyana Reto, Fernando Ascensão, Margarida Santos-Reis</td>
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<td><strong>Patterns of amphibian fatalities in a Mediterranean landscape: insights from a low traffic road in Southern Portugal</strong></td>
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<td>Paulo Sá-Sousa</td>
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<td>12:00-13:30</td>
<td><strong>Policy and planning</strong></td>
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<td>Chairs: Lars Nilsson (SE), Tony Sangwine (UK)</td>
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<td><strong>Transport sensitive areas in Europe: Identification and policy instruments</strong></td>
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<td>Lennart Folkesson, Anna Melin, Gunnar Lindberg</td>
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<td><strong>A methodology to assess impacts of plans and programmes on the network foundation of Natura 2000</strong></td>
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<td>Johan Lammerant</td>
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Two milestones in the realisation of the long-term defragmentation program
Hans Bekker, Bert Stegehuis, Martijn de Haan, Marleen Moelants

Implementing ecological knowledge in road planning: Road 73, a practical example from Sweden
Lars Nilsson

12:00-13:30 Disturbance, pollution and invasion Room C
Chair: Lisa Dolan (IE), J-O Helldin (SE)

The effect of highways on native vegetation and reserve distribution in the state of São Paulo, Brazil
Simone R. Freitas, Cláudia O. M. Sousa, Jean Paul Metzger

Traffic noise impact on biodiversity - a method for assessment
J-O Helldin, Per Collinder, Åsa Karlberg

Railroad construction and farmland breeding birds - a study of the Bothnia Line
Adriaan de Jong

Interactions between road infrastructure and adjacent ecosystems
L.M.J. Dolan, M. Emmerson, R. Thompson, E. O'Rourke, P.M. Whelan

13:30-14:30 Lunch

14:30-16:00 Fauna passages and their efficacy I. Room A
Chair: Miklós Puky (HU), Edgar A. van der Grift (NL)

Beyond passage use: How to evaluate effectiveness of road mitigation for wildlife populations
Rodney van der Ree, Edgar A. van der Grift, Jochen Jaeger, Lenore Fahrig, Francisco Madrinan, Glenn Cunnington, Scott Findlay, Jeff Houllahan, Nina Klar

Testing amphibian tunnels under motorways in Hungary
Balázs Vági, Tibor Kovács, János Török

What is the impact of human co-use of wildlife overpasses on the use of these crossing structures by wildlife?
Edgar A. van der Grift, Fabrice Ottburg, Jolanda Dirksen

Conservation science for the management of transportation systems and fragmentation-sensitive species in the Canadian Rocky Mountains
Anthony P. Clevenger

14:30-16:00 EIA and SEA Room B
Chair: Johan Lammerant (BE), Malin Andersson (SE)

Methods and tools for integration of landscape level ecological impacts in environmental assessment
Martina Walter, Ulla Mörtberg, Berit Balfors

New roads versus landscapes
Eva Kaczmarczyk

Wildlife and roads: world problems, sustainable solutions
T.E.S. Langton

Identification and comparison of road and railway projects effects on natural habitats
A. Ginot, D. François, A. Jullien
14:30-16:00  Road mortality and barrier impacts II.  Room C
Chair: Antonio Mira (PT), Marco Dinetti (IT), Marguerite Trocmé Maillard (CH)

Assessing road effects on bats. The role of landscape, road features and bat activity on roadkills
Denis Medinas, J. Tiago Marques, António Mira

All wildboar-vehicle collisions respond to the same variables? Looking for patterns using self-organizing maps
Víctor Javier Colino Rabanal, Miguel Lizana Avia, Salvador José Peris Álvarez

Can we model wolf-vehicle collisions? Using a logistic model with corrections to identify the variables involved in the road-kills
Víctor Javier Colino Rabanal, Miguel Lizana Avia, Salvador José Peris Álvarez

The risk of being hungry: Influence of prey availability in verges on predator skills
Carmo Silva, António Mira, M. Paula Simões

Potential impact of motorway and express roads upon migratory trails of wolves in Poland
Boguslaw Bobek, Marta Wojciuch-Płoskonka

16:00-16:30  Coffee break

16:30-18:00  Fauna passages and their efficacy II.  Room A
Chair: Miklós Puky (HU), Edgar A. van der Grift (NL)

Bat crossings across Irish national roads - implications for planning mitigation measures
Isobel Abbott, Fidelma Butler, Simon Harrison

Comparison of ecoducts structure systems in the region of Central Europe
Jan Pěnčík, Marek Foglar

Amphibian mitigation measures design: do we focus enough on conservation status and species-specific requirements?
Miklós Puky

Vegetation structure on overpasses is critical in overcoming the road barrier effect for small birds
Darryl Jones

16:30-18:00  Fragmentation and landscape  Room B
Chair: Jochen Jaeger (CA), Andreas Seiler (SE)

Monitoring landscape fragmentation in Europe: How well can socio-economic variables explain the differences between regions?

Towards integrative SEA: From fragmentation indices to landscape sensitivity units
Lena Pernkopf, Stefan Lang

Response times of amphibian populations to replacement pond following road construction
David Lesbarrères

Studies of road effects on small vertebrates in southern California, USA
Cheryl S. Brehme, Robert N. Fisher

16:30-18:00  Road mortality and barrier impacts III.  Room C
Chair: Antonio Mira (PT), Marco Dinetti (IT), Marguerite Trocmé Maillard (CH)

Car accidents caused by wild fauna in the Tuscany region
Paolo Banti, Sabrina Nuti, Maria Paola Ponzetta, Francesco Sorbetti-Guerri
Factors influencing vertebrate carcasses retention time on roads: A preliminary study on Mediterranean context  
Filipe Carvalho, António Mira

Analysis of the relationship between seasonal and locational features of Sika deer-vehicle collisions in Hokkaido, Japan and deer ecology towards collision reduction  
Misako Noro, Fumihiro Hara, Ayami Saga, Toru Hagiwara

Spatial and temporal evaluation of the wildlife-vehicle collisions along the M3 Highway in Hungary  
Ferenc Markolt, László Szemethy, Róbert Lehoczki, Miklós Heltai

Birds and transportation infrastructure  
Marco Dinetti

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
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<tbody>
<tr>
<td>18:00-19:00</td>
<td>Tuesday poster session</td>
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</table>

Policy and planning  
Chair: Lars Nilsson (SE), Tony Sangwine (UK)

TU1  
Support and promotion of the local administrations to avoid the fragmentation caused by the routing of large communication infrastructures in the region of Girona  
Jaume Hidalgo i Colomer

TU2  
An initiative to increase knowledge exchange and promote best practices between the stakeholders involved in transport and biodiversity issues  
Georgina Álvarez, Carme Rosell, Ferran Navàs

TU3  
Initial steps in the design of compensation measures for habitat and landscape effects of road construction  
Ana Villarroya, Jordi Puig

TU4  
Transalpine Transport Architects (TRANSITECTS)  
Matthias Wagner

Road mortality and barrier impacts  
Chair: Antonio Mira (PT), Marco Dinetti (IT), Marguerite Trocmé Maillard (CH)

TU5  
Can we use road-kill data set to enhance our knowledge about the spatial distribution of ungulate species?  
Víctor Javier Colino Rabanal, Salvador José Peris Álvarez, Miguel Lizana Avia

TU6  
Risk and deterministic factors effecting bear train collisions along the Canadian Pacific Railroad  
Benjamin Dorsey

TU7  
Roadkilling wildlife in southern Spanish oak woodlands  
Juan D. Delgado, Natalia Arroyo, Jorge Durán, Alexandra Rodríguez, Antonio Rosal, Valle Palenzuela, Jesús R. Sánchez

TU8  
Wildlife road mortality in Mediterranean coastal wetlands (East Spain)  

TU9  
Optimization of sampling effort on species diversity and road-kills in southern Brazil  
C. García-Suikkanen, A. Remolar, P. Vera, C. Hernández, E. Gielen, V. Benedito
TU10
Birds and highway: effects on species diversity and road-kills in southern Brazil
Alex Bager, Clarissa Alves da Rosa, Gustavo Ferreira de Brito, Thálita de Resende Cardoso, Ana Carolina Maia, André Luis Pracucci Gomes dos Santos

TU11
Index ranking of priority sites for mitigation of wildlife road-kill
Alex Bager, Clarissa Alves da Rosa

TU12
Effect of sampling effort on estimated richness of road-killed vertebrate wildlife
Alex Bager, Clarissa Alves da Rosa

TU13
Road mortality of amphibians in western Ukraine (Lviv Province)
Ostap Reshetylo, Taras Mykitchak

TU14
Roadkills and the dynamics of the faunal casualties in Battonya town (SE Hungary)
András István Csathó, András János Csathó

Disturbance, pollution and invasion
Chair: Lisa Dolan (IE), J-O Helldin (SE)

TU15
Effects of the construction of a high-speed railway on the distribution and home range of the stone martens (Martes foina) in Cuenca (Spain)
Esther Juárez, Francisco J. García, MGS Colomer, Francisco Suárez

TU16
Impacts of a highway construction on great bustards threatened population: threshold distances and effects on population dynamics
Aurora Torres, Carlos Palacín, Juan C. Alonso, Javier Seoane

TU17
Ecological considerations for the management of non-native invasive species during the maintenance and operation of national road schemes in Ireland
R. Thompson, L.M.J. Dolan, M. Emmerson, J. Dauber, J. Stout, P.M. Whelan

TU18
Space use by Brown bear (Ursus Arctos) in relation to noise during and after Egnatia highway construction activities in Pindos mountain range
Alexios Giannakopoulos, Triantafyllos Akriotis, Yorgos Mertzanis, Athanassios Tragos, Konstantinos Godes, Vasilios Dalamagas, Nikolaos Karameros

TU19
Mortality and habitat fragmentation from wind farm development
Joris Everaert

Fauna passages and their efficacy
Chair: Miklós Puky (HU), Edgar A. van der Grift (NL)

TU20
Quantifying the effects of wildlife crossing structures on the population viability of arboreal mammals
Kylie Soanes, Rodney van der Ree

TU21
Factors influencing design, location and function of ecoducts
Jan Pěnčík, Marek Foglar

TU22
Adjustable groundwater level on overpasses to benefit amphibians
Anne Martine Kruidering
TU23
The usual approach to ecological bridges design and construction and its possible innovation
Marek Foglar, Vladimir Kristek

TU24
Methods of accelerated design of ecological overbridges
Marek Foglar, Vladimir Kristek

TU25
An overpass for amphibians - does it work?
Edgar A. van der Grift, Fabrice Ottburg, Robbert Snep

TU26
Improving toad tunnel efficiency at Parassapuszta, Hungary: inappropriate design and construction could partly be counter-balanced by maintenance
Miklós Puky, Timea Mechura, Dorottya Gémesi, Gergely Szövényi

TU27
Brown bear crossings along Egnatia Highway in Northern Greece
Alexios Giannakopoulos, Triantafyllos Akriotis, Dimitrakopoulos Panagiotis, Theodorou Kostas, Yorgos Mertzanis, Susan Riegler, John Beecham, Ioannis Tsaknakis, Yorgos Iliopoulos, Kostas Poirazides

19:30-22:00
Social event
### Wednesday, 29 September

<table>
<thead>
<tr>
<th>Time</th>
<th>Session Title</th>
<th>Room</th>
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<tbody>
<tr>
<td>08:30-10:00</td>
<td>Plenary session II.</td>
<td>Room A</td>
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<tr>
<td></td>
<td>Highspeed railways and nature conservation: a growing challenge or an opportunity?</td>
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<td>Michael Below</td>
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<td>Transport ecology in Japan and Asia</td>
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<td>Fumihiro Hara</td>
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<td>10:00-11:30</td>
<td>Ecological networks and corridors as tools for defragmentation I.</td>
<td>Room A</td>
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<td>Chair: Ruben Hulse (NL), Marita Böttcher (DE)</td>
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<td></td>
<td>Ecological networks in the Czech Republic</td>
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<td></td>
<td>V. Hlaváč, P. Anděl, M. Andreas, T. Mináříková, M. Strnad, I. Gorčicová, D. Romportl, A. Bláhová</td>
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<td>Design of multifunctional landscape corridors using effective mesh-size for regional targeting of urban development restrictions and open space development</td>
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<td>Hans-Georg Schwarz-von Raumer, Heide Esswein</td>
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<td>Biotope networks - networks of life: promoting a forest corridor system with a European perspective</td>
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<td>Mark Hoersternann, Thomas Mölich, Jochen Vogel</td>
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<td>From Patchwork to Network: ECONAT</td>
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<td>Hans Bekker, Phil Baader</td>
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<td>10:00-11:30</td>
<td>Transport corridors as habitat</td>
<td>Room B</td>
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<td>Chair: Peter Spooner (AUS), Sofia Gylje (SE)</td>
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<td>Contrasting fragmentation and disturbance effects on roadside vegetation</td>
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<td>Peter G. Spooner, John Losciavo</td>
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<td>Biodiversity in railway environment. How to measure, preserve and enhance threatened species on railways.</td>
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<td>Magnus Larsson, Sofia Larsson</td>
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<td>Can infrastructure habitats contribute to the preservation of threatened biodiversity?</td>
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<td>Tommy Lennartsson, Sofia Gylje, J-O Helldin, Anna Dahlström</td>
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<td>Living on the verge: Are roads a more suitable refuge for small mammals than streams?</td>
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<td>Helena Marques, António Mira</td>
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<td>A study on some insect groups in Hungarian highway margins (Orthoptera, Coccoidea, Auchenorrhyncha)</td>
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<td>Balázs Kiss, Ferenc Kozár, Barnabás Nagy, Éva Szita</td>
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<td>10:00-11:30</td>
<td>Case studies: Mitigation and monitoring</td>
<td>Room C</td>
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<td>Chair: Anders Sjölund (SE), J-O Helldin (SE)</td>
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<td>Mitigating the impact of the highway E314 crossing the National Park Hoge Kempen (Province of Limburg, Flanders, Belgium)</td>
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<td>Jorg Lambrechts</td>
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<td>Identification of corridors and linkage zones for brown bears as a compensation measure to the impacts of the construction of the “E65” highway in Central Greece</td>
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<td>D. Bousbouras, L. Georgiadis, D. Chouvardas, C. Evangelou, L. Krambokoukis, E. Lampou, A.A. Karamanlidis</td>
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<td>Making the connection: Mammal mitigation measures on national road schemes in Ireland</td>
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<td>E.J. Finnerty, P.M. Whelan, M. Emmerson, L.M.J. Dolan</td>
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<td>Wildlife accidents. The new Swedish preventing strategy.</td>
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<td>Anders Sjölund</td>
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<td>11:30-12:00</td>
<td>Coffee break</td>
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<td>12:00-13:30</td>
<td><strong>Ecological networks and corridors as tools for defragmentation II.</strong></td>
<td>Room A</td>
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<td><em>Chair: Ruben Huele (NL), Marita Böttcher (DE)</em></td>
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<td><strong>Network of protected areas in Central European border regions</strong></td>
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<td>Marco Neubert, Sylvi Bianchin</td>
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<td><strong>From national planning to regional implementation: initiatives for reconnection of habitats in key areas in Schleswig-Holstein (Germany)</strong></td>
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<td>Björn Schultz</td>
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<td><strong>Restoring the web of life – Ecological networks for more biodiversity in the Alps</strong></td>
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<td>Yann Kohler</td>
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<td><strong>Developing an ecological continuum suitability index for the Alps – Acting with indicators, geodata and web based map tools</strong></td>
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<td>Ruedi Haller, Dominik Affolter, Christian Schmid, Angelika Abderhalden</td>
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<td>12:00-13:30</td>
<td><strong>Defragmentation approaches for existing transport networks</strong></td>
<td>Room B</td>
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<td><em>Chair: Carme Rosell (ES), Edgar A. van der Grift (NL)</em></td>
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<td><strong>The Swiss defragmentation program - from design to global planning. An overview.</strong></td>
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<td>Marguerite Trocmé</td>
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<td><strong>Roads and wetlands: Can we mitigate the impact of the existing transport network?</strong></td>
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<td><strong>Efficiency of re-connecting habitat networks for invertebrate populations - an integrated approach for impact assessment and landscape planning</strong></td>
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<td>Reinhard Klenke, Rüdiger Jooss</td>
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<td><strong>A regional mitigation blueprint for herpetofauna in Southern Ontario</strong></td>
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<td>Kari E. Gunson, Dave Ireland, Frederick W. Schueler</td>
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<td><strong>Restoring ecological networks across transport corridors in Bulgaria</strong></td>
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<td>Edgar A. van der Grift, Valko Biserkov, Vanya Simeonova</td>
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<td>12:00-13:30</td>
<td><strong>Fences and animal detection systems</strong></td>
<td>Room C</td>
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<td><em>Chair: Marcel Huijser (USA), Mattias Olsson (SE)</em></td>
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<td><strong>How effective are wildlife fences in preventing collisions with wild ungulates?</strong></td>
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<td>Milia Niemi, Anne Martin, Ari Tanskanen, Petri Nummi</td>
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<td><strong>The barrier effect of twin tracked, non fenced railroads in Sweden</strong></td>
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<td>Mattias Olsson, Evelina Augustsson, Andreas Seiler, Per Widén, J-O Helldin</td>
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<td><strong>A quantitative comparison of the reliability of animal detection systems and recommended requirements for system reliability</strong></td>
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<td>Marcel P. Huijser, Tiffany D.H. Allen, Matt Blank, Mark C. Greenwood, Shaowei Wang</td>
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<td><strong>Restoring permeability of roads for wildlife: wildlife warning systems in practice</strong></td>
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<td>Martin Strein</td>
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<td>13:30-14:30</td>
<td>Lunch &amp; luncheon <em>(IENE awards)</em></td>
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<td>14:30-18:00</td>
<td><strong>Workshop: Fragmentation measures</strong></td>
<td>Room A</td>
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<td><em>Chair: Jochen Jaeger</em></td>
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<td>14:30-18:00</td>
<td>Workshop: CEDR task 7 - Wildlife and traffic</td>
<td>Room B</td>
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<td>14:30-16:00</td>
<td>Workshop 1: Gaps in 341 Handbook</td>
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<td>16:30-18:00</td>
<td>Workshop 2: Efficient institutional systems</td>
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<td>14:30-18:00</td>
<td>Workshop: Rail and road</td>
<td>Room C</td>
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18:00-19:00 Wednesday poster session

**Fragmentation and landscape**
*Chair: Jochen Jaeger (CA), Andreas Seiler (SE)*

**WE1**
Habitat fragmentation due to transportation infrastructure: the state of the art in Italy
Marco Dinetti

**WE2**
Modelling the effect of roads on Moor frog metapopulations
Maj-Britt Pontoppidan, Gösta Nachman

**WE3**
Ecological impacts of transportation network on wildlife, key biodiversity areas and protected areas of Turkey
Semiha Demirbaş Çağlayan, Özgün Emre Can, Nilgün Karadeniz, Eray Çağlayan

**WE4**
Roads and fragmentation of wild reindeer habitat in Norway: Consequences of the development of infrastructures for conservation
Manuela Panzacchi, Bram Van Moorter, Roy Andersen, Tobias Falldorf, Olav Strand

**WE5**
Effects of the Transylvanian motorway on droving of livestock
J-O Helldin, Ciprian Corpade

**Ecological networks and corridors as tools for defragmentation**
*Chair: Ruben Huele (NL), Marita Böttcher (DE)*

**WE6**
Migration corridors for large mammals in the Czech Republic and their linkages to neighbouring states
V. Hlaváč, T. Mináříková, M. Strnad, P. Anděl, I. Gorčicová, M. Andreas, D. Romportl, A. Bláhová

**WE7**
Habitat suitability models as a tool for designing wildlife corridors in the Czech Republic; synthesis of two different approaches
Dušan Romportl, Eva Vávrová, Tomas Chuman, Michal Andreas, Luděk Bufka, Martin Strnad

**WE8**
From Patchwork to Network: Results peer exchange De-Fragmentation inside ECONAT
Hans Bekker

**Defragmentation approaches for existing transport networks**
*Chair: Carme Rosell (ES), Edgar A. van der Grift (NL)*

**WE9**
Gap analysis in road permeability - towards a mitigation action plan for wildlife
Andreas Seiler, Mattias Olsson, J-O Helldin, Mats Lindqvist, Anders Sjölund

**WE10**
Strategic solutions for defragmentation of a very dense area
Anne Martine Kruidering
Transport corridors as habitat
Chair: Peter Spooner (AUS), Sofia Gylje (SE)

WE11
Roadside vegetation in Mediterranean wetlands: defragmentating or increasing mortality of birds? Management implications
P. Vera, A. Remolar, C. García-Suikkanen, C. Hernández, E. Gielen, V. Benedito

WE12
Study on some insect groups on Hungarian highways in relation to climate changes
Ferenc Kozár, Zsuzsanna Konczné Benedicty

WE13
Fragments of steppe vegetation in roadsides and railway verges in the Great Hungarian Plain
András István Csathó

WE14
How contribute the Service Areas on Polish motorways to the diversity of flora and vegetation?
Maria Wojterska, Halina Ratyńska

Case studies: mitigation and monitoring
Chair: Anders Sjölund (SE), J-O Helldin (SE)

WE15
Ecological highway development in the area of Piacenza, Cremona and Brescia
Francesco Acerbi, Marcello Pilla

WE16
Long time monitoring of biodiversity on D4707 motorway
Jaroslav Žák, Mojmír Foral, Jan Mayer, Jan Pěnčík, Marek Foglar, Radomír Bocek

WE17
Species at risk in Ontario, Canada: habitat fragmentation, a threat to survival
Barbara Slezak

WE18
When fencing and translocation is the right measure to prevent road-related amphibian decline: mass migration of Lissotriton and Triturus newts at Lake Kapszeg
Zoltán Blaskovits, Miklós Puky

WE19
Wetland creation and restoration near the Bothnia Line railroad – a pioneer project in ecological compensation for northern migrant birds
Niklas Lindberg, Anders Enetjärn

WE20
Living in the road vicinity – unique habitat of Zamenis longissimus in the Ohře River Valley, the Czech Republic
Radka Musilová, Karel Janoušek, Vít Zavadil

WE21
Effects of installing amphibian tunnels and amphibian fence on roads in Poland and Denmark
Lars Briggs

Fences and Animal detection system
Chair: Marcel Hujiser (USA), Mattias Olsson (SE)

WE22
Monitoring the effect of a screen installed to mitigate the impact of a high speed railway on bats
Carles Flaquer, Marc Fernández-Bou, Carme Rosell, Rosa María Mata, José Miguel Siller, Ruth García-Ráfols
WE23
Highway fencing and moose migrations in northern Sweden
J-O Helldin, Andreas Seiler, Per Widén, Mattias Olsson, Owe Geibrink

WE24
Efficiency of odour repellents on free ranging red deer (*Cervus elaphus*) and roe deer (*Capreolus capreolus*): a field test
Morten Elmeros, Jens K. Winbladh, Poul N. Andersen, Aksel Bo Madsen, Jens T. Christensen

Trans European wildlife network
Chair: Annette Spangenberg (DE), Djuro Huber (HR)

WE25
Importance of landscape connectivity for wolf and lynx in Bulgaria
Diana Zlatanova, Alexander Dutsov, Kostadin Valchev

WE26
Patterns of mammals mortality on main roads in the Northwestern Poland
Robert W. Mysłajek, Sabina Nowak

WE27
Migration corridors for large carnivores in the West Carpathians, Czech Republic – current threats and conservation activities
Miroslav Kutal, Tomáš Krajča, Michal Bojda, Martin Janča

19:30-22:00
Conference dinner
Thursday, 30 September
08:30-09:30
Field trip introduction

09:30-19:00
Field trip

Friday, 1 October
08:30-10:00
Plenary session III. Room A
Ecology and Transportation: Trends and Challenges and Opportunities
Paul J. Wagner

Transport infrastructure planning in Europe
Tony Sangwine

10:00-11:30
Trans European wildlife network Room A
Chair: Annette Spangenberg (DE), Djuro Huber (HR)

Introduction to Trans European Wildlife Network
Djuro Huber, Annette Spangenberg

Mitigation of negative impact of transport infrastructure on large carnivores in Poland
Sabina Nowak, Włodzimierz Jędrzejewski, Robert Mysłajek

Using the Brown bear (Ursus arctos) as an indicator species for landscape connectivity - a tool for spatial conservation prioritization
Thomas A.M. Kaphegyi, Csaba Domokos

Green bridges and other structures for permeability of highways in Croatia: Case of large carnivores
Djuro Huber, Josip Kusak

Brown bear connectivity in Bulgaria and the effect of the highways
Diana Zlatanova, Alexander Dutsov, Kostadin Valchev

10:00-11:30
Workshop: IENE project: Geographic interactive database on fauna passages Room B
Chair: Andreas Seiler (SE), Javier del Real (ES)

10:00-11:30
Workshop: Ecological connectivity - towards a framework for understanding network nature Room C
Chair: Ruben Huele, Hans Bekker, Helias A. Udo de Haes (NL)

11:30-12:00
Coffee break

12:00-13.30
Plenary session IV. Room A

Conclusions of the conference
Lars Nilsson

Closing remarks, outlook to the next conference in 2012
Andreas Seiler, Miklós Puky

13:30-14:30
Lunch

14:30-18:00
IENE General Assembly 2010
Tuesday, 28 September

Abstracts

Tuesday, 28 September

Plenary session I.

**Mitigating road effects on wildlife populations: why we know less than we think we know**

Lenore Fahrig

Many studies have shown that roads can have large, negative effects on animal populations (Fahrig and Rytwinski 2009). How should these effects be mitigated? I argue that appropriate mitigation depends on the mechanism through which roads affect animal populations. The three most frequently hypothesized mechanisms are (i) mortality effects, (ii) roads as movement barriers (limiting access to habitat and resources), and (iii) roads as sources of disturbance such as noise. Appropriate mitigation of road effects depends on which of these mechanisms is most important. In the case of mortality, mitigation measures should aim to keep animals off roads. If the important mechanism is the movement barrier effect then mitigation measures should focus on connections that allow animals to move across roads (ecopassages). If traffic noise is the main mechanism then mitigation should involve structures to block noise, and/or the use of materials (e.g., tires and pavements) that reduce noise levels.

Three types of population-level studies have been taken as evidence of these three mechanisms, respectively: (i) depressed populations next to high-traffic roads, (ii) absence or rarity of a species in areas with high road densities, and (ii) increasing animal numbers with increasing distance from roads. However, inferences from these patterns to the road effect mechanisms are flawed. Mortality, movement barrier effects, and/or noise could cause depressed populations next to high-traffic roads. Likewise, all three mechanisms could cause the absence or rarity of a species in areas with high road densities. Finally, either road mortality or traffic noise (or another form of road disturbance) could cause patterns of increasing animal numbers with increasing distance from roads. Since the current state of research does not allow a general conclusion about the relative importance of the different mechanisms, we are currently unable to make rationale choices about the most appropriate type of mitigation for population-level road effects.

I outline some initial attempts from research in my lab to compare the relative importance of the three mechanisms in causing population-level effects of roads. Preliminary results suggest that road mortality may be generally a more important effect than the effects of either movement barriers or noise. A simulation study (Jaeger and Fahrig 2004) predicted that mortality is more important than the movement barrier effect in about 82% of the parameter space examined. This conclusion is supported by a comparison of two species, the white-footed mouse and the leopard frog. Translocation studies showed that the white-footed mouse avoids roads, so roads act as movement barriers to this species (McGregor et al. 2008). In contrast, leopard frogs do not avoid roads, so roads are a significant source of mortality for this species (Bouchard et al. 2009). Population-level studies showed a positive effect of roads on the mouse (Rytwinski and Fahrig 2007) but a negative effect of roads on the frog (Carr and Fahrig 2001, Eigenbrod et al. 2008). Therefore, the negative effect of roads at the population level was much stronger for the species exposed to road mortality than for the species for which roads act as a movement barrier. A study of bird abundance vs. noise levels across 10 high-traffic sites showed that bird abundance is not related to noise level, after controlling for distance from the road, and that birds with lower song frequencies (KHz) (so more likely to be masked by traffic noise) are not more strongly affected by roads than those with higher song frequencies (Summers and Fahrig submitted). Similarly, male frogs calling in the presence of traffic noise adjust their calls, and these adjustments completely compensate for any effect of traffic noise on mate attraction (Cunnington and Fahrig in press; submitted). In all cases the most likely mechanism for the negative effects of roads appears to be mortality. Therefore, I conclude that, unless in a particular situation there is evidence to the contrary, the first priority for road mitigation should generally be reducing road kill. Increasing connections and reducing noise disturbance are secondary.

What is actually known about effectiveness of mitigation measures for reducing road mortality? An experimental study on effectiveness of culverts for reducing mortality in amphibians suggests that culverts are not effective at reducing mortality unless they are combined with fencing to keep the
animals off the roads (Cunnington et al. in prep). I propose that an effective mitigation for reducing mortality would be to replace culverts at road-stream intersections with expanded crossings that allow for the natural stream and stream banks to flow beneath the roads. This proposal is based on the notion that road-stream intersections are road-kill hotspots. Finally, I suggest that there is an urgent need for long-term, experimental (before-after-control-impact), population-level tests of road mitigation effectiveness (Roedenbeck et al. 2007).

References:

- Summers, P.D. and L. Fahrig. In review. Are negative effects of roads on breeding birds caused by traffic noise?

Road mortality and barrier impacts I.

Spatial wildlife-vehicle collision models: A review of current work and recommendations for their application to transportation mitigation projects

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Keywords: Wildlife-vehicle collision, roads, mitigation, spatial, temporal

It is well documented that wildlife-vehicle collisions (WVCs) are clustered on roads, prompting road ecologists to link road and landscape characteristics to WVC occurrence. Typically, their objective is to predict the best locations to place wildlife mitigation measures, such as crossing structures, to allow wildlife to cross the road safely avoiding collisions with motorists. We explored and summarized research results that determine the road, e.g. traffic volume and landscape features, e.g. habitat that influence WVCs. We then provide recommendations for model design to better predict where WVCs may occur. Our review shows WVCs commonly occur when road segments bisect favourable wildlife habitat, drainage movement corridors, and flat terrain. Furthermore, road characteristics such as high traffic volumes, and decreased motorist visibility also contribute to more WVCs. These results are intuitive and well documented. Future models need to select variables that provide additional information for the interaction of WVCs and roads at the required mitigation planning scale. At this point, selecting few pertinent variables would outweigh the benefits of including many general variables which often lead to confounding results that are difficult to interpret. Another issue is most WVC modelling designs only encompass a static spatial snapshot of the variables that influence WVCs although previous research has shown that where a WVC occurs is also dependent on when it occurs. Predictive spatial modelling needs to encompass the changing spatial dynamics of the landscape especially when using long-term data sets. In conclusion, prior to WVC modelling analyses research should first perform two-dimensional spatiotemporal analyses, to supplement informed selection of the variables at an appropriate spatial and temporal scale. Modeling output can then be maximized to assist transportation planners and road ecologists at devising the most effective mitigation strategy, i.e. permanent crossing structures with fencing, or more seasonal road traffic control on roads.
The factors implied in bird casualty distribution on motorways
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Keywords: motorways, birds, mortality, spatial distribution
The bird movements and the induced distribution of bird casualties on motorways, are influenced by several factors, among which landscape structures such as adjacent hedgerows or road elevation.
This study intends to determine which combinations of these factors influence the distribution of bird fatalities on motorways, especially for Passerines and Owls which are the most frequently crashed, taking account of major sources of uncertainty associated with censuses.
Method: 5 successive counts of bird carrions during 3 days censuses were made each season from a car, driven at 40-50 km.h\(^{-1}\) on the safe lane. Road elevation and vegetation structure of verges (grass / shrubs / trees / artificial, in % surface) were recorded on 100 x 20 m verge sections, from car and from aerial photographs.
Landscape structure was evaluated with Corin Land Cover 2006 for soil occupancy, BD Topo® vegetation for hedgerows and woods, and BD Topo® hydro for hydrographic system.
Results and discussion: Passerine fatalities are mainly located on embanked, ground level, and mixed-profile motorway sections, and on verges with more than 50% of shrubs. Owls are mainly killed by traffic on sections with 50-75% of shrubs or trees.
At the landscape level, the analysis of the distribution of fatalities suggests that Passerines are more likely to be killed near wetlands areas and waterponds. Owls are more often crashed near forests. Both are killed in vineyard areas.
These results will help developing new mitigation designs in zones that concentrate the main factors responsible for bird mortality.

Behavioural responses of barn owls and stone martens to highways: Do ecological or highway features explain the differences?
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Keywords: movement patterns, radio-tracking, crossing rates, passages use
Several studies have documented that owls and carnivores are two taxa highly impacted by road mortality, but little is known whether roads attract or repulse individuals. The main goal of this study was to evaluate the response behavior of two model species (barn owl and stone marten) through the (a) home-ranges shape and size; (b) effect of traffic volume on the space use patterns; and (c) highway crossings rate. We radio-tracked 10 barn owls and 10 stone martens captured within 2000m of A2 and A6 highway (14900 and 5700 vehicles/day, respectively) in southern Portugal. Fixes were taken every 30 minutes from dusk to dawn. Six individuals of each species provided data to estimate home-range and the response behaviors were not similar. All barn owls had the highway as the home-range (95% Kernel estimator) boundary while stone martens randomly included or excluded the highway in the home-range. Barn owls also showed a positive correlation between the distance to highways and traffic volume, while stone martens only responded to trucks traffic. On average, we found 7.47 barn owls highway crossings in each 100 radio-tracking hours while for stone martens this value was almost three times higher (16.5 crossings). The most likely explanation for the observed species-specific differences is behavioral. Owls use the acoustic system to communicate and locate prey, and therefore seem to be more...
sensitive to the presence of highways and traffic than stone martens. Low traffic (2000 vehicles/night) may explain the tendency of stone martens to cross the highways instead of using the existing passages (1.96 passages/km). Reducing risk of mortality is therefore a management need. Natural obstacles would force owls to fly higher whilst crossing the highway and will also reduce the disturbance in the vicinity, while passages adaptation may improve its use by stone martens.

**Patterns of amphibian fatalities in a Mediterranean landscape: insights from a low traffic road in Southern Portugal**
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Keywords: Mediterranean amphibians road fatalities Portugal

Amphibian fatalities were monitored on the local road M1078 (of total length 7.1 km) that runs across a rural Mediterranean landscape in the Alentejo region (Southern Portugal) during 4 years (September 2003 – November 2007). Although whole road had low vehicular traffic (< 60 cars/hour counted at night during the sampling sessions) it was divided into two stretches: one stretch [VG = 4.2 km] between Valverde and Guadalupe had 9.0 ± 5.9 cars/hour, whilst the other [GE = 2.9 km] between Guadalupe and the cross with the national road N114 had 23.8 ± 18.9 cars/hour. The road was monitored in car at low speed (< 20 km/hour) by two people over 62 early night sessions comprising the wet periods of the year (Autumn, late Winter and Spring). A cumulative total of 2,014 amphibian individuals (64.7 % were fatalities) representing 12 species were found crossing the road. Amphibian abundance was similar in the both stretches, being toads more frequent (62.3-68.0%) than urodels (15.3-19.7 %) and frogs (16.7-18.0 %). When calculated the percentage of fatalities (road kills/total individuals observed), several results were > 50% for toads (*Bufo calamita*, *Pelobates cultripes*), salamanders (*S. salamandra*, *Pleurodeles waltl*) and frogs (*Pelophylax perezi*, *Discoglossus gaiganii*). However the percentage of fatalities was significantly higher in the second stretch [GE] where most species reached between 66% and 84%. These results suggest that even significant differences among low levels of vehicular traffic may have been a real impact on amphibians crossing the road M1078.

**Policy and planning**

**Transport sensitive areas in Europe: Identification and policy instruments**
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Keywords: sensitive areas, policy instruments, encroachment

The EU project ASSET aimed at developing an approach to the identification of transport sensitive areas (TSA) in Europe, and at analysing potential policy instruments to strike a balance between transportation and the natural and cultural values in such areas. Using indicators, criteria and thresholds, TSA:s were identified. Combinations of potential policy instruments (such as road pricing, subsidies, traffic regulations, mitigation measures and public opinion) were tested on ten greatly differing case-study areas (metropolitan, mountainous, natural, sea). The study considered environmental pressure from noise, air pollution, traffic accidents and (road, rail, air and maritime) infrastructure. The approach is demonstrated using the Swedish case Omberg/Tåkern, a sparsely inhabited natural area with outstanding landscape values and historical continuity. Many of the indicators for TSA identification were little applicable here since the criteria did not cover what was relevant. Examples are “sensitive ecosystems” (no UNESCO Biosphere Reserve), “cultural heritage” (no World Heritage Site), “touristic value” (few overnight stays) and “topography” (flat area). Alternative indicators were proposed for possible application also in Europe, e.g. “areas of national interest for the purposes of nature conservation, conservation of the cultural environment or outdoor recreation” and “letters to the editor”. Based on shadow pricing, an effort was made to monetize the encroachment on the landscape made by upgrading an existing road vs. investing in new infrastructure. The derived value was based on the ex post political decision of choosing to improve the road passing outside the TSA instead of the shorter and transport economically more beneficial road through the TSA. An annual value of 1.9 M€ (by 2020) was arrived at. This can be seen as a minimum (annual) valuation of the encroachment in the Omberg/Tåkern case. This
rather high value shows that encroachment can be an important factor in CBA concerning decision making for infrastructure investments.

**A methodology to assess impacts of plans and programmes on the network foundation of Natura 2000**

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Keywords: SEA, Network Coherence, Network Impacts, Network Assessments, Natura 2000 Network, Appropriate Assessment, Habitats Directive

The Birds Directive and the Habitats Directive offer the legal European framework to establish and manage the Natura 2000 network. The key obligation under the Natura 2000 network is to provide the necessary conservation measures to maintain and restore favourable conservation status for a number of protected species and habitats.

At all institutional levels governments are launching plans and programmes to promote the development of transport, communications, energy, tourism, etc. Many of these plans are in a direct or indirect way potentially affecting Natura 2000 sites.

According to the SEA Directive the environmental impacts of these plans have to be investigated and mitigating measures have to be proposed. According to Art 6(3) of the Habitats Directive a so-called Appropriate Assessment has to be executed to investigate if nature conservation objectives in the potentially affected Natura 2000 sites could be harmed. In almost all cases the above assessments are carried out at site level but not at the level of the network. As a result impacts on network coherence are often overlooked.

ARCADIS developed a practical methodology to allow authorities to assess the impacts of major plans and programmes on the coherence of the Natura 2000 network and thereby to minimize the impact on the network in an early stage. The methodology is based on the generally applied ‘good practices’ for performing appropriate assessments and SEA, but has a specific focus on network impacts.

The methodology contains a number of practical tools to deal with complex issues as:

- Defining functional ecological networks
- How to deal with network coherence in the SEA screening phase?
- Role of network coherence in achieving/maintaining conservation goals at site level
- Criteria to allow significance evaluation at the level of impacts on network integrity

**Two milestones in the realisation of the long-term defragmentation program**

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Keywords: infrastructure, wildlife passage, ecoducts, road ecology, international cooperation

The Long term De-Fragmentation Program (MJPO) has been launched in 2004. This program gives a set of identified problem points (208) and an amount of money for counteracting fragmentation inside the National Ecological Network due to national infrastructure.

Two milestones will be presented.

1. An improvement in the way of tendering by making contracts for realisation of packages of fauna passages. In this paper we will look at the most renewing of these packages: the tender of 9 ecoducts.

Many authorities are cooperating in this package of 9 ecoducts and all with their own procedures, policies and procedures. The contract has been signed in May 2009 and the contractor, H2Eco, has started the work. In this paper we present the way of working and the evaluation of the steps to this contract.

2. Some of problem points of the Dutch MJPO are situated close to the border with Belgium or Germany. One is at the highway between Antwerp and Eindhoven (E34/A67). It the Netherlands ‘De Beerze’ is part of a so-called ‘robust connection’ inside the National Ecological Network. In
Flanders the connected Postel region was selected as important zone for de-fragmentation. Both areas are part of one large cross-border natural zone and from ecological point of view this zone have to be respected as one. This project was based at a common study from Flandres and the province Noord-Brabant in the Netherlands and the study resulted in two alternatives. In December 2009 politicians of both administrations in Flandres and Noord-Brabant signed the agreement to reconnect in cooperation this cross-border region. Both partners will provide half of the budget. They decided to go for an ecoduct right on the border itself. The paper will describe most important arguments for this choice. It was a challenge to bring together the two different national processes.

**Implementing ecological knowledge in road planning: Road 73, a practical example from Sweden**

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The old road 73, from Stockholm to Nynäshamn, has probably been used since the Viking age and only, little by little, upgraded and broadened. Increased traffic during the past fifty years made the road known as a “road of death” and called for a completely new road.

However, the region is especially rich in natural and cultural landscape values, and these assets had to be given the same dignity in the planning of the new road as traditional concerns about traffic safety, accessibility and regional development.

To meet this obligation, ecological processes and their requirements, cultural heritage in all aspects, outdoor activities and landscape aesthetics were interwoven into all process levels, from feasibility study down to design and building phases. A unique collaboration between different fields of expertise evolved and resulted in an road architecture that underlines and supports landscape features. In addition, road near habitats have been enhanced to provide greater opportunities for wildlife and efforts were made to ensure safe animal crossings. Groundwater catchments have been protected by lined ditches and run-off water is collected and cleaned before being released into sensitive waterways. In the wider surroundings, natural habitats received special protection status. Overall, the new road was built with an approach to integrate nature, wildlife and people. Raised environmental awareness by everyone involved in the project coupled with specific environmental adaptations made this achievements possible without a significant increase of the costs. Today, the new road 73 is known in Sweden as “a road to the future”.

**Disturbance, pollution and invasion**

The effect of highways on native vegetation and reserve distribution in the state of São Paulo, Brazil

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Keywords: road ecology, tropical forest, biodiversity conservation, tropical savanna, South America

Highways affect the environment in different distances and intensities. Thus, it is important to evaluate areas which are ecologically affected by highways, perhaps including highway distance as criteria to define priority spaces for conservation and restoration. This work aims to: 1) estimate areas which have been ecologically affected by highways, in the whole state of São Paulo, for each type of vegetation, and in all reserves; 2) investigate the influence of highway distance on the native vegetation cover and on the reserve distribution; and 3) discuss the possibility of including roads as additional factors to define priority areas for conservation and restoration. The area of study was the state of São Paulo (southeastern Brazil), where two biodiversity hotspots biomes occur: the Brazilian Atlantic Forest and the Brazilian Cerrado. About 10% of São Paulo has been ecologically affected by highways, being the dense ombrophylous forest and most reserves greatly impacted. Native vegetation and reserve areas have increased with the increase of highway distance. Priority areas defined by species abundance, fragment size and proximity have shown low correlation to highway distance, and highways have been considered a threat to the vegetation cover and its biodiversity; therefore, we considered relevant to include highway distance as a criterion to define top priority conservation and restoration areas. Ninety-four fragments have been specified as top priority for conservation and restoration, and were ranked according to distance to
nearest highway. In conclusion: in order to improve conservation and restoration strategies, we suggest that highways be carefully considered, prioritizing remote areas.

Traffic noise impact on biodiversity - a method for assessment
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Keywords: Traffic noise, Biodiversity, Impact assessment

Previous research has pointed out the negative impact of traffic noise on biodiversity adjacent to major infrastructure corridors. In particular, the effects of road traffic on birdlife are well documented, but effects on other taxa and of railway traffic are also described in the literature. In a similar manner, traffic noise decreases the value of human recreation in natural environments, such as urban green areas as well as more remote nature reserves. Noise emissions from roads and railroads can hence be seen as a considerable problem for nature conservation and outdoor recreation. Despite these strong scientific evidence, the impact of traffic noise in natural environments are rarely assessed, and even more rarely treated, in Swedish road or railroad planning. We develop a method for assessing the noise impact on areas of special importance for nature conservation. The method is based on effect levels presented in literature, available GIS data on protected areas, bird observation data, road data and a simplified model for noise distribution. The method can be used to identify conflict points along an infrastructure network or a corridor, to direct mitigation measures, and to monitor efficiency of mitigation. We present the results of the method applied on the road network in a pilot area in mid-Sweden, and outline how the method will be further developed to include railway noise and the impact on outdoor recreation.

Railroad construction and farmland breeding birds - a study of the Bothnia Line
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Keywords: Railroad construction, Farmland breeding birds, BAC, Mixed model analysis

The construction of a new 190 km railroad track gave a rare opportunity to study its effect on numbers of farmland breeding birds in a Before-After Census (BAC) study. The Bothnia Line was built 2001-2009 through the boreal forest landscape west of the Gulf of Bothnia in northern Sweden. Farmland is scarce in the region, mainly found on sediment soils in valleys of rivers and streams. Farming is dominated by dairy production with ley and barley for fodder as the main crops. The farmland breeding bird community is rich in comparison to landscapes dominated by arable land, but several species have started to decline in numbers, like they have been doing for decades in rationalized agricultural landscapes across Europe. The breeding populations of 17 bird species were monitored by territory mapping (4 visits/year) in 2002-2009. All thirteen patches of farmland (> 10 ha) that became affected by the railroad (total area 1016 ha), as well as six reference sites (807 ha) were included in this study. The total number of breeding territories in the analysis was 3886. Model selection among 10 mixed effects models was performed for each species. Combinations of None, Treatment (before, under and after) and Year were used as fixed effects. Site and Year were used as random effects. For fourteen species no effect of railroad construction (Treatment) was included in the most adequate models (best fit + 3 AIC). The preferred model for Numenius arquata included Year (negative trend), but not Treatment as fixed effect variables. For Sturnus vulgaris, Charadrius dubius and Motacilla flava, Treatment was included in the preferred model. The population of Sturnus vulgaris declined during railroad construction, but the populations of the other two species increased. In all three cases, the effect is thought to be indirect.

Interactions between road infrastructure and adjacent ecosystems
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Keywords: ecosystem services, disturbance, habitat, mitigation measures, monitoring
The establishment of new roads can affect ecosystem structure and diversity, leading to a loss of integrity and function in adjacent semi-natural ecosystems, therefore having adverse effects on an ecosystem’s ability to provide the flow of ecological services within a landscape. During the process of land conversion, services such as flood control, biocontrol, pollination and invasion resistance may be severely compromised and habitats transformed into dependent ecosystems requiring mitigation, compensation and ongoing monitoring (Dolan, in prep). Potential impacts which may arise include habitat fragmentation, loss of native species, non-native species invasion, noise/visual disturbance etc. (see Southerland, 1995; Lugo and Gucinski, 2000; Dolan, 2003). As with agro-ecosystems, roads can be considered ecosystems in that they occupy ecological space and exchange matter, energy and natural resources with adjacent semi-natural ecosystems, influencing ecological patterns, processes (Pauwels and Gulinck, 2000) and services and experiencing temporal change (Haber, 1990; Hall et al., 1992; Van Bohemen, 2002). The interaction between roads and the landscape can be defined by the "dynamics within and through a 'cylinder' (Lugo and Gucinski, 2000). Along its path, the road ecosystem interacts with other systems and environmental conditions, with the result that the cross-sectional area of the cylinder is not constant. It expands when the road traverses sites vulnerable to its presence (e.g. wetlands) and contracts when conditions are more resistant. In intensively managed landscapes, it is now recognised that new roads may actually provide an opportunity to restore former ecological services, habitat and corridors for species dispersal (see Dolan et al., 2004). This paper will detail measures being put in place on an 36km stretch of Irish road which are aimed at maintaining/restoring: (1) hydrology within adjacent wetlands, (2) habitat connectivity, and (3) experimental regimes examining (i) invasion resistance through the manipulation of abiotic and biotic conditions and (ii) promoting beneficial pollinators and carabidae as natural biocontrol agents in local crop production.

Fauna passages and their efficacy I.

Beyond passage use: How to evaluate effectiveness of road mitigation for wildlife populations

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Keywords: monitoring and evaluation, efficiency, mitigation program, wildlife crossing structure, research framework

Mitigating the negative effects of human activities on the natural environment is a major focus in many parts of the world. These mitigation programs are focused on a wide range of species, ecosystems and issues and encompass a diversity of temporal and spatial scales. The last 20 years has seen a dramatic increase in efforts to mitigate the effects of roads and traffic on wildlife, including fencing to prevent wildlife-vehicle collisions and under-and over-passes to facilitate landscape connectivity. While not necessarily explicitly articulated, a fundamental motivation behind the mitigation of the negative effects of road and traffic is to prevent the decline and extinction of local populations. Concomitant with the increased effort to mitigate has been a focus on evaluating the use and effectiveness of the mitigation structures. Recent reviews of the literature have unequivocally demonstrated that wildlife crossing structures are used by many species of wildlife. While most mitigation programs are likely to also have an effect at the population level, it has rarely been demonstrated or quantified. Therefore, the critical question that remains unanswered is ‘to what extent does mitigation improve the viability of a population?’

A scientifically rigorous assessment of mitigation effectiveness and efficiency is essential to ensure (i) populations do not decline or become extinct despite our efforts to prevent it; (ii) we know when to continue (or stop) improving the design and efficiency (and by how much) of mitigation designs; and (iii) to maximise the conservation gain for the money spent. In this paper we outline the essential elements of a good experimental design and prioritise the parameters to be measured. The framework we propose will facilitate collaboration between road agencies and scientists to undertake research programs that more fully evaluate effectiveness and efficiency of mitigation efforts.
Testing amphibian tunnels under motorways in Hungary
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Keywords: Motorway tunnels, anurans, migration, body temperature

Construction of motorways has increased in Hungary since 1990. Due to improving environmental regulations motorway constructions are now subject to environmental impact assessment, which includes the consideration of amphibian and reptile migration routes, breeding sites and population sizes, in order to designate the most appropriate location of animal tunnels. However, knowledge is lacking concerning both the species, which utilise these tunnels, and their frequency of use. Moreover, there is a paucity of data regarding the behavioural responses of amphibians, which use the tunnels. For the most appropriate design, it is important to determine if body temperature gradients are too great when using the tunnels, and whether there is a preference for a particular tunnel design. We examined tunnel use by amphibians along 3 motorways of Hungary (M7, M3, M30). The study included counting of common toad Bufo bufo specimens, measuring their body temperature as well as the microclimate in the tunnels, and testing the preference of toads in humid-vs-dry and dark-vs-light tunnel models. The climatic patterns in the surveyed tunnels did not match the ecological requirements of the toads. Although temperatures within the tunnel did not vary significantly with the outside environment, during the nights the relative humidity within the tunnels dropped below the values measured outside, providing sub-optimal environments for migration. The body temperature of the Bufo bufo did not show significant change between the entrance and the middle of the tunnels.

We observed only a few migrating specimens but no substantial migration in any of the tunnels. Individuals caught by the pitfall traps at the tunnel entrances consisted almost exclusively of species, which had populations existing on both sides of the motorway (i.e. spadefoot toad Pelobates fuscus and sand lizard Lacerta agilis) and, thus, the tunnels apparently offered no function for substantial migration.

What is the impact of human co-use of wildlife overpasses on the use of these crossing structures by wildlife?
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Keywords: habitat fragmentation, wildlife overpass, monitoring, recreational co-use

In the highly fragmented landscapes of the Netherlands, currently the pressure of both the public and recreational interest groups intensifies to open up wildlife passages for recreational co-use. The most frequently expressed request is to allow hikers, bikers and horseback riders to pass across wildlife overpasses. The national and provincial government is often reluctant to approve such requests as yet it is not clear what the impact of recreational co-use will be on the use of these crossing structures by wildlife. The objective of our study was to assess whether the use of wildlife overpasses by medium-sized and large mammals is affected by recreational co-use. We chose two wildlife overpasses where recreational co-use is currently allowed – overpass Zanderij Crailoo en overpass Slabroek - and monitored the use by both mammals and humans for over one year. The monitoring aimed primarily to assess which species use the crossing structures, to assess the frequency of crossings, and to assess the behaviour of the animals while crossing. The results were compared with data on the use of wildlife overpasses strictly for wildlife elsewhere in the country. Furthermore, we studied whether there is a correlation between the crossing frequency of humans and the crossing frequency of the animals as well as the time of the day that the animals use the overpass. Crossings were detected of almost all medium-sized to large mammal species that were present in the areas around both wildlife overpasses. Crossing rates differed significantly between species. Crossing rates were not necessarily less compared to wildlife overpasses without recreational co-use elsewhere in the country. No correlations were found between the crossing frequency of humans and the crossing frequency of wildlife. However, some of the species do tend to use the overpass later in the day on days with high recreational use.
**Conservation science for the management of transportation systems and fragmentation-sensitive species in the Canadian Rocky Mountains**

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Keywords: Assessment, Banff National Park, partnership, population viability, wildlife crossing structures

Roads represent one of the most extensive causes of habitat fragmentation on the planet today. For nearly 30 years, Banff National Park has been the focus of efforts to mitigate the impacts of the Trans-Canada Highway (TCH) on wildlife mortality and habitat fragmentation. This four-lane highway comprises the first large-scale complex of highway mitigation measures for wildlife of its kind in the world. It is the perfect natural laboratory for understanding the conservation value of highway mitigation measures for a variety of wildlife species. Since 1996, a long-standing program of research, monitoring, and evaluation has played a critical role in assessing the performance of the TCH mitigation. In 2005, an innovative public-private partnership was formed with three private foundations to further research and better understand the link between highway mitigation measures, gene flow and population viability. Currently, an additional 30 kilometers of TCH expansion threaten to fragment and isolate transboundary populations of wide-ranging, fragmentation-sensitive species residing in the heart of the Canadian Rockies. The scale and magnitude of the project are unprecedented for Parks Canada, including 21 new wildlife crossing structures (including five, 60-m wide overpasses). We report on what we have learned during the last 15 years, in three discrete phases of research that encompass varying levels of biological organization and ecosystem concerns. We discuss the strategies we have adopted to not only garner research support from outside organizations, but communicate the resulting science through education and art.

**EIA and SEA**

**Methods and tools for integration of landscape level ecological impacts in environmental assessment**

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Keywords: Integrated assessment, infrastructure planning, environmental assessment, biodiversity, landscape

In infrastructure planning and design there is a need for methods for integrated assessment of impacts of infrastructure on landscape level. Infrastructure cause a wide range of such impacts, not at least on biodiversity. These impacts affect the ecological processes on a landscape scale, since they contribute to loss and fragmentation of natural habitat. Thus, prediction of ecological impacts aiming to minimize these adverse impacts on biodiversity is necessary. Methods for describing and evaluating ecological values of landscapes are urged for including the formulation of targets and the prediction and assessment of impacts on biodiversity on a landscape scale. Such methods should facilitate the integration of multiple criteria and qualities of the landscapes and link them to existing planning frameworks in infrastructure planning, among others environmental impact assessment (EIA) and strategic environmental assessment (SEA). The aim of this project is to develop methods and tools for the integration of biodiversity objectives in infrastructure planning. Particular focus will be on tools for landscape assessment which are linked with targets for biodiversity values in landscapes and compatible with environmental impact assessment at the project and strategic levels. Strategies and methods for landscape ecological assessment will be developed based on the experiences from various examples through the advancement and application of GIS-based habitat models. The habitat models will be developed using geological, hydrological, vegetation, infrastructure and other development data as independent variables and selected ecological profiles as dependent variables. The outcome will be models of habitat networks that include habitat suitability and connectivity that can be synthesized and visualized in maps and used in strategies for landscape ecological assessment in planning and environmental assessment. The project will result in tools compatible with integrated assessment on landscape level, which support localisation decisions with multiple objectives within the infrastructure sector.
New roads versus landscapes
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Keywords: Landscape protection, EIA procedure, linear transport infrastructure

Linear transport infrastructure projects cut not only environmental connections but also landscapes and their particular characteristics. Therefore the presentation focuses on ecological connections from visual and ecological point of view. The goal is to present current situation and a progress in the protection of the mentioned above, visual and ecological connections in Poland. In the past landscape features were merely described in environmental impact assessment reports for linear infrastructure projects. Nowadays, mitigation measures regarding negative visual influence are presented or included into multi-criteria analysis (depending of type of landscape and strength of impact) more often. The research is based on the analysis of existing environmental documentation of big infrastructural transport projects. The presentation contains three examples of such projects, where the issue of landscape protection has been considered. Nevertheless there are still a lot of questions to answer, whether visual aspects of a landscape should affect a decision on either the construction or the location of projects or whether every kind of a landscape should be protected and how to balance the environment needs and the esthetic feelings of road users.

Wildlife and roads: world problems, sustainable solutions
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Keywords: International, mortality, carbon, defragmentation, mitigation, sustainability

Worldwide, the movements of 750 million vehicles on 50 million km of public roads kill an estimated 200 vertebrate animals per second. Around 900 people are injured or killed each day from animal/vehicle contact. Medical and vehicle damage costs are around Euro 5-10 million per day. These rates could increase significantly by 2020. By then China aims to build 650,000 km of new major roads and India, Africa and Eastern Europe among others will greatly expand and upgrade their road networks. Growth in the use of various impacts-mitigation measures is accelerating. As international oil supply peaks and energy costs increase, maximum permitted speeds are likely to reduce for greater efficiency, probably to around 80-90 km/hr and this may help reduce mortality. Sustainable solutions might best use 50-year predictions, given the life expectancy of road construction materials and the likelihood of a subsequent emphasis (2020-2030) on more regional travel and supply patterns. Designs for new regional road networks, vehicle use policies and objectives for landscape defragmentation require well advanced planning. To avoid waste and repetition of outmoded designs, mitigation planning urgently now requires clearer international standards. A more detailed reference glossary of terminology, and a more informed and consistent approach, including theoretical and field research-based objectives could deliver more effective and low-maintenance applied designs.

Identification and comparison of road and railway projects effects on natural habitats
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Keywords: Railways, roads, effects, natural habitats, indicators

In the classical driving procedure of terrestrial transport infrastructure projects, natural environment is taken into account at a late stage. Moreover, it is essentially regarded as a regulatory constraint by the professionals in charge of construction. This situation leads to misunderstanding between the various actors of land planning and results to un-optimal decisions from the collective point of view, unbalanced between social, economic and environmental issues. In order to clarify the local ecological issues, the present research aims at identifying in an exhaustive way the potential disturbances anticipated from the four life cycle stages (works; infrastructure; use; maintenance) of road and railway infrastructure projects on natural habitats. In addition to the natural habitat destruction within the limits of the construction area (land reassignment), terrestrial transport infrastructures are responsible of numerous territory modifications: topography and permeability changes; barriers to natural flows... These changes generate modifications of local ecological conditions related to soil; exposure; brightness; water
Abstracts

Assessing road effects on bats. The role of landscape, road features and bat activity on roadkills
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Keywords: bats; roadkills; landscape; mitigation; variance partitioning
Recent studies suggest that the damage caused by roads on bats may significantly affect bat populations. However, despite bats being one of the most threatened groups of European vertebrates, scientific information is still lacking to effectively mitigate this effect. We daily surveyed roadkilled bats in 52 km of roads with different traffic volume in southern Portugal, between March and October 2009. During the same period we also monitored bat activity in the study area. We found 154 roadkilled bats of 11 species. Pipistrellus kuhlii and P. pygmaeus represent 64 % of total specimens collected. We also found threatened and poorly known species like Barbastella barbastellus (2), Rhinolophus ferrumequinum (1), R. hipposideros (5), Miniopterus shreibersii (1) and Nyctalus leisleri (1). A peak of mortality occurred in late summer with 67% of bats being killed between 15 of July and 15 of September. The males were killed more often than females, except in June when this pattern was inverted. The mortality of young was recorded only from June onwards and was a small percentage of total kills (approx. 16%). The relationship between bat fatalities and different types of explanatory variables (landscape, road characteristics and bat ecology) was assessed by generalized linear model (GLM) and variance partition techniques. Overall, landscape features explained about 37% variance (pure+joint effects) in bat mortality and were the most important of the three variable sets analyzed. Nevertheless, bat activity, traffic and the proximity to known roosts also had a significant influence on mortality. The results have shown an increase in mortality in road sectors crossing high quality habitat (forests, streams and pond vicinity); near bat roosts and core activity areas; and on high traffic roads. The importance of these findings for the management and implementation of effective mitigation measures of bat roadkills are discussed in this communication.

All wildboar-vehicle collisions respond to the same variables? Looking for patterns using self-organizing maps
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Keywords: Animal-vehicle collisions, wild boar, SOM, pattern.
Selecting the most efficient mitigation measures to reduce animal-vehicle collisions is difficult without knowledge of the circumstances on each stretch of road. The identification of patterns, based on the variables that explain the spatial distribution of road-kills would be useful to improve decision-making. We used data mining techniques to identify patterns within a dataset of wild boar-vehicle collisions in Castilla y León, Spain. Collisions were grouped using a Kohonen´s self-organizing map which is a neural network of competitive learning. A 4x4 matrix was derived to obtain 16 groups of collisions with similar properties in relation to the traffic, the road and the surrounding environment. This number could vary to improve the adjustment between patterns and mitigation measures. We used logistic regressions to model each pattern. Knowing what the more important variables in each collision are, we could choose the best type of mitigation
measures in accordance with the road segment properties. Expensive wildlife passes and fences should be restricted to segments of highways with high traffic volumes and hotspots, where the probability of successful crossing is very low. For medium and low volumes of traffic the best solutions vary in relation to the characteristics of the surrounding landscape.

**Can we model wolf-vehicle collisions? Using a logistic model with corrections to identify the variables involved in the road-kills**

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Keywords: Animal-vehicle collisions, carnivores, fencing, logistic modelling, rare events

The studies about large carnivore road-kills are scarce despite this being one of the main causes of mortality. This absence can be explained partly because of difficulties in obtaining sufficient sample sizes. We collected evidence from locations of 82 wolf road-kill sites in the Castile and Leon region, northwest Spain. Landscape, traffic and anthropogenic models to characterise collision localities were evaluated using logistic regressions with corrections for rare events. These corrections contribute to minimize the statistical problems derived from small sample sizes. Best models included traffic and human disturbance parameters. Landscape variables did not improve predictive power. Fencing was a decisive key predictor; road-kill was proportionally higher along fenced highways than on similar major roads that lacked fences. Wolf adaptation ability may prevent them from being killed on roads but the design failures and the lack of maintenance in fences favour that wolves reach the highways, becoming trapped on the road. In such case fencing has the opposite effect because it supposes an increase in the time of residence on the road and an increase in the number of road-kills. Moreover, speed and traffic volumes, proximity to municipal borders and distance to populated areas were significant variables. At regional scale wolf-vehicle collisions were more common on the agricultural areas, although wolf densities were lower in these zones. Both the higher density of important roads and the greater proportion of roaming wolves on the plateau may explain this pattern.

**The risk of being hungry: Influence of prey availability in verges on predator skills**

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Keywords: Landscape features, predator roadkills, prey availability, road verges, variance partitioning.

Road verges may provide important refuges for small fauna, particularly when roads cross intensive agricultural or grazed landscapes. In these circumstances, the increasing use of verges by important prey species may attract predators to road surroundings increasing the likelihood of their roadkill. The main goal of this study is to evaluate the importance of prey abundance (rabbits and small mammals) in verges on predator road fatalities. We analyzed this effect on different kinds of predators including snakes, owls and mammal carnivores. The study took place on a 10km stretch of a main National Road (EN4) in southern Portugal. Small mammal abundance was evaluated as the number of animals caught at 200 Sherman live traps, located at 50 m interval along the road. Rabbit counts were assessed in ten morning car cruises, moving at a constant speed of about 20km/h. Landscape and road characteristics were also considered in the analysis. Relationships between predator mortality and explanatory variables (prey abundance, landscape and road features) were evaluated by means of Generalized Linear Models (GLM) and multivariate Redundancy Analysis (RDA). Explained variance of each group of explanatory variables was accounted through a Variance Partitioning procedure. Our results show that prey abundance on verges enhances the likelihood of predator mortality, even though landscape attributes explain the main variation in predator road-kills. Among preys, Wood Mouse and Rabbits were the species that most contributed to this outcome. In contrast, road features were the group of variables with lower power in explaining predator fatalities. Therefore, actions aiming to mitigate predator roadkills must consider the management of vegetation on verges in order to diminish prey abundance in
Abstracts

these areas, thus reducing predator attractiveness. On the other hand, such treatments may jeopardize one of the most important refuges for small fauna when roads cross intensively grazed and agricultural areas.

Potential impact of motorway and express roads upon migratory trails of wolves in Poland
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According to official records published by statistical yearbook, population size of wolves in Poland amounted to 702 individuals in 2008. Data on wolf distribution show there are 3 major core areas of the species occurrence. Most numerous (n = 300 animals) is wolf population inhabiting Polish part of Carpathian Mnts (A). The second core area is north – eastern part of Poland where about 200 wolves are present (B). The third core area is central – eastern Poland that is inhabited by about 150 animals (C). The remaining wolves are mainly dispersing animals colonizing new ranges mostly in western Poland (D).

Records on wolf distribution and their migratory patterns were obtained using reports on wolves occurrence in hunting districts and National Parks. There are 4 major wolf migratory trails. Population A is dispersing from east to west along south – western part of the country (Trail I) and from east to north along Polish – Ukraine border (Trail II). Individuals from population B are migrating from east to west using northern part of Poland (Trail III) and from east to south along Polish Byelorussian border (Trail IV). Migrating animals using trail I and III have establish small wolf population in western Poland that extended its range to Germany. Dispersing animals using trail II and IV mixed with wolf population C. Cranial measurements of wolves showed that populations C and D are results of hybridization of A and B population.

In Poland, up to year of 2000 there was only one, 75 km motorway. Now under construction there are 3 motorways which total length will be about 2 000 km and several express roads. According to the governmental plan 7 300 km of motorway and express road will be build during this decade. Motorway A-1 (from Gdańsk to Polish Czech border) is constructed accross I and III wolves migratory trails. It probably stop wolf dispersal pattern from east to west. Motorway A – 4 (from Polish – German to Polish Ukraine borders) and A – 2 (from Polish – German to Polish – Belorussian borders) will cut II and IV wolf migratory trail. Heavy traffic of express roads will result in mortality of dispersing wolves.

At this moment it is difficult to predict scale of negative impact of wolf habitat fragmentation in Poland due to new road transportation system. However that is high probability that range distribution of wolves will decrease, mainly in western part of the country.

Fauna passages and their efficacy II.

Bat crossings across Irish national roads - implications for planning mitigation measures
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Keywords: Bats, roads, mitigation, fragmentation, underpass

Typical life-history traits of bats, such as low reproductive rate and long life-span, make bat populations vulnerable to decline. Conservation concerns have resulted in comprehensive legal protection for all European bat species, and road management agencies are required to mitigate the potential negative impacts of roads on local populations. The severance of linear landscape features (hedges, treelines, waterways) due to road construction potentially acts as a barrier to bat movement and causes habitat fragmentation. Many bats are reluctant to fly over open ground, and use these landscape structures as commuting routes between traditional roosting, foraging and mating grounds. We investigated potential bat crossings at sites where a newly-constructed motorway (50-100m wide) has severed such landscape features. Using acoustic detectors, bat activity was recorded at four kinds of potential bat crossing point (minor road underpasses, minor road overpasses, river bridges, and severed treelines), and compared to simultaneous bat activity levels along connected landscape features in the adjacent habitat. In the case of underpasses, overpasses and river bridges, bat passes recorded above and below the structure were also quantified. Six bat species/families were encountered. Crossing activity was markedly higher
beneath river bridges relative to other potential crossing routes, and was comparable with activity levels at reference river sites distant from the motorway. Few bats crossed at minor road overpasses, with activity levels much lower than those at control sites in the surrounding habitat. In contrast, underpasses generally had higher bat activity relative to control sites, suggesting the potential of these incidental wildlife passages to maintain functional landscape connectivity for bats. Surprisingly, many bats also flew across the motorway, from a severed treeline on one side to another on the opposite side, in the absence of any connective element. Practical implications for the design of bat mitigation measures during road planning are discussed.

Comparison of ecoducts structure systems in the region of Central Europe
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Keywords: Sustainable, structures, fragmentation, ecoducts, Central Europe.

Construction of huge road structures such as expressway and motorway roads cannot bring irreversible effects or damages of biological relations which in case of road structures can affect large areas or can bring isolation of populations. High capacity and intensively used roads makes mainly for bigger mammals with difficulty overcome barriers that cause fragmentation of landscape and populations. For maintaining possibility of animal migrations are in present for newly constructed highways and motorways in place of biocorridors designed special structures – ecoducts. These structures serve for minimization of animal population fragmentation. The paper deals with a comparison of a current state in ecoducts build-up in Central Europe region. It compares different shapes and types of construction systems, construction technology and discuss their advantages and disadvantages with respect to their usage for animal migrations.

Amphibian mitigation measures design: do we focus enough on conservation status and species-specific requirements?
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Keywords: amphibian migration, mitigation measure, conservation status, species-specific needs

Amphibian mitigation measures have got a forty year history in Europe. During that time interventions at over 1,000 road and rail sections were made to help amphibians crossing safely. In the overwhelming majority of permanent solutions tunnels were built or culverts were modified and fences were erected to direct amphibians into them. There is a great diversity in the actual technical solution, it is mainly the result of engineering inventions as most mitigation measures were constructed according to the requirements of large common species with a considerable migration distance, the common toad (Bufo bufo) and the common frog (Rana temporaria), which are abundant and play an important role in the local ecosystems. At most sections, however, several species cross roads or railways together due to their similar habitat needs. Their relative abundance may vary from site to site according to their local population sizes. In Hungary, for example, at least four taxa (Triturus vulgaris, Bufo bufo, Pelobates fuscus, Rana esculenta c.) with different characteristics are known to be the amphibian with the highest individual number to cross at the different road sections. Besides site-specific differences in different geographical regions, the conservation status of some species should also be taken into consideration when the actual mitigation measures are planned. Accordingly, the long-term survival of the local amphibian community may require different measures to cross linear infrastructure elements the most efficiently. As such, the actual mitigation measure design should not only meet general standards but also reflect to the composition and relative abundance as well as the vulnerability of the individual species of the local amphibian fauna to function as an effective corridor.
Vegetation structure on overpasses is critical in overcoming the road barrier effect for small birds
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Keywords: Road barrier effect, fauna overpass, birds

Although overpasses are a widely used structure for facilitating safe fauna crossings, most focus has been on mammal species, both small and large. Very little attention has been paid to the road barrier effect on birds, presumably because many species readily fly over even large road systems. However, it is becoming increasingly clear that for smaller species, even relatively small roads with moderate levels of traffic can be significant or complete barriers to movement. In Australia, we have been intensively investigating fauna crossings on the Compton Road Land-bridge, an hourglass shaped structure spanning a busy four-lane highway. Although a wide range of mammal, amphibian and reptile species began using the structure within weeks of completion, small birds avoided the overpass for several years. Movements of passerines began to be noticed once the dense plantings had reached about 2-3m in height. Since then, movement of even edge-avoiding species has been regular with a total of 23 species being recorded within the vegetation; most of these species were never detected crossing the road away from the structure.

Fragmentation and landscape

Monitoring landscape fragmentation in Europe: How well can socio-economic variables explain the differences between regions?
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Keywords: driving forces, effective mesh density, road networks, population density, limits to landscape change

Data on the degree of landscape fragmentation in Europe are urgently needed in monitoring systems of biodiversity and sustainability of human land uses. In order to compare different regions, their degree of fragmentation needs to be interpreted in terms of geophysical and socio-economic measures such as population density, GDP, level of education, and volumes of freight and passenger transport. This paper presents a quantitative analysis of landscape fragmentation in Europe on the level of NUTS-X regions for two points in time (2002 and 2008) to measure the level and current rate of increase of fragmentation in Europe. The resulting data will be included in the European State of the Environment Report by the European Environment Agency. The paper also determines the relative importance of socio-economic factors as potential drivers of landscape fragmentation and identifies regions that are particularly fragmented, i.e., to a higher degree than is justifiable by economic productivity and the density of humans, among other causes. We used effective mesh density ($s_{eff}$) to measure the degree of landscape fragmentation as the response variable for three different fragmentation geometries (including combinations of different road classes and natural barriers). Two factors alone (population density and GDP per capita) explained most of the variation. This information can be used by managers in future environmental politics and decision making. For example, quantitative limits to the future degree of landscape fragmentation are still missing in current environmental politics.

Towards integrative SEA: From fragmentation indices to landscape sensitivity units
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Keywords: landscape fragmentation, effective mesh size, high-level indicator, transportation

SEA (Strategic Environmental Assessment) is an anticipatory planning tool introduced by the European Union that allows for the assessment of potentially adverse impacts on the environment associated with strategic plans and programmes. Thus, environmental effects can be considered at
a very early stage (equal to economic and social aspects) in order to foster a sustainable development in Europe. Transportation is among the sectors affected by SEA. In Austria, changes within the major road network with likely significant effects on the environment are legally subject to an assessment. Landscape fragmentation is one of the main ecological effects associated with the construction of transportation infrastructure that needs to be taken into account. Literature reveals several landscape metrics that quantitatively describe the degree of fragmentation. The following four approaches were tested with regard to their applicability in SEA: (1) density of transportation infrastructure, (2) number and size of non-fragmented areas having a certain minimum size, (3) effective mesh size and (4) contagion index. A trans-boundary road infrastructure project in Lower Austria served as case study. The results showed that quantitative fragmentation measures are well suited to assess and compare different planning scenarios. Especially the effective mesh size is an informative, intuitively interpretable and relatively simple computable approach. Next to landscape fragmentation there are other ecological aspects, and beyond that economic and social aspects, which should be considered in SEA processes. An integrative view of the overall sensitivity of areas affected by the impacts of transport infrastructure is desirable. This challenge is currently addressed by a research project funded by the Austrian Academy of Sciences. The aim is to establish a high-level spatial indicator by integrating ecologic, economic, and social factors and to map it as spatially explicit ‘sensitivity units’ (SensUs), showing the spatial variability of landscape sensitivity to an impact. Furthermore, the automated delineation of sensitivity units provides decision makers with updated information for monitoring purposes, which is another requirement within SEA processes.

Response times of amphibian populations to replacement pond following road construction
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Keywords: anurans, colonization, community persistence, mitigation plan, pond restoration

Habitat degradation, road construction and traffic are among the anthropogenic threats facing wildlife from both aquatic and terrestrial habitats. In the case of Amphibians, pond replacement programmes have often been used in response to fragmentation and destruction of suitable habitats. There is, however, an urgent need to follow their success in order to better understand and compensate for the decline of amphibian populations. Following construction of a highway in western France, a restoration project was initiated and the success of restoration efforts was monitored. Eight replacement ponds were created consistently with the old pond characteristics and taking into account the amphibian species present in each. Amphibian diversity was recorded every year during the breeding period before original ponds were destroyed and for four years following pond creation. Species richness initially declined following construction of the replacement ponds but generally returned to pre-construction levels. Species diversity followed the same pattern but took longer to reach the level of diversity recorded before construction. Pond surface area, depth, and sun exposure were the most significant habitat characteristics explaining both amphibian species richness and diversity. Similarly, an increase in the number of vegetation strata was positively related to anuran species richness, indicating the need to maintain a heterogeneous landscape containing relatively large open wetland areas. These results highlight the species-specific dynamics of the colonization process and recovery time, including an increase in the number of replacement ponds inhabited over time by some species and, in some cases, an increase in population size. We suggest that successful replacement ponds can be designed over a relatively short time around simple habitat features, providing clear benefits for a range of amphibian species, which will have positive cascading effects on local biodiversity.

Studies of road effects on small vertebrates in southern California, USA
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We assessed the abundance and movement patterns of small vertebrates in relation to three types of roads transecting coastal sage scrub habitats: unimproved dirt, secondary paved, and a primary highway. For each road type, we established 8 paired trapping arrays at two distances from the road and tracked movements near the road using fluorescent dye. The bulk of data were generated for three small mammal and two lizard species. There was little effect of distance from road on relative abundances of most species. In general, dirt roads did not impede or increased movement, while the primary highway was a significant barrier. Movements in relation to the secondary paved road differed among species. Overall, we found that species with open microhabitat preferences
were more likely to venture out onto roads and those that did suffer increased mortality due to vehicular traffic. Secondly, we conducted a road mortality study on 10 different roads totaling 94 km. Repeat surveys were conducted at different times and environmental conditions. Species composition differed greatly between day and night surveys. We also documented a two-fold increase of dead animals at night and over a 25-fold increase on wet nights, particularly frogs and toads. Conservation and management implications of these studies are discussed.

Road mortality and barrier impacts III.

Car accidents caused by wild fauna in the Tuscany region
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Keywords: Accidents, Wild fauna, Tuscany, Driving safety

In recent years, accidents caused by wild animals have increased greatly in the region of Tuscany (Italy) and have caused remarkable social and economic implications. In 2004, the Regional Government of Tuscany promoted a long term study on the topic of “car accidents caused by the wild fauna in the Tuscany Region” with the aim to gain a deeper knowledge regarding the characteristics of this topic in order to suggest possible solutions for the prevention and mitigation of the increasing problem. The study was carried out by the University of Florence (with the help of provincial and regional governments) in order to assess the reports of car accidents happening on the road network of Tuscany during the period 2001-2008. Subsequently, a detailed analysis of the collected information was correlated in order to give evidence of the evolution and of the main peculiarities of these occurrences. The results of the research can be summarised as follows: a) for the studied period, figures of the phenomenon has increased in the whole Regional territory; b) the phenomenon affects each Province in different ways; c) the number of the interested Municipalities has increased over time; d) the most important wild species involved are ungulates, in particular Wild boar and Roe deer; e) the accidents occur every day of the week and increase at the weekend; f) the time band of higher risk range between the twilight hours and the first hours of morning; g) the greater animal presence is not the only and most important cause of the accidents; h) the awareness of the drivers and their driving behaviour play a fundamental role in avoiding car accidents or more serious consequences. Moreover, the study permitted the identification of the most dangerous roads. Finally, the main guidelines are laid out for the prevention and the mitigation of the problem.

Factors influencing vertebrate carcasses retention time on roads: A preliminary study on Mediterranean context
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Keywords: carcass survival time, vertebrates, roadkills, Cox regression, Portugal.

Monitoring vertebrate roadkills is a task increasingly done in the last decades in order to better evaluate the impact of roads on wildlife. However, these studies usually underestimate the real number of road kills counts, due to the sampling strategy and because large time intervals (frequently weekly monitoring) are used between surveys. On summer of 2005 in central of Portugal, we carried out in a 26 km stretch of a main national road, a trial survey consisting in 31 consecutive day’s road kill monitoring. The initial position of the corpse on road and spatial geographic location were registered. Species biomass, daily temperatures, precipitation and traffic
load were also considered as possible factors affecting the number of days the carcass remain on the road after animals have been hit by a vehicle.

We used the Cox regression to model the survival time that road killed vertebrates remain on the road. A total of 188 corpses belonging to 40 vertebrate species were recorded. The biomass was the only significant factor influencing the maintenance of a corpse on the road. Larger individuals (>500g) have 0.65 probability of remaining on the road after three days, comparing to 0.35 for medium ([50g-500g]) and 0.2 for small individuals (<50g). By the end of the trial survey, the majority (more than 95%) of the medium and small animals have already disappeared, while 20% of the larger animals may persist. Moreover, we would have lost almost 70% of the corpses if road kills were monitored twice a month and almost 55% under a weekly survey.

Our results may have important conservation implications when planning road kills monitoring, because small species with a high conservation concern (e.g. bats) may not be counted on twice a month or weekly surveys.

Analysis of the relationship between seasonal and locational features of Sika deer-vehicle collisions in Hokkaido, Japan and deer ecology towards collision reduction

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Keywords: Sika deer, deer-vehicle collisions, GIS, Poison regression models, prevention measures

Collisions between vehicles and wildlife are a serious problem in many countries around the world. Ungulate-vehicle collisions are the most problematic, because the damage from such collisions, including injuries and fatalities of humans and animals, tends to be serious. The number of sika deer on Hokkaido, the northernmost island of Japan, is steadily increasing, as are deer-vehicle collisions (DVCs) there. To achieve greater traffic safety and harmony between wildlife and humans by developing measures to prevent such collisions, this study investigated the details of DVCs on the national highways in the Kushiro area, one of the most DVC-prone areas in Hokkaido, using a database that includes the number of DVCs for the 12 years from 1995, each DVC location, the route name and the pickup date. First, the relationship between DVC frequency and deer seasonal behavior was investigated. Next, a Poisson regression model was used to understand the effect of explanatory valuables on the number of DVCs. These explanatory valuables included DVC site topography features such as avg. annual max. snow depth, avg. elevation, vegetation type, land-use classification, distance from the nearest river, distance from the nearest woods, distance from the nearest wildlife sanctuary and average day traffic volume (ADT). A topographic dataset including the spatial distribution of avg. elevation and of avg. annual max. snow depth, and roadside landscape features within the 1,000-m wide zone on both sides of each sample road by 1 km long section was created by using GIS software. On the basis of the results of the data analysis, effective DVC prevention measures by features of DVC prone sites were considered.

Spatial and temporal evaluation of the wildlife-vehicle collisions along the M3 Highway in Hungary

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Keywords: highway, fragmentation, passages, wildlife-vehicle-collisions, hotspots

Among linear facilities highways have special significance, because the large-scale traffic and wildlife-fencing represent nearly total barrier effect for the wildlife. The data analyses of the road-kills are important since they enable us to choose the proper mitigation measures, both for traffic-safety and ecological aspects. Based on the road-kill database of the ÁAK Zrt. we evaluated the data of the period between 2002 and 2009 of the Hungarian M3 highway of four selected species that are large enough to cause a threat to traffic safety. These were the following: roe deer, wild boar, Eurasian badger and red fox. Our primary aim was to describe the spatial patterns of WVCs (wildlife-vehicle-collisions). Road-kill data were summarized in 500 meter long segments of the highway. We observed the relation and counted correlation between the frequency of WVCs and
the local density of these species. In order to do so, we used the National Game Management Database as source of estimation data of the populations of the four wild species. We did not find any strong or significant correlation between road-kill frequencies and the estimated densities of the populations. As a temporal evaluation we analyzed the frequency of WVCs of each month (secondary aim). Kruskal-Wallis test and Dunn's post-hoc test were run as well. In each case, apart from the Eurasian badger, we found at least one month that differed significantly (p<0.05) from the other months. May for the roe deer, September for the wild boar, and October for the red fox were the months with the highest road-kill frequency. Based on our results we believe that the frequencies of WVCs are not predominantly determined by the local density of the population. The differences in WVC frequencies during certain periods of time point at the most vulnerable periods in the life cycle of a given wild species.

Birds and transportation infrastructure
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Keywords: Road ecology, birds, ecological impacts

Avifauna is an important component of fauna communities. The main impacts caused by transportation infrastructure on birds are: 1) Fragmentation and barrier effect - The construction of road infrastructure results in habitat loss and fragmentation, with bird populations suffering the consequences, particularly the most sensible and the forest-interior species. 2) Disturbance - Noise from traffic can be so loud that bird vocalization may be concealed. The habitats next to highways are less effective, causing decreased numbers of breeding birds. 3) Direct mortality - The data on bird mortality on European roads pass from 350,000 birds/year in Denmark to 27 million birds/year in England. Birds of prey and owls are particularly vulnerable to road mortality, because often forage near roads. Water birds are endangered if the road pass near wetlands; the installation of poles along the edge of the bridge induce birds to fly higher. It is possible to erect "bird-protection walls" or vegetation belts that encourage migrants to fly over passing traffic. In the debate about the worldwide decline of sparrows (principally House Sparrow) some role of the cars was stated -direct as road mortality, or indirect from pollution that reduces the insects used to raise the nestlings. 4) Indirect mortality - Highway medians and roadsides provide some habitat, but this kind of linear habitat close to traffic can represent an ecological trap. Some birds use bridges and viaducts as breeding site, but maintenance practices in spring can conflict with successful nesting. There are many lethal road associated structures, as powerlines that are hazardous to birds. Especially transparent/reflective noise barriers are very dangerous. Actions for mitigation were implemented, for example in Switzerland and Italy, using markers like strips and silhouettes. Following similar enterprises conducted in Canada and United States, a manual was produced for giving advice to planners and architects.

Tuesday poster session

Policy and planning

TU1
Support and promotion of the local administrations to avoid the fragmentation caused by the routing of large communication infrastructures in the region of Girona
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Keywords: Infrastructure, defragmentation, connectivity, Girona, local administration

The Council of Local Initiatives for the Environment of the Girona region (CILMA), an association of local organizations, was established in 1999 and promoted by the a regional governmental body Diputació of Girona to promote sustainable development in municipal management and politics. The CILMA, as a part of its objectives of offering support and encouraging the local administrations to promote the sustainable development of communication infrastructures, has given support to the local organizations affected by the route of the rail/TGV, the expansion of the motorway AP-7 and the A-2 by-pass in the Girona region in order to minimize the accumulated barrier effect in the
construction of these infrastructures and the fragmentation of the territory, which imply a serious problem for the flow of biodiversity between the natural areas and serious damage to traditional activities and quality tourism. Throughout the years, a proposal with a consensus between the local organizations for each infrastructure was presented to the Spanish Government. In terms of the rail/TGV, approximately 400 million Euros were obtained for corrective measures; however there has been no response yet for the AP-7 or the A-2. The affected local organizations sent a request-demand to the Ministry of Development to obtain the permeability of 24 ecological and social connectors, and therefore ensure the coherence with the measures accepted for the rail/TGV and made it possible for these to be functional. Specifically regarding these three communication infrastructures, we want the poster to be used for spreading information about the effort of the work carried, to create awareness of the detailed proposals and the negotiation process, indicating the main points of permeability needed to ensure the connection between, which through the implementation of different types of structures (overpasses or underpasses), the barrier effect can be diminished.

TU2

An initiative to increase knowledge exchange and promote best practices between the stakeholders involved in transport and biodiversity issues

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Keywords: Governance, Habitat fragmentation, Working group, Integration

The integration of biodiversity into economic sectors is a key goal of sustainable development. The planning and construction of transport infrastructures involves new challenges, to satisfactorily pass the Environmental Impact Assessment (EIA and Strategic Environmental Assessment (SEA) processes, which address habitat fragmentation and other biodiversity-related issues. However, new and more appropriate mitigation measures are progressively being implemented. One of the key mechanisms for achieving comprehensive, suitable management goals is effective governance. This is required to manage communication between the experts, scientists and decision-makers involved in all stages of a project, including its design, planning and programming.

Spain has established an effective governance tool through a specific working group, which brings together professionals who work in the sectors of transport infrastructure and nature conservation.

This working group was formally constituted in 1999 in the framework of the COST 341 Action (1998-2003). At the end of the project, the group was maintained to continue its activities. At present, it is supported by the Spanish Ministry of Environment, Marine and Rural Affairs and is comprised of approximately 60 people, designated by the transport and environment administrations of the 19 autonomous communities and by the Spanish State. The group’s work has led to several publications on wildlife and traffic and to a collection of technical prescriptions for the design and monitoring of fauna passages. Two additional volumes are currently in press on habitat fragmentation indicators and the prevention of fragmentation during the planning of transport infrastructures. The guidelines on fauna passages have been adopted by several regions as criteria to be accomplished during the EIA process.

The group also promotes knowledge dissemination by organising meetings every two years and producing an electronic bulletin that reaches approximately 1500 people. The bulletin includes information about projects, monitoring of results, publications and events in the field.

The results obtained by the working group in its 10 years of operation have been very positive. It provides a coherent and comprehensive way of finding common ground and of attaining specific targets and measures that enable us to move forward together. The high number of projects carried out in Spain during recent years, including the construction of hundreds of wildlife passages, several defragmentation projects and other measures to diminish the effects of habitat fragmentation caused by transport infrastructures, is evidence of the positive impact of bringing transport and environment professionals together.
TU3
Initial steps in the design of compensation measures for habitat and landscape effects of road construction
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Keywords: ecological compensation, habitat deterioration, habitat loss, greenhouse emissions, fragmentation

Although environmental impacts caused by road construction may be reduced or rectified, some unavoidable residual damage persists. In order to improve sustainability, it is necessary to carry out some compensation measures. Different kinds of impacts require different kinds of compensatory measures. We can make a general classification of road impacts attending to three criteria: local/global effects, visual/not visual impact associated, measurable/not easy to measure. Thus, four main kinds of impacts can be distinguished: (1) habitat deterioration, e.g. noise level rise (local, not visual, measurable); (2) greenhouse emissions increase (global, not visual, measurable); (3) habitat loss (local, visual, measurable); (4) fragmentation (not only local, visual, not easy to measure). Regarding the way of carrying out the measures, we can distinguish four kinds of compensation: establishment (creation), restoration, enhancement, and preservation (US EPA, 2010). The following rules apply to in-kind compensation (using ‘in-kind’ as in Rundcrantz and Skärbäck, 2003). Then, the best kind of compensation for each type of impact may be: (1) in-site enhancement compensation (to raise the global quality of the affected habitat); (2) in-site or off-site measures (it makes no difference since effects have a global reach), consisting of either restoration, creation or enhancement (to increase the ‘gas-drain’ surface); (3) off-site restoration or creation (looking for a net gain of acres); (4) in-site establishment or restoration (focusing on re-connecting populations and landscape units). Here we present a series of tips to enhance the design of compensation measures. Among the studied scenarios, fragmentation may be the most difficult kind of impact to be compensated. Successful results may depend many times on the target species behaviour. Besides, in high-road-density zones it would be difficult to find an adequate place to execute the compensatory measures.

References:

TU4
Transalpine Transport Architects (TRANSITECTS)
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Keywords: Alpine Space, Modal shift, Combined transport, Air pollutant emissions, Noise assessment

TRANSITECTS develops and implements attractive transport and logistic rail products and systems to disburden traffic bottlenecks in the Alps and mitigate related negative effects of traffic. The initiative is co-financed by EU funds within the ETC Alpine Space program. Building on the experience of the predecessing project “AlpFRail”, numerous partners from Austria, Germany, Italy and Slovenia work together to promote the rail attractiveness for transalpine freight transport, making the rail network more accessible to the logistics market and thus mitigate the negative effects of road freight transport in the Alpine Space. During the project competitive and sustainable alternatives to road transport will be defined and later implemented. TRANSITECTS aims at a modal shift from road to rail, thereby contributing to relieve the environment along major Alpine transit corridors. The Institute for Regional Development and Location Management at the European Academy of Bolzano will identify and assess environmental impacts for each developed pilot project. Apart from assessing the effects on the Modal Split in transalpine freight transport, the evaluation of the associated emission reduction (e.g. nitrogen oxides and carbon oxides as well as particulate matter) plays a major role in the evaluation. For this, an environmental model will be
developed taking into account relevant emission parameters. This includes defining common parameters and criteria to evaluate emissions and other environmental values. For each pilot project the benefits in terms of reduction of gases and other air pollutant emissions will be estimated. In addition, noise parameters will be assessed in order to evaluate the impacts on traffic noise disturbance. These parameters will help assessing the sustainability of each pilot rail connection with regard to its environmental effects. Overall, TRANSITECTS will contribute to accomplish a change in the transport sector towards a greater environmental sustainability.

Road mortality and barrier impacts

TU5

Can we use road-kill data set to enhance our knowledge about the spatial distribution of ungulate species?

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Keywords: Road-kill dataset, spatial distribution, temporal repeatability, ungulates.

Reported road-kills constitute a source of information that is only rarely taken into account, but one that could be useful for the environmental authorities because it is constant, abundant, cheap, and has nearly complete territorial coverage around the world. For this reason, we explore the possibilities and the limitations of road-kill data set. To assess its usefulness, we compared (for three ungulates: wild boar, roe deer and red deer) the spatial distribution in a 10 x 10 UTM grid obtained using road-kill reports with the distribution described in the Atlas y Libro Rojo de los Mamíferos Terrestres de España, using the region of Castile and Leon as the study area. The results show that road-kills offer a good complement to the data sources employed in the preparation of that Atlas, contributing new sites in insufficiently sampled areas. However, road-kills cannot be used as the sole source of information. Traffic reports worked better than other sources in areas such as the central Spanish plateau, which is characterised by higher road densities and higher traffic volumes, and lower species populations because of the lack of suitable habitats. In the mountainous periphery, with higher population densities, the road network method was as good as those used in Atlas in grids with medium road density, but was unable to detect species presence in low-road density zones. The repeatability across time in the detection of presence increased with the level of development of the road network and the percentage of area suitable for the species in question.

TU6

Risk and deterministic factors effecting bear train collisions along the Canadian Pacific Railroad

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Train collisions are the largest source of human caused grizzly bear (Ursus arctos) mortality in the Canadian Mountain parks and make up 5% of total mortality in Alberta based on long term monitoring data over the past eighteen years. The spatial distribution of train collisions with grizzly and black bear (Ursus americanus) were compared to that expected based on relative abundance and historic data. Ratios of observed to expected mortality were calculated to reveal non-constant risk and spatial clustering along 133 kilometers of the Canadian Pacific Railroad in Banff and Yoho National parks. These results were used to identify high risk rail segments and analyze a set of spatially varying risk factors including: train speed, track curvature, and track grade. Akaike Information Criterion was used to assess the model which best described mortality risk from an a priori model set. Analyses were repeated at four spatial scales (0.25, 1.6, 3.2, and 16.0 km). These analyses indicated that a single predictor model, which included track curvature, best explained bear-train collision risk. These results may aid in planning and design of railroad twinning and construction as many countries move to more sustainable transportation systems.
TU7
Roadkilling wildlife in southern Spanish oak woodlands
Juan D. Delgado, Natalia Arroyo, Jorge Durán, Alexandra Rodríguez, Antonio Rosal, Valle Palenzuela, Jesús R. Sánchez

Roads are likely to produce heavier impacts where wildlife populations are dense, have susceptible or vulnerable species, vehicle traffic is more intense and speed is higher. Animal mortality also depends on seasonality, landscape configuration and road permeability among other factors. We assessed the role of motorized traffic on roadkill rates of wildlife on asphalt roads dividing southern Spanish rangelands ("dehesas"), oak woodland pastures where livestock growing is combined with agroforestry and hunting. Four road segments of the Sierra Morena range (Huelva and Seville provinces) were surveyed two times (autumn-winter 2009-2010 and spring-summer 2010). Total road length (53 km) was walked along both roadsides (overall length walked = 106 km) on each field season by 1-4 trained observers at 1 km/h. Asphalt right-of-way and road verges and ditches were exhaustively inspected for all dead vertebrates, which were georreferenced and identified to the lowest taxonomic level possible. All real and putative wildlife passages (mainly drainages and cattle tunnels) were spatially referenced to contrast roadkill data with potential road permeability. Nearly 400 casualties classified into 66 species were recorded, including 5 amphibians (1 newt, 2 frogs and 2 toads), 7 reptiles (2 lizards, 1 blind snake, 3 snakes and 1 turtle), 37 birds and 18 mammals. Composition and percentage casualties per species differed greatly between seasons and roads. Proximity to villages, traffic density and traits of species (i.e. habitat selectivity) were partially responsible of the roadkill rates in the road sink, as well as animal community structure of the habitat sources.

TU8
Wildlife road mortality in Mediterranean coastal wetlands (East Spain)
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Keywords: Wetlands, Wildlife, Road kill, Kernel, Predictive models

Roads have a great impact on the natural environment, especially when they have heavy traffic and go through valuable ecosystems like wetlands. We have studied wildlife casualties on different type of roads over three coastal wetlands in the Iberian Peninsula: Albufera, Marjal de Pego-Oliva and Aiguamolls de l’Empordà Natural Park. The aim of this study was to determine the main species and species groups affected by wildlife-vehicle collision, to investigate the spatial pattern of these collisions and to identify the main factors involved in the presence of the fatalities. Eight different roads that cross Mediterranean wetland areas were monitored at least 10 times each season sampling on food or by bicycle. All road casualties found were reported and the carcasses were removed to avoid double counting. Data analysis was performed using the SANET ver.4 Beta GIS based tool developed by Okabe et al., (2008). This tool is used to estimate the mortality density distribution over a network using a Kernel Density Estimation (KDE). Predictive models of presence/absence data were constructed to determine the common explanatory factors associated with the location of casualties on the eight monitored roads. An important number of casualties were registered in all wetlands: 2008 in Albufera, 599 in Pego and 2983 in Aiguamolls. Several threatened species were found dead on all these wetland roads such as some chiroptera like Mediterranean horseshoe bat (Rhinolophus euryale), and Schreibers’ bat (Miniopterus schreibersii). Also we registered great differences in the main groups affected by roads between wetlands. While in the Aiguamolls Natural Park the main group affected was amphibians, in the other two Natural Parks, birds were the main group. These differences are strongly correlated with the abundance of each group in the respective environments. Also other landscape and local variables show influence in the distribution of vertebrate road mortality. Otherwise the SANET tool has proved to be an interesting tool to determine the locations of hotspots, with easy application and shows results which are easy to interpret.
TU9
Optimization of sampling effort to determine wildlife road mortality
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Keywords: Wildlife, Road kill, Sampling methodology.

When a study of wildlife road mortality is performed it is always assumed that the amount of registered road kills is an underestimate of the real number of animals killed. The accuracy of estimation greatly depends on the sampling frequency of the study. The discrepancy in the road kills found related to the difference in sampling effort is important when we want to compare results from other studies that employed different sampling frequencies. The aim of this study was to determine the magnitude of data losses that can be a consequence of different sampling effort and propose an optimal sampling frequency depending on it. Five roads with different characteristics of two Natural Parks in Valencia (Albufera and Marjal Pego-Oliva) were sampled. The roads were sampled twice a week for 5 weeks each season. The first time the road was visited; the road kills were recorded and marked with a bright colour spray. The second time we registered both the new casualties and the carcasses registered the first time that were still on the roads. This time all the carcasses were removed from the road. This methodology was repeated for 20 weeks during the year 2009. The number of casualties registered in the two wetlands was 572 (422 in Albufera and 150 in Marjal Pego-Oliva). Approximately 16% of road kills were lost between the two consecutive visits to the road whereas another 11%, despite still being on roads, were so damaged that they were unrecognizable. The permanency of the carcasses on roads depends on the road and traffic characteristics and the characteristics of the species killed.

TU10
Birds and highway: effects on species diversity and road-kills in southern Brazil
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Keywords: Birds, road-kill, structure community, southern Brazil

Between November 2008 and April 2009 we conducted monitoring of birds in three wetlands along highway BR 392 in southern Brazil, by means of bimonthly samplings, totaling three sampling periods in each wetland. Each period consisted of three consecutive days of sampling. The “Domain Area” (DA) was in a circle with a radius of 150 m that was centered on the highway; the “Control Area” (CA) was a circle of equal size located 300 m from the highway. Each area was monitored for 10 minutes, and all species identified visually or by sound were recorded. Concurrently, we conducted weekly monitoring of wildlife road-killed along 60 km of the same highway, that included the three wetlands. The richness ranged from 52 to 62 species, with a Simpson’s evenness ranging from 0.19 to 0.36, demonstrating a high dominance of some species. Lower evenness values were found in the DA (Mean=0.23), compared with 0.34 for the CA. The structure of birds was compared between DA and CA, within each area, and among the wetlands. We analyzed the data using ANOVA with 10,000 resamplings. There was no difference in the communities when comparing DA and CA, within each area, and among the wetlands. We found 67 birds killed along the highway (0.09 ind./km of 26 different species. The three species most affected were Passer domesticus (0.01 ind./km), Nothura maculosa (0.007 ind./km), and Furnarius rufus (0.006 ind./km), all are common or synanthropic species. The structure of the bird community was similar, regardless of the distance from the highway. However, the evenness differed, indicating the inability of some species to adapt to the presence of the highway. Abundant, generalist species were most likely to be killed along the highway, with no significant implications for ecological processes.
TU11
Index ranking of priority sites for mitigation of wildlife road-kill

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Keywords: Index ranking, priority sites, road-kill, Brazil, diversity

We propose an index ranking of priority sites for implementation of measures to mitigate wildlife road-kill. We conducted a case study along 34 km of highway BR 392 in southern Brazil. We compared site priorities established only by road-kill rates, and those defined by our index. The index uses four parameters: the target-species richness, the diversity of road-killed species, the road-kill rate of target species, and the presence of endangered species. Although it is impossible to protect the entire community of vertebrates affected by road-kill, we defined nine target species, five mammals and four reptiles. For each parameter we defined coefficients from 0 to 3. The maximum value for a site index was 12, but in practice the maximum value was 8. Considering only road-kill rates, a total of 12 sites received priority. Using the hierarchical index, we identified 16 sites. The implementation of mitigation devices led to a significant change in site priority, and to changes in the protected species. When only the road-kill rate was included, the definition of priority sites protected especially reptiles, to the detriment of all mammal species, including those threatened with extinction. Sites with high road-kill rates continued to be rated among the most important for conservation, but the index diluted the effect of this parameter, changing the priority. We suggest that, when available, the parameters of richness, diversity, and endangered species in the area surrounding the highway be incorporated into the index. This index can be an effective tool to aid government agencies in decision-making, especially when more elaborate analysis is not feasible for reasons of insufficient time, resources, or trained personnel.

TU12
Effect of sampling effort on estimated richness of road-killed vertebrate wildlife

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Keywords: Chao 1; community structure; experimental design; sampling effort; threatened species.

Road-killed mammals, birds, and reptiles were collected weekly along 117 km of federal highways in southern Brazil during 2002 and 2005. The objective was to assess the variation in the richness of species impacted by road-kills as estimated from different sampling efforts, to aid in the experimental design of future sampling campaigns. We discuss how different objectives (e.g., the maintenance of ecological processes and the reduction of road-kill rates of the most-affected species) require different sampling efforts with respect to the frequency and number of samples. The richness observed in weekly samples was compared with resamplings for different periods. The sampling sufficiency of each period was calculated by the Chao 1 species-richness estimator. In each period, the list of road-killed species was evaluated with regard to: 1) the maintenance of community structure in relation to the weekly samplings; 2) the presence of the ten species most subject to road mortality; and 3) threatened species. Weekly samples were sufficient only for the reptiles and mammals, considered separately. The richness estimated from the biweekly samples was equal to that found in the weekly samples, and gave satisfactory results for sampling the most abundant and the threatened species. The road-mortality rates and the dominance structure of the ten most-affected species remained constant, independently of the sampling interval. The experimental designs changed when reptiles, birds, and mammals were considered separately; birds required greater sampling effort. When species are killed at different rates in different seasons, it is necessary to take biweekly samples for a minimum of one year. For monitoring the total richness impacted by road-kills, weekly or more-frequent sampling for periods longer than two years is necessary.
TU13
Road mortality of amphibians in western Ukraine (Lviv Province)
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Keywords: roads, amphibians, mortality, migrations, Ukraine

There are very few publications concerning amphibian and other animal road mortality in Ukraine. There is a need to start active investigations on the topic in Ukraine, as the scale of animal mortality on the roads increases with the development of motor transport and subsequent traffic intensity. Our investigations were held on the main roads of Lviv province in Western Ukraine these included two roads of Pan-European importance. Over 1200km of road going through lowlands, mountains and river valleys were investigated during April – November 2006. 60 places of amphibian mortality were found; with a total of 3555 individuals from 13 species being observed. These were Triturus cristatus, T.montandoni, Bombina bombina, B.variegata, Pelobates fuscus, Bufo bufo, B.viridis, Hyla arborea, Rana temporaria, R.arvalis, R.ridibunda and R.esculenta. The Common Toad and Common Frog were the most numerous species and made up over 90% of all casualties. Three key factors of amphibian mortality were analyzed with the corresponding parameters of impact level. The factors were: the number of killed individuals (under 20, 20-50 and over 50 individuals), traffic intensity (under 1000, 1000-5000 and over 5000 vehicles per day) and the distance between the road and breeding place (up to 100m, 100-500m and over 500m). 10% of the investigated places were found to be under the high level of impact, 56% – middle and 34% – low. The given criteria are proposed to be used for establishing the level of road impact on amphibians. The seasonal dynamics of amphibian migrations were also investigated in details in a sample area within the region. The examples of the most abundant species (B.bufo, R.temporaria) show that, despite species differences, general migration patterns display three peaks during the season occurring in second half of April, July and September–October.

TU14
Roadkills and the dynamics of the faunal casualties in Battonya town (SE Hungary)
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The poster presents the main results of our total surveying of the roadkills (faunal casualties) in the total prefecture of Battonya town. In this 14,577 ha area we registered the data of every found roadkills between 1995 and 1999. The place we examined well represents a common plain landscape in which many agricultural area can be found. The surveyings achieved by bicycle covers the total period of the years. During 5 years we registered the data of 10,820 roadkills which belongs to 291 taxons, in which 255 taxons are species ranked. Among the found species 70 species are under protection, 4 species are strictly protected. Some interesting data: Lycosa singoriensis (n=1), Bombus argillaceus (n=2), Eudia pavonia (n=2), Falco tinunculus (n=1), Falco vespertinus (n=1), Coturnix coturnix (n=2), Tyto alba (n=1), Athene noctua (n=3), Merops apiaster (n=2), Riparia riparia (n=1), Ficedula hypoleuca (n=2), Lanius minor (n=1), Nyctalus noctula (n=2), Mustela eversmanni (n=2), Cricetus cricetus (n=227), Muscardinus avellanarius (n=1). The list of the species is completed by the following rare species found in the further years: Nymphalis polychloros, Ixobrychus minutus, Caprimulgus europaeus, Alcedo atthis, Turdus viscivorus, Lanius excubitor, Martes martes, Nannospalax leucodon. Beside the fact that how many specimen of the species are killed by the vehicular traffic we seeked the answer whether which correlate with the squelches. The data mirrored the seasonal changes of the activity of each species (e.g. flight time, crossrun, flying of the eyas). In some cases – e.g. Common Hamster (Cricetus cricetus) – the number of the elements of the sample was enough to do population dynamical conclusions. The 16-year-old data line completed by the results of the further years shows, that major changes of the Common Hamster population is followed by the Steppe Polecat (Mustela eversmanni) population.
Abstracts

**Disturbance, pollution and invasion**

**TU15**

**Effects of the construction of a high-speed railway on the distribution and home range of the stone martens (Martes foina) in Cuenca (Spain)**

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Keywords: Barrier effect, Home range, Radio tracking, Railway, Stone marten (Martes foina)

Habitat fragmentation caused by the transport infrastructures is one of the main problems for the conservation of vertebrates in developed countries. Moreover, when these infrastructures roam adjacent on the same territory, the cumulative barrier effect could have negative effects. This project has been carried out in the mountain range of Sierra de Cabrejas, Cuenca (Spain), where the future high-speed railway (AVE Madrid-Valencia) is being built adjacent to the highway A40 and the road N400. This investigation shows the result of 5 radio tracked stone martens (Martes foina) before and during the railway construction in this area. The objective was to examine the disturbance on their distributions and home ranges, to evaluate the initial barrier effect. We capture and radio-tagged 5 stone martens with radio collars (Biotrack TW3) 2 adult male, 1 young male, 1 adult female and 1 young female, representing all possible kinds of age and sex. For trapping we used 9 single-door cage traps baited with sardines and fresh eggs. The monitoring was carried out from December 2006 to June 2007 and was similar by individual. We obtained 865 valid locations as a total monitoring effort. All stone martens showed nocturnal activity and their shelters were located near water streams in pine-oak forest. The average kernel density estimation area (IK90) evidenced home range of 2.38 km$^2$ in males and 2.21 km$^2$ in adult females. Home ranges did not differ during the monitoring, that is to say, the construction of the high-speed railway not affect to the size of home ranges. Nevertheless, distribution or location of the home ranges of stone martens located to less than 3 Km of distance of the area of construction of the high-speed railway were displaced considerably.

**TU16**

**Impacts of a highway construction on great bustards threatened population: threshold distances and effects on population dynamics**

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Keywords: BACI, population trends, road effects, steppe birds, reproductive success

Road density is being increased due to a constant development of the transport network. This fact is especially noticeable in peri-urban areas, becoming crucial the planning and management of activities. In most of the studies which analyze road effects focused on population items, the weakness of the analysis performed questions the results. We studied the effect of the construction of a highway in a protected area in central Spain, over great bustard (Otis tarda), which is a globally threatened species. The study was carried out by demographic time series (1997-2009) analysis, whose data were obtained before, during and after infrastructure building. Generalized additive models (GAMs) and regression trees were built to check the effect of road distance over probability of species’ presence, inside a 2 km band from the road. In addition, a Before-After-Control-Impact (BACI) study design was used to analyze changes in population trends and family group density. Our results suggest that the highway has had negative effects on great bustard use of space. The species tended to avoid a buffer zone around 500 m from the roadside, since the beginning of construction. In spring the avoided band was narrower, so the highway perturbing effect can be considered as secondary when compared to the marked site-fidelity to the exhibition grounds. Concerning the demographic trends, the number of individuals was reduced gradually up to 50% since the highway opening. However, in control zones individual’s abundance has been maintained or even increased. The effects on density of family groups were not so evident, probably due to a high natural variability in great bustard reproductive success.
TU17
Ecological considerations for the management of non-native invasive species during the maintenance and operation of national road schemes in Ireland
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During road construction non-native invasive species can be disturbed by machinery and brought into or out of a route corridor, in the form of plant fragments or seed, either within the soil load or on the tyres or tracks of machinery. Cutting of roadside vegetation can also distribute seeds and plant fragments of invasive species, which can then be carried along the road corridor by wind or on tyres of vehicles including cars (see Wace 1977; Wilcox 1989).

Dolan (2004) identified the following invasive species typically found in roadside landscapes in Ireland: Japanese knotweed (Fallopia japonica), Winter Heliotrope (Petasites fragrans), Giant Rhubarb (Gunnera tinctoria), Traveller’s Joy (Clematis vitalba) and Himalayan Balsam (Impatiens glandulifera) (see Reynolds, 2002).

Prevention, early identification and management of non-native invasive species can avoid or reduce the need for long-term maintenance regimes (with associated costs) and impacts on the Irish landscape. While awareness and early detection of invasive species prior to or during construction will provide a means to implement management regimes at an early stage in an invasion event, it is the prevention of an invasion that is likely to be the most environmentally sound approach.

The key areas that determine invasion success are a combination of a habitat’s degree of susceptibility to invasion (Pyšek and Prach 1993; Burke and Grime 1996), plus the traits of the invading plant species (Pyšek and Richardson, 2006). Although, susceptibility is easy to categorize, it is the identification of consistent traits which is proving more difficult (Thompson et al. 2001), as different traits may be more advantageous in different habitats (Alpert et al. 2000). Furthermore, the establishment of non-native invasive species also appears to be determined by the presence of mature native plant communities (Lugo and Gucinski 2000; Lundgren et al. 2004).

Whereas the mature native plant communities within the general Irish landscape may be somewhat resilient to invasion, the removal of vegetation and topsoil provides ideal opportunities for non-native species to invade adjacent ecosystems, alter plant community structure and composition (e.g. Saunders et al. 2002), limiting their ability to perform ecological functions and services (Dolan et al. 2005).

As Ireland is currently undergoing a large extension to its national road network, it is clear that much of Ireland’s land area has recently, and will, become more susceptible to non-native invasive species.

To date the management of non-native invasive species on Irish national road schemes is absent, inappropriate (e.g. mechanical flailing) or predominantly herbicide based - the latter appearing to ‘control’ rather than to eradicate.

Given the amount of disturbance that accompanies road building, this research project (part of SIMBIOYS: multi-disciplinary research across Trinity College Dublin, University College Cork and University College Dublin) aims to utilize field and simulated environment (cold greenhouse) based research to investigate and identify various environments (and subsequently techniques) e.g. various soil types, nutrient levels pH, soil moisture, degree of light exposure and soil microfauna; which may provide resistance or unfavourable conditions for the establishment of non-native invasive species within Irish roadside landscapes.

References
Abstracts


TU18

Space use by Brown bear (Ursus Arctos) in relation to noise during and after Egnatia highway construction activities in Pindos mountain range

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Keywords: Noise, Brown Bear, Highway, Greece

Over the last decades, large human infrastructure have been further extending over suburbanized and undisturbed areas, resulting in degradation of forest ecosystems due to noise disturbance.

The present work illustrates the preliminary results of recording and mapping of noise distribution induced by to the 37km Egnatia highway stretch “Panagia_Grevena” under construction in relation to the spatial behavior feedback of the indigenous brown bear population. In particular, bear habitat use is evidenced through satellite/GSM telemetry and is correlated to the noise levels induced by the highway construction works.

In parallel, the influence of the traffic volume noise over a functional section of the highway upon bear spatial behavior is also examined.

From the first results it appears likely that the increase of bear nocturnal activity levels are not only related to the existing biological and ecological factors but also to the possible negative impact of high construction noise levels during the daylight hours. It comes out that over the total study area, for the 17 sampled bears the highest rate of active radiolocations occurs during the night hours whereas during the daylight hours the active bear radiolocations are at their lowest levels in correlation to the highest construction noise levels.
Mortality and habitat fragmentation from wind farm development
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Keywords: birds, bats, wind farms, mortality, habitat fragmentation

The use of wind as a renewable energy source is expanding rapidly worldwide. However, wind energy is not without its own potentially damaging consequences for nature conservation. Therefore, there is a need to balance the risks and benefits and to minimise any adverse environmental effects. Birds and bats can collide with wind turbines, or encounter the vortex wake behind the turbines. They can also become disturbed in their breeding, resting, and foraging areas, or during migration. Because the effects depend on a wide range of factors including the wind farm configuration, surrounding land, and species present, there is considerable variation in the reported impacts. Many studies are also methodologically weak, and more long-term assessments are required. Although the direct habitat loss from wind turbines and possible accompanying infrastructure like access roads and power lines is relatively low, the effects because of visual and acoustic disturbance can sometimes result in significant habitat loss or habitat quality degradation for birds and bats. In this rapidly changing environment, more wind farms can lead to avoidance of previously suitable habitat and will serve as barriers to movement. This will likely increase fragmentation in an already fragmented landscape. There is a strong consensus that the selected location for wind farms is critically important in determining the likelihood of deleterious cumulative impacts on birds and bats. Strategic planning on regional and national or international scale is therefore recommended, including the use of dynamic fauna and ecosystem vulnerability maps. These maps can be created from fauna distribution data, sensitivity categories and policy frameworks. An integrated approach will also be necessary, so that current and planned habitat defragmentation measures coming from the aspect of transportation and infrastructure can remain successful.

Fauna passages and their efficacy

Quantifying the effects of wildlife crossing structures on the population viability of arboreal mammals
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Keywords: canopy bridge, glider pole, barrier effect, population genetics, survival

The construction of new roads and widening of existing road corridors subdivide remnant habitat patches, limiting the movement of wildlife through the landscape. Arboreal mammals are particularly vulnerable to these impacts, as they are limited in their ability to cross large gaps in canopy cover. In south-east Australia canopy bridges, gliding poles and vegetated medians have been used to provide connectivity for arboreal mammals across a major dual-carriage highway. However, the impacts of these structures on population viability have not been evaluated. This project aims to quantify how effectively these crossing structures are able to maintain or restore connectivity and normal population processes. Prior to mitigation, radio-tracking and genetic studies showed the dual-carriage highway was a barrier to multiple species of arboreal mammal. Furthermore, estimations of the annual survival of the Squirrel Glider (Petaurus norfolcensis), a threatened species of arboreal mammal, revealed that the annual survival rate for populations living alongside the highway was 60% lower than for populations living further away. As a result, in 2007, canopy bridges and gliding poles were retrofitted at sites where the barrier effect was greatest. Gliding poles and canopy bridges were also used along a recently widened stretch of highway (completed in December, 2009). At these sites, monitoring surveys on arboreal mammal populations were regularly conducted throughout the construction process, beginning in late 2007 at the pre-construction phase. Monitoring of some of the earlier canopy bridges and glider poles using remotely triggered infrared cameras has already revealed regular use by multiple species (e.g. Squirrel Gliders use the canopy bridges at an average rate of 0.45 crossing per night). Post-construction and mitigation data on population density, survival and genetic structure will be compared to data collected at earlier phases to determine the extent to which the viability of...
arboreal mammal populations has changed as a result of the highway duplication and implementation of mitigation structures.

**TU21**

**Factors influencing design, location and function of ecoducts**

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Keywords: Fragmentation, ecoducts, design, location, function.

For maintaining possibility of animal migration over expressway and motorway roads are in present for newly constructed roads in place of biocorridors designed special structures – ecoducts. These structures serve for minimization of animal population fragmentation. During their designing it is necessary to take into account for what animals are determined, their location in terrain preferably in place of their current natural migration traces. The way of designing and implementation must enable their further functional use. Therefore is necessary to chose proper shape and used materials and also modification of their surroundings and access places. Among factors influencing design, location and function of ecoducts are width, surface treatment, surface ordering, location, technical equipment supplementary steps and loads. Each mentioned factors influencing functionality of ecoducts are in paper discussed and are assumed generalized conclusions and recommendations.

**TU22**

**Adjustable groundwater level on overpasses to benefit amphibians**

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Keywords: ecoducts, ecological network, amphibians, technical solutions

In the southern part of the Netherlands ARCADIS has designed an ecoduct with a special adjustment for species of wet habitats. At the top of the construction an adjustable waterlevel can be maintained by a pump and drainage system. By pumping up groundwater in the top layer there is a permanent groundwater level in a ditch at the top of the overpass. Despite of some technical problems concerning the pump this type of new design has shown some interesting results. Monitoring shows the overpass is frequently used by some rare amphibians like crested newts.

**TU23**

**The usual approach to ecological bridges design and construction and its possible innovation**

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Keywords: Ecological bridges, planning, design & construction

The paper presents a new strategy which can change the regular decision-making process in ecological bridges design and construction. The usual decision making process in ecological bridges design and planning does not reflect the changes of migration routes of the wildlife due to the effect of motorway construction and often leads to waste of public resources. The new approach determines the decision whether to build or not to build an ecological bridge on long-time monitoring and maximizes the role of compensation measures in the decision-making process. The described approach is summarized in organization charts, differences are explained and benefits of the new one are explained. Newly, the key role in assuring the permeability of the countryside is attributed to underbridges and compensation measures. An ecological overbridge should be, as proposed, built when all the compensation measures are depleted during the operation of the motorway.
TU24
Methods of accelerated design of ecological overbridges
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Keywords: Ecological bridges, planning, design&construction, accelerated construction

In some special cases, mainly if the migration needs change rapidly, there is a need to build an ecological overbridge during the operation of the motorway. The paper presents construction systems of ecological bridges which satisfy this need. Three structural systems are studied in detail, the hinged arch mode of timber, reinforced concrete buried arch and the integral frame. The structural description is accompanied by the summarization of the specifics of the construction and demands on traffic limitations. The construction sequence is studied in detail, together with time needs for construction processes. Innovative pre-cast structures, which can be built after the start of the operation of the motorway without influencing it, can on one hand mitigate the habitat fragmentation and on the other hand save financial resources by being built only when really necessary and when all the compensation measures were depleted. With the use of buried arch structures, the soil-structure interaction has to be studied in detail.

TU25
An overpass for amphibians - does it work?
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Keywords: habitat fragmentation, wildlife overpass, monitoring, amphibians, ecological engineering

In the Netherlands wildlife overpass “Groene Woud” is one of the first that aims to provide habitat connectivity for amphibians. In both the design and management of the overpass much attention has been given to create optimal conditions for amphibians. Besides a controllable groundwater level on top of the overpass, across the whole length of the overpass and its access ramps a wetland zone has been constructed existing of a chain of small pools. Water is pumped up to the top of the overpass and slowly released through the cascade of small pools towards bigger pools at the feet of the access ramps. The philosophy of these special adaptations is to maintain sufficient humid conditions to improve amphibian use throughout the dry season. The question we addressed is if those expectations are correct, i.e. whether the use of the overpass by amphibians is significantly improved in contrast with the situation that the humid conditions on the overpass are not artificially maintained. We monitored amphibians 1-2 times a week at the overpass and in the direct surroundings for three years (2006-2008). We analysed the impact of the overpass adaptations on amphibian use by: (1) comparing amphibian numbers in periods in which the humid conditions on the overpass were maintained with amphibian numbers in periods in which the water pump was not operating, and (2) comparing amphibian numbers in the wetland zone on the overpass with amphibian numbers in the dry zone on the overpass during periods that the water pump was operating. We found that, depending on general weather conditions, the adaptations to maintain a humid environment on the overpass and its ramps significantly improve overpass use by amphibians. As a result wildlife overpasses with special adaptations as implemented at the Groene Woud overpass may become an alternative, and less costly, measure than elevating roads to restore habitat connectivity for semi-aquatic species in wetland areas. Further research should focus in more detail on individual movements of animals to better quantify overpass use and qualify the role of the linkage in maintaining amphibian life cycles and population persistence.
TU26
Improving toad tunnel efficiency at Parassapuszta, Hungary: inappropriate design and construction could partly be counter-balanced by maintenance
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Keywords: amphibian migration, road mortality, mitigation measure, maintenance, Hungary
Mitigation measures to help amphibian migration under roads have been made since the late 1960s in Europe. Its design, however, is a matter of discussion till today. The Hont – Parassapuszta section of the no. 2. road in Hungary is a site of amphibian rescue since 1987. In 2006 a mitigation measure was built including already existing culverts as well as new toad tunnels connected by plastic fences. No advice was taken from local experts, however, either in the planning or in the construction phase of the mitigation measure resulting in a system inadequate for helping amphibian crossing. Lack of maintenance made the situation even worse with less than 0.5% of amphibians in the tunnels during the 2007 and 2008 migration period. In spring, 2009 fences were improved and connected to the tunnel entrances in a more appropriate way. Maintenance increased the ratio of amphibians crossing under the road to over 10%. Common toads (Bufo bufo) were found in the tunnels most often using both modified culverts and new tunnels. The highest species diversity was recorded in the largest culvert, through which other amphibian species (Bufo viridis, Pelobates fuscus) and grass snakes (Natrix natrix) also moved from their hibernation area to their breeding site or summer habitat.

TU27
Brown bear crossings along Egnatia Highway in Northern Greece
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Keywords: Brown Bear / Crossings/ Fragmentation / Highway
Traffic volume, as well as construction of new highways (i.e Via Egnatia) in NW Greece have an increasing impact on brown bear habitat connectivity and population status. Egnatia highway is a 680 km long six-lane highway and belongs to the Transportation European Network (TENT).
We present the preliminary results of our work on the permeability of brown bears (Ursus arctos) along the 37 km "Panagia-Grevena" stretch of Egnatia (25km of them were currently under construction). In the above section there are 13 tunnels of 8.85 km long, 11 bridges of 2.64 km long and 9 wildlife underpasses.
We used telemetry data from 20 brown bear (Ursus arctos) specimens collected during a three year monitoring period (2007-2009).
Preliminary results showed that tunnel natural overpasses and bridge viaducts with cover and away from human activities and disturbance were locations on highway where brown bear crossed more frequently. Some types of underpasses especially culverts were not used by bears. Despite more than 30% of the above section are suitable areas for crossings (natural tunnels and bridges), two road accidents involving brown bears have happened during 2009, first year of operation. Moreover, 20 more accidents have taken place on the Egnatia Highway and intersecting roads since 2003. Monitoring highway animal crossing locations can help wildlife managers to gain knowledge and design effective mitigation measures for wildlife connectivity.
Plenary session II.

Highspeed railways and nature conservation: a growing challenge or an opportunity?
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The recent growing-rates of railway traffic pointed out the importance of this modern and environmental compatible transportation mode. In the near future it is expected to increase even more. This is due to both kinds of railway traffic: freight and passenger transport. In the context of landscape fragmentation – especially the development of high speed traffic – will lead to new technical and ecological challenges.

The presentation will focus on the aspects of nature conservation based on the actual discussions about the decrease of species and loss of biodiversity in relation to railways. A three-dimensional view will be given on the different species which may be influenced by railway traffic:

Areas along the lines: Beside the positive aspects like railway lines as migration ways for different species (linking habitats) there are also negative facets like spreading invasive species e. g. In addition the railway embankments can be the final retreat areas of rare species – especially in urban and agriculture areas.

The cross section of track: While the migration of animals and plants along the railway lines is rather easy, the crossing of the track could cause a problem for some species due to the track construction and by passing trains. Some examples of the influence onto species and possible solutions will be given in the presentation.

Air space above the track: The third dimension, the air space above the track could affect flying animals due to overhead contact installations for the traction system and passing trains as well.

Beside the existing knowledge about the effects of fragmentation by railway lines there are still lots of open questions, which will be addressed to the audience.

Transport ecology in Japan and Asia
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Wildlife-vehicle collisions are of growing concern in Asia, as it is already in Europe and North America. I will report the current state of wildlife-vehicle collisions and the efforts to prevent such collisions in Japan, China and Korea. The outline of the report follows.

1. The state of wildlife-vehicle collisions by region, wildlife type and accident cause in Japan.
2. The analysis using GIS of vegetation and landscape features as factors contributing to deer-vehicle collisions which are rapidly increasing in Hokkaido, the northern most island of Japan.
3. Measures that have been implemented in Hokkaido to prevent deer-vehicle collisions and their effectiveness.
4. The state of rare animal-vehicle collisions and efforts to reduce such accidents in Japan through literature research and the hearing from rare animal-vehicle collision experts. The rare animals include black rabbits, iromote wild cats and okinawa rails.
5. The state of animal-vehicle collisions and collision prevention efforts in China and Korea through literature research. The prevention efforts include those made in the occasion of Qinghai highland railway construction.
Ecological networks and corridors as tools for defragmentation I.

Ecological networks in the Czech Republic
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Keywords: ecological network, animal migration, migration corridors, fragmentation

Due to growing fragmentation of natural habitats, the future survival of many animal species is becoming endangered. In the Czech Republic, the dealing with a problem of landscape permeability by protection of ecological network has more than twenty years tradition.

To protect the landscape connectivity the „Territorial system of ecological stability” (TSES) was introduced into the Czech nature conservation law in 1992 (Act no. 114/1992). On the basis of the law the TSES plan serves obligatory as documentation for: land-use planning, forest management plans, water management documents and other documents regarding protection and restoration of the landscape. TSES ecological network is based on a connection of similar types of biotopes and it well reflects the demands of organisms that are closely connected with this biotope (flora, invertebrates, small terrestrial vertebrates, etc.). However, the experience showed that the current TSES doesn’t work sufficiently as corridors for migration of large mammals. That is why the Ministry of the Environment decided to prepare a new concept of corridors based on the requirements of large carnivores (lynx, wolf, brown bear) and large ungulates (moose, red deer). These target species were selected not only for the protection of themselves per se, but also as an “umbrella species”, as the preservation of their habitat will help to save the habitat of many other species.

Preparation of a new system of migration corridors is realized in the following steps:

- Identification of areas important for permanent living and migration of large mammals
- Identification of main migration directions
- Identification of concrete migration routes.

The whole project is based on actual data about distribution and migration of target species, their habitat preferences, models of the potential habitat usability for target species, analysis of all types of barriers, and on field verification of permeability of all migration routes.

So far, about 10.000 km of migration routes has been identified, and their field verification is about to be finished by the end of 2010.

Design of multifunctional landscape corridors using effective mesh-size for regional targeting of urban development restrictions and open space development
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Keywords: landscape fragmentation, landscape corridors, bio-connectivity, effective mesh-size, strategic territorial development planning (muss hierher laut abstract-Vorgabe)

One of the fundamental consequences of urbanisation can be found in the loss of permeability of open space due to the development of settlement networks and urban growth. Ecological (e.g. bio-connectivity, remoteness, air exchange and uncontaminated soils and water) as well as other landscape qualities and services like suitability for recreation, cultural and agricultural functions or visual integrity, are affected by the landscape being dissected with roads, settlements and other infrastructure facilities. ‘Effective mesh-size’ (Jaeger 2000) is widely used as an indicator of open space being permeable for animal and recreational movement but also for the other aspects mentioned. Using ‘effective mesh-size’ areas with low density and impact of urban and transportation infrastructure can be identified (Esswein et al. 2002) and underlay strategic territorial planning (Schwarz-v.Raumer, 2002; Girvetz, 2008) and environmental monitoring (Jaeger et al., 2007; Jaeger et al., 2008). Our contribution suggests a GIS-technique which leads to landscape corridors of low degree of dissection. They connect extraordinary big meshes in the
settlement network using the most permeable corridor region. The technique is based on a moving window analysis for ‘effective mesh-size’ and due to this it identifies the multifunctional aspects of landscape described above. The result of the procedure is analysed considering its coincidence with existing delineations of wildlife and biotope corridors and is discussed with regard to its meaning and use in regional and state level strategic development planning (Stuttgart Region and state of Baden-Württemberg).

References:


Biotope networks - networks of life: promoting a forest corridor system with a European perspective

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Since 2004, the German environmental group Friends of the Earth Germany/BUND is working together with government authorities, landowners and hunters to develop 20,000 kilometres of migration corridors for the endangered European wild cat (felis sylvestris). Because of increased traffic intensity, development of settlements and agricultural intensification, the wild cat has disappeared from a large part of its original habitat. Remaining populations in central and southwest Germany are genetically distinct. Under the BUND initiative, connectivity between existing and potential habitats will be restored through the planting of trees and shrubs along migration routes and the construction of ‘green bridges’. A first corridor has been realised between the Thuringian Forest and the Hainich National Park (in the Thuringia region) after years of careful preparation and studies. Many more corridors are currently under construction in Germany, for example in Rhineland Palatinate which hosts almost half the German wild cat population. In cooperation with scientific partners new monitoring methods based on hair samples and genetic analysis were developed and improved. Although the wild cat is the target species of the initiative, many other species such as badgers, beetles and tree frogs will benefit, thereby improving the health of entire forest ecosystems. In 2010, the BUND started an accompanying publicity campaign to raise public awareness and garner support for what has become one of the largest conservation projects in central Europe. The campaign is funded by the EU (Life+). In addition, proposed corridors in Thuringia will be financed by EU ELER Fund. BUND is now searching for partners for the next stage of the Wildcat network – the international linkage. Countries with similar conditions like France, Czech Republic, Austria, and others may join the interconnection which one day may reach from Spain to the Balkans – the natural range of the European wildcat.
Transport corridors as habitat

Contrasting fragmentation and disturbance effects on roadside vegetation

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Keywords: edge effects, plant recruitment, road verge, road ecology

Habitat fragmentation and changes to human disturbance regimes are acknowledged as key ongoing threats to biodiversity worldwide. For example in south-eastern Australia, 150 years of agricultural development has resulted in widespread clearing and fragmentation of once continuous Eucalyptus woodlands, and replacement with crops or exotic pastures. Remaining woodlands now occur as remnants of varying size, quality and isolation, and exist primarily in small conservation reserves, and as an extensive network of roadside (vegetation) corridors. Fragmentation results in both external (e.g. edge effects) and internal (e.g. grazing) modifying influences, but also changes to natural fire regimes, which is important in maintaining Eucalyptus woodlands. Understanding the effects of changes to these landscape processes is vital for future conservation management activities of remnant vegetation in road corridors.

The purpose of this study was to investigate potential fragmentation and disturbance effects on remnant vegetation in the Mallee region in northern Victoria. We surveyed the structure of Mallee vegetation (in terms of dominant trees, shrub strata, and groundcover), and collected field based and documentary evidence on disturbances, to compare and contrast structural differences between roadside vegetation and small, medium and large remnants. Sampling of larger remnants was stratified based on core or edge habitat. Results of this study showed that the structure of roadside vegetation corridors was similar to the edge of larger remnants. Roadside vegetation and edges had a greater mean height and girth (DBH) of dominant trees, than the core of medium and large remnants. In contrast, the core of medium and large remnants possessed greater shrub diversity and more complex understory cover than roadside vegetation. These results are discussed in terms of prevailing fragmentation paradigms and disturbance history, and highlight the conservation importance of roadside corridors in providing habitat for threatened species in such human altered landscapes.

Biodiversity in railway environment. How to measure, preserve and enhance threatened species on railways.

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Keywords: Red-list species; Insect diversity; Endangered; Infrastructure; Action plans

Railway stations, railway lines and other anthropogenic environments are important biotopes for numerous species. Today we know that many threatened species live and reproduce in railway environments. Knowledge about ecology and distribution of these species is a prerequisite to promote biological diversity in the greenest mode of travelling: the railway. We have performed a survey of biodiversity in railway environments in south and mid Sweden. 180 railway stations were visited and analyzed for beetles, wasps, day-flying butterflies, hemipterans and vascular plants. The survey also included 8 parts of railway lines. In total, more than 2 000 species from these groups were found during 2008-2009. Among these, 102 species were red listed in Sweden. Two of the red listed species (sand lizard and large blue butterfly) were also listed in the EC Habitats Directive. A system with indicators was used to detect spots of high biological diversity. These spots were suggested for to become part of certain measures in order to develop the biological diversity. The railway environment is characterized by disturbance and is often exposed to drought and sun. This biotope has become an important environment for many species originated from agricultural landscape. As the agricultural landscape changes, the railway and other infrastructures become more important for these species. Also, when new railways are built new infrastructure biotopes will be created. If the biological perspective is considered from the beginning, these biotopes will become valuable for biodiversity. During the inventory we found that 15 existing action plans for threatened species were represented in the investigated railway environment. The system of indicators used in this survey was shown to be appropriate to use on small but not large
railway stations. The result of this inventory points at the great variety of species that occur in railway environment.

**Can infrastructure habitats contribute to the preservation of threatened biodiversity?**
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Keywords: Red-listed species, Habitat ecology, Road verge, Railway, Quarry

Infrastructure creates a number of different types of man-made nature that can serve as habitat for species. Many of these have been acknowledged for their species richness, for example some road sides, railway stations, and sand quarries. Also threatened species occur in such habitats, but can infrastructure contribute significantly to the preservation of red-listed species and to halt the loss of biodiversity? If so, which infrastructure habitats are most important and which groups of species are in particular affected? We have studied habitat preference, threats, suggested conservation actions, and distribution of Swedish red-listed species of plants and insects. The results show in short that infrastructure habitats harbour red-listed species to an extent that is well comparable with more traditional habitats such as pastures, hay-meadows, and some forest types. Particularly important are road sides, railways, sand quarries, and open corridors for electric power lines. Some species occur also in other habitats, mainly habitats in the agricultural landscape, whereas others at present occur only in infrastructure habitats. For the first group, infrastructure complement other habitats and distribution areas, for the second group infrastructure has the main responsibility for the preservation of the species. Most of the species can be attributed to historical habitats in the agricultural landscape, for example hay-meadows, dry open pastures, sandy forest pastures, traditional arable fields and leys, heaths, river banks, and subalpine forests. Suboptimal management of such traditional habitats contributes to increasing the relative importance of infrastructure habitats. However, also infrastructure habitats need considerable improvements of their management in order to function as sustainable habitats, and in order to use their full potential. We suggest that understanding of the species’ original habitats in combination with understanding of the species’ ecology is a key factor for developing suitable habitat conditions and management methods for infrastructure habitats.

**Living on the verge: Are roads a more suitable refuge for small mammals than streams?**
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Keywords: Linear Habitats, Small mammals, Road Verges, Small Streams; Mediterranean

Retaining natural remnant corridors of habitat is a useful and practical conservation tool, which can attenuate the effects of habitat loss and fragmentation on wildlife. By providing additional habitat for small fauna living in highly modified environments linear structures may contribute to the conservation of biodiversity. We assessed the importance of road verges as refuge areas for small mammals, in highly intensified grazed pastures in a Mediterranean landscape, and compared road function as refuge with the one of riparian galleries, which have already been described as important shelter location for these species in the Mediterranean context. For this purpose, a small mammal trapping study was undertaken in October 2007 on two road verges and two small stream sides in the vicinity of Évora, southern Portugal. We captured a total of 457 individuals of five different species. * Mus spretus * was the most common species captured, followed by * Crocidura russula*. Captures were 4.6 times higher inside both linear habitats (roads and streams) than 12m away on the surrounding matrix. Individuals captured in the matrix presented a smaller body size and a lower body condition, suggesting that this suboptimal habitat is mainly occupied by subadults, probably making dispersing movements. * M. spretus * was 46% more abundant on roadsides than on streamside vegetation, whilst * C. russula * had similar abundances in both habitats. * M. spretus * were bigger on streams, but showed no differences in body condition between roads and streams. * C. russula * had better body condition and slightly higher body lengths on roadsides. Our results thus show that roadside verges, in intensively grazed Mediterranean landscapes, act as important refuge habitat for small mammals and constitute equally vital habitats for small mammals as do riparian vegetation strips, in landscapes where other suitable habitat is scarce.
A study on some insect groups in Hungarian highway margins (Orthoptera, Coccoidea, Auchenorrhyncha)
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Keywords: road-ecology, faunistics, corridor

As opposed to flightless vertebrates, highways do not represent an isolation line for most of the insect populations. On the contrary: plant covered highway margins and rest areas are suitable habitats for a number of small bodied animals. These habitats may serve for them as a corridor of spreading or as a refuge in an intensive agricultural or urban landscape. To understand better the role of highways for insect populations we investigated the faunistic composition of five main Hungarian highways (M0, M1, M3, M5, M7) on more than 50 collecting points since 2007. The study was focusing on three groups of insects (Coccoidea, Orthoptera and Auchenorrhyncha) representing different levels of vagility. Our first results have shown that highway margins are unexpectedly species rich habitat for scale insects: 102 species (54 % of the Hungarian fauna) were found during the two starting years of the study, while in Orthoptera 45 species (36 %) were detected. The occurrence of protected or rare species was also demonstrated (e.g. Porphyrophora polonica, Gampsocleis glabra, Calliptamus barbarus, Acrida hungarica). Apart from evaluating natural values, monitoring of insect assemblages of highway ecosystems gives also the opportunity to follow the spreading of some newly introduced pest species. The citrus plant hopper (Metcalfa pruinosa) was firstly found in Hungary in 2005 in the centre of Budapest. In our 2009 survey this species occurred in 5 collecting points in the vicinity of Budapest (<50 km), and in one more point at the Croatian-Hungarian state border (M7, Letenye). Scattered specimens of the Moroccan locust (Dociostaurus maroccanus) – causing formerly several outbreaks in the Carpathian Basin – were also detected, surprisingly. Our first results have shown that highway insect assemblages should be further explored for evaluating the opportunities incidentally offered by these large-scale human constructions for insects.

Case studies: Mitigation and monitoring

Mitigating the impact of the highway E314 crossing the National Park Hoge Kempen (Province of Limburg, Flanders, Belgium)
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In March 2006, the opening conference on the first Belgian National Park (NP), named ‘High Campine’, was held. This National Park includes some 5000 ha of heath land and woods, holding important populations of Smooth snake (Coronella autriaca), Natterjack toad (Bufo calamita) and Moor frog (Rana arvalis). These species are listed in the European Habitat directive and are very sensitive to fragmentation by roads.

Some of the most interesting heath lands are former mining areas. They were reshaped by the local mining company at the time their activities ceased, following recommendations by the Flemish government. Indeed, the after use for this area was destined as nature development. Arcadis functioned as intermediate agent between the two parties and conducted several EIA’s (Environmental Impact Assessment), which included detailed studies on the fauna and vegetation in the mining areas as well as nature development in the after use.

The highway E314 cuts through the NP from west (Brussels) to east (Aken), setting a serious problem to the populations of amphibians and reptiles, amongst others.

The Flemish government already implemented some important defragmentation measures:

- 2 bridges have been closed for motorized traffic and have been transformed towards ‘ecoveloducts’;
- 1 large ecoduct ‘KIKBEEK’ has been built;
- 1 tunnel has been transformed to ecotunnel (closed for motorized traffic);

The ecoduct Kikbeek, the second built Flemish ecoduct, has been intensively monitored by Arcadis, in 2007 and 2009. The results were astonishing: almost all of the target species were recorded, usually in large numbers.
However for a complete defragmentation, one more move is desirable. A large ‘ecovalley’ underneath the E314 would realise a much better defragmentation, especially for species linked to wet habitats.

Therefore, cooperation between the Flemish government and mining company Sibelco, streamlined by Arcadis, is once more necessary. The first studies concerning the feasibility have already been executed.

Raw materials will be mined underneath the high way. Afterwards, the two quarries will be connected and moreover the ideal baseline will be prepared by the company so wet and dry heath land can develop optimally. These types of vegetation will also be developed in the after use for the quarries. A win win for economical benefit and ecological surplus value is the main goal.

Identification of corridors and linkage zones for brown bears as a compensation measure to the impacts of the construction of the “E65” highway in Central Greece

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Keywords: Linkage zones, wildlife corridors, brown bear, compensation measures

A new threat endangering the survival of wildlife in Greece is the fragmentation of the limited habitat available in the country through the construction of large infrastructure projects, such as roads. The “Egnatia” highway, which links the western to the eastern part of the country, is such an example and its effects on the local brown bear (Ursus arctos) population are being closely monitored.

The new highway “E65”, linking the southern to the northern part of the country, aligned between the mountain ranges of Pindos and Olympus - Pieria, will most likely negatively affect habitat connectivity of all large mammals populations. For preventing eventual fragmentation of natural habitats, special mitigation measures have been planned for a 40.8 km section of this road, including 5.1 km of tunnels and 4.1 km of large bridges. Additionally in order to ensure wider natural habitat continuity, a pilot study was carried out aiming to identify and propose special additional compensatory measures. Using the brown bear as an indicator species the study aimed in identifying the local linkage zones that would ensure intermountain habitat connectivity and was based on GIS mapping and on the least cost analysis model. The model’s input were land use types, the impact of human settlements and the type and density of the road network. The study identified the actual and potential corridors and linkage zones that allow brown bears to move between the Pindos and Olympus - Pieria Mountain ranges. The main land use types in the model affecting habitat connectivity were coppice oak forests, arable lands and grasslands. Based on these results inversion of coppice forests to high forests in the areas surrounding the construction site of the highway has been proposed and actively promoted in order to secure the long term functionality of the corridors and linkage zones.

Making the connection: Mammal mitigation measures on national road schemes in Ireland

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Keywords: mammals, mitigation measures, effective monitoring, best available technology, road kills

It is known that roads can create permanent barriers to the dispersal of wildlife as a result of chronic disturbances from human activities and traffic. As a result, wildlife can maintain some distances from roads, ultimately separating home ranges of species, which can have detrimental effects on populations, including local extinctions. Studies of mammal mitigation measures in Ireland to date remain observational at best. There are a multitude of constraints on experimental design such as habituation periods, levels of human activity, equality of species perceived access
to each crossing structure, the density of crossing structures, multi-species or community level responses and meta-population dynamics which must be taken into account. It is also known that poor crossing structure designs have the potential to decouple ecosystem level processes, for example, in the formation of prey-refuge zones in predator-prey relations. Systematic surveys of mitigation measures on 5 national road schemes in Ireland are to be undertaken. The study will include monitoring of mitigation measures for pine marten (*Martes martes*), otter (*Lutra lutra*) and badger (*Meles meles*) and amphibian underpasses designed for smooth newt (*Triturus vulgaris*) and common frog (*Rana temporaria*). Also, occupancy of artificial badger setts, and use of overpasses and underpasses put in place for agricultural use will be reviewed. A Geographical Information System is also to be deployed in conjunction with Alterra in The Netherlands which will provide an overview of habitat connectivity and bottlenecks to connectivity across the landscape of Ireland along with known hotspots of road kills for protected fauna. A combination of computer analysis and stakeholder input will then be utilised to identify locations which require examination in terms of the selection of appropriate mitigation measures. It is intended that this study will provide the necessary background information to protect the Irish populations of deer, pine marten, badger and otter, among other species into the future.

**Wildlife accidents. The new Swedish preventing strategy.**

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A few years after the turn of the century it was noticed that the number of wildlife accidents increased in spite of the fact that the populations of moose and raw deer was decreasing. Furthermore it was difficulties locating the scene of the accidents since it often was not properly marked. And often voluntary hunters were not able to trace the injured animal due to poor equipment, unskilled dogs or where insufficiently trained themselves. A growing population of wolfs, brown bears and lynx caused new problems. How to deal with injured and dangerous predators? At the same time crucial questions was raised about responsibility, financial compensation to involved hunters and about the overall organisation.

It was obvious that Sweden needed a new strategy to diminish wildlife accidents, to secure that injured animals was properly found and killed and that killed animals was removed safely.

The Swedish government established a completely new organisation for this purpose, the National Wildlife Accident Council. At the same time chances in the legislation was introduced. Also a new system for registration of accidents was taken into operation. The responsibility for this new organisation was designated to the Swedish Police. At the same time the Swedish Transport Administration was given a special responsibility to provide measures against wildlife accidents.

Although the numbers of wildlife accidents are still very high in Sweden (last year o total of 44,366 accidents was recorded) we have a good hope for a change in the future. This is due to:

- The new organisation guarantees cooperation between all concerned parties (Authorities, Agencies, Administrations, the Swedish Hunters Association, several insurance companies, SOS-Alarm, The Swedish Motor-Vehicle Inspection Company.)
- All members works towards the same targets and all have stated there intensions.
- All wildlife accidents must be reported according to the new law.
- All wildlife accidents must be properly marked according to the new law
- All wildlife accidents are reported with co-ordinates
- All hunters involved are approved and have passed an advanced course
- All involved hunters are guaranteed proper equipment
- All approved hunters are financially compensated

**Ecological networks and corridors as tools for defragmentation II.**

**Network of protected areas in Central European border regions**

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Keywords: Ecological networks, GIS, connectivity, protected areas, Central Europe
Within the project TransEcoNet (Transnational Ecological Networks in Central Europe, http://www.transeconet.eu/) transnational network of ecological important areas in border regions within Central and Eastern Europe is analysed. In this study the ecological network is to be understood as the existing network of protected areas. The area under investigation stretches from the Baltic Sea to the Ukraine and to the Adriatic Sea covering the NUTS3 regions adjoining the selected inner Central European national boundaries. The analyses are based on spatial data and are performed in a Geographical Information System (GIS). After collecting and harmonising national data as well as European data sets of protected areas all areas have been classified due to the international standard provided by the categories of IUCN (International Union for Conservation of Nature) and categorised as core and non-core areas according to their protection status and size. Following these basic data preparation steps different analyses have been performed. First, the connectivity of the network was analysed using the results of a nearest neighbour analysis. In general the result shows a good protection status of the area under investigation. Thus, also other border areas beside the Green Belt, the former Iron Curtain, are forming important ecological networks and supply important ecological functions and services for the society. Furthermore, based on the connectivity analysis and the determination of potential habitat corridors gaps within the network are detected. For these gaps strategies will be developed to reconnect the single parts of the network. Further results of the project will be management strategies for the sustainable development of ecological important border regions which are currently in preparation.

From national planning to regional implementation: initiatives for reconnection of habitats in key areas in Schleswig-Holstein (Germany)
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Keywords: Habitat corridors, fragmentation, wildlife crossings, Schleswig-Holstein

Germany’s northernmost federal state Schleswig-Holstein is the gateway to Southern Scandinavia and therefore of vital importance for transnational exchange processes between central and northern Europe, both for human traffic and biodiversity.

Currently the construction and enlargement of several motorways in this key region improves the quality of the transportation network, but at the same time threatens interregional biological migration routes, regional dispersal and local habitat qualities. Thus the department transportation plans to implement a regional dense network of green bridges and other fauna passages. These passages are the first step to enhance the landscape permeability, but the reconnection of valuable habitats linked to the passages is essential and must follow. Therefore the state foundation for nature conservation has funded several regional project initiatives: 1) “Holstian Habitat Corridors” in central Schleswig-Holstein, its preliminary study was funded by the federal german agency for nature conservation, 2) INTERREG-funded “BioGrenzKorr” at the border to Denmark. Both initiatives aim at implementing a network of habitat corridors linked to fauna passages.

In this presentation we will describe:
• types of measurements we will use in the projects areas,
• partnerships that have been established between regional stakeholders
• financing concept we have developed.

We show the project’s relevance as a component of national and regional habitat networks, which ensures biological exchange processes via the road network.

Restoring the web of life – Ecological networks for more biodiversity in the Alps
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Keywords: Ecological networks, Alps, transnational approach

In response to decreasing biodiversity and phenomena such as climate change, a transnational approach aimed at creating an Alps-wide ecological network has been developed during the last few years in the Alps. It is promoted in particular by three initiatives: Ecological Continuum Initiative, ECONNECT project and Platform Ecological Network of the Alpine Convention. This Alps-wide approach underlines the importance of both an international framework and the need to extend connectivity activities to other sectors than nature protection. In 2007, four Alps wide
institutions, ALPARC (Alpine Network of Protected Areas), CIPRA (International Commission for the Protection of the Alps), ISCAR (International Scientific Committee on Research in the Alps) and WWF (with its alpine programme), launched the "Ecological Continuum Initiative", its aim being to improve ecological connectivity in the Alps. Unlike the national approaches, the cross-border approach developed by these organisations is based on a new vision of protecting the natural environment of the Alpine massif as a whole, from France to Slovenia. The Initiative is financed by a Swiss Foundation. Launched in September 2008 and financed through the European Union’s Alpine Space Programme, the three-year ECONNECT project – with its motto "Restoring the web of life" – is designed to promote model network implementation in seven pilot regions. The pilot regions are working to show how networking can be improved in the specific case at the local level. To promote cross-border working in the development of ecological networks, the Ecological Network platform was established in the framework of the Alpine Convention in 2007. This platform brings together the relevant authorities in the countries of the Alps, the Alpine Convention observers and other actors from administrative bodies, the research community and the regions of the Alps. It encourages a political dialogue with the objective of generating political support for networking initiatives in the Alps.

Developing an ecological continuum suitability index for the Alps – Acting with indicators, geodata and web based map tools

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Keywords: ecological connectivity, ecological network, GIS, web mapping, Swiss National Park

Several studies in the Alps in the last years have shown to experts the need maintain or rather to restore missing links between small and large scaled habitats. They are aware of the specific needs of a particular plant or animal. Nevertheless, the action or measurement to support migration must be done on the landscape functionality. Each landscape patch has to fulfil a specific requirement concerning the ecological continuum. But often we struggle with the required patch size compared with the study area as well as with a lack of public awareness of all these facts and components.

This study shows a possible solution for these aspects: A web based mapping tool was developed combining an ecological continuum suitability index (CSI) with the visualisation of migration probability of specific species. The CSI is built with nine environmental indices derived from a heterogeneous set of geodata in seven pilot regions in the Alps and weighted with different approaches combining known landscape indexes and expert opinions using the multi criteria approach.

The web map tool allows a user to analyse the CSI and compare the results in different areas as well as to simulate cost paths for a virtual migration of an individual. It also offers uploading data to compare the simulation with real observations. Using GIS functionality and the Google Maps API for ArcGIS Server it supports a seamless zoom from the alpine wide view to a very local insight only restricted by the data resolution varying between 1 ha and 1 km².

The availability of the tool in the World Wide Web and the user friendly interface offers the public a new view into ecological connectivity – so far restricted to experts - and will help to raise the awareness in this important aspect for the future of the Alps.

Defragmentation approaches for existing transport networks

The Swiss defragmentation program - from design to global planning. An overview.
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Keywords: Fauna, transport infrastructure, fauna passage, mitigation measures, defragmentation

Switzerland has one of the densest infrastructure networks of Europe (3-4 km/km² on the Central Plateau). Fragmentation of natural habitats has become a major conservation concern. The mortality of animals on roads is high, with more than 8‘000 roe deer killed yearly by traffic. Many local amphibian populations have disappeared after road building cut off spawn sites from
wintering grounds. Highways have proven to be an impassable barrier for the lynx, impeding colonization of eastern Switzerland.

A census of bottlenecks where infrastructure intercepts important wildlife corridors was carried out in the 1990's. 51 points needing restoration measures were identified. Many of these are along first generation highways built along an east-west axis and cutting off any possible exchange between wildlife populations in the Alps and the Jura.

The Swiss defragmentation program spans transport infrastructure planning and building, improving both existing infrastructure as well as setting new standards to minimize future conflicts. Every aspect of planning and design has been reviewed.

A ministerial guideline sealed a partnership the Swiss Agency for Environment, Forests and Landscape (SAEFL) and the Federal road office. The defragmentation program is now included in the highway maintenance program and is to take place over the next 20 years. 12 conflict points have been recently retrofitted in the context of highway maintenance or widening schemes.

In order to facilitate long term planning different instruments have been developed. Standards have been defined by the Swiss Association of Road and Transportation Experts (VSS, 2004) to guide engineers and biologists in the analysis of existing structures and potential permeability for fauna. These standards develop criteria to facilitate the choice of the optimal type of passage for each given situation. Further elements of roads structures are being examined and their design adapted so as to improve permeability (drainage systems and culverts).

This paper proposes an overview of these achievements.

**Roads and wetlands: Can we mitigate the impact of the existing transport network?**


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Keywords: Wetlands, Defragmentation, Mitigation measures, Road, Wildlife

In the Mediterranean area, there is a dense transport network that provides access to urban and tourist areas. This area is also a strategic transport corridor. It includes major infrastructures such as highways and high speed railways that will be expanded in the near future. These infrastructures put a lot of pressure on the rich biodiversity of the Mediterranean coastal wetlands that are included in the Natura 2000 Network, most of which are designated Special Protection Areas (SPAs).

A research project included in the Spanish National Plan for Scientific Research, Development and Technological Innovation 2008-2011, which is supported by the Ministry of the Environment and Rural and Marine Affairs, aims to define a scheme to mitigate and prevent the impact of transport networks on wetland habitats, which are of high conservation interest.

Monitoring took place during 2008 and 2009 at the Natural Park Aiguamolls de l’Empordà (Girona) and Albufera de Valencia. It included analyses of road mortality, the use of wildlife passages, the behaviour of birds crossing the infrastructures and the abundance of mammals and birds at different distances from the roads. These data have been combined with landscape analysis using GIS, which provides information about habitat distribution and connectivity features.

Based on these empirical data, a scheme will be defined to identify and prioritise the most conflictive points, at which defragmentation measures or other actions will be implemented to reduce the impact on biodiversity. In addition, guidelines will be established to mitigate the existing impact and to avoid the effects of new infrastructure.
Efficiency of re-connecting habitat networks for invertebrate populations - an integrated approach for impact assessment and landscape planning
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Keywords: habitat networks, statistical habitat model, individual based dispersal model, metapopulation analyses, impact assessment

The assessment and mitigation of biological effects caused by landscape fragmentation and sub-dissection by planned highways, roads and railroads is an integrated and obligatory part of EU impact assessment as well as of German landscape planning procedures. Measures to re-establish habitat networks like the integration of wildlife crossings are increasingly accepted. However, in the past research has been mainly focussed on the reduction of sub-dissection effects for mobile vertebrate species. In contrast, the effects of measures improving habitat connectivity for wingless and slow moving invertebrates and especially on their population viability are not well understood. In a project financed by the German Federal Agency for Nature Conservation we use two approaches to assess the efficiency of different measures for improving connectivity for slow moving invertebrates. Both approaches are applied in the same areas of study placed in various landscapes of Germany. In a ‘scientific approach’ habitat suitability is modeled using multifactorial statistical habitat models. The permeability of the landscape matrix is analysed by least cost path methods. In an ‘applied landscape planning approach’ habitat suitability is assessed by expert knowledge using typical planning-data like mapped vegetation units. The species dispersal is modeled using an individual-based movement model. In both approaches metapopulation analyses are applied to assess population viability. Different scenarios of re-connecting habitats after a dissection by traffic infrastructure are analysed like integrating wildlife crossings (one large vs. several small), improving existing habitats and/or creating new stepping stones. To analyse the efficiency of the measures, in each scenario the feasibility of implementation and expected costs are also assessed. One goal of the project is to derive ‘thumb-rules’ for applied landscape planning on reconnecting habitat networks for invertebrates. Therefore, the research aims to derive suitable methods and the minimum of data necessary for sound analyses within planning processes.

A regional mitigation blueprint for herpetofauna in Southern Ontario
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Keywords: Road-kill, mitigation planning, herpetofaunal, connectivity, Ontario (Canada)

Roads are a dominant feature in the landscape bisecting natural habitat often isolating wildlife populations compromising species richness, genetic diversity, and species abundance. As wildlife disperse to access resources, movement corridors and roads often intersect resulting in road-kill hotspots along roads. Hotspots of road-kill are often clustered in specific spatiotemporal extents which present opportunities for road ecologists to predict when and where road mortality may occur. This can assist in placing mitigation measures such as wildlife crossing structures in specific hotspots in the road network where they will be most effective. Here we present a methodology developed to predict where herpetofaunal road mortality hotspots occur in a regional urban landscape in southern Ontario. We focused our analysis in a region of the Niagara peninsula that has been selected for transportation infrastructure development as part of an environmental assessment study. We selected semi-aquatic turtles, e.g. blanding’s turtle and pond-breeding amphibians, e.g. wood frog that make annual migrations to breeding and over wintering sites. We mapped and scored wetland-forest sites using a land use geospatial layer for the area. We quantified a habitat suitability index (HSI) for each pixel (15 m by 15 m) in the landscape, by summing the pixels scores within a 200 m radius buffer. We validated the model results using Chi squared statistics with species alive and dead on road location data. We then used a series of criteria to prioritize hotspots that would maximize connectivity in the landscape, e.g. effective mesh size with and without the road. In addition, mitigation areas were prioritized according to their ability to maintain population viability of the target species, e.g. see LARCH model. Examples
of final output maps with some recommended mitigation strategies are presented. Future work and recommended implementation plans are discussed.

Restoring ecological networks across transport corridors in Bulgaria
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Keywords: habitat fragmentation, population viability, mitigation, defragmentation

Bulgaria faces the challenge developing a sustainable road and railroad network that facilitates the needs for efficient transport of goods and people but does not threaten areas that are especially valuable for nature conservation. Currently plans have been developed to substantially upgrade and expand the national transportation networks. The existing transportation corridors and the proposed extensions pose a threat to wildlife and affect the development and functionality of both a national and Pan-European ecological network. The overall objective of our study is to set up a national road mitigation program to minimize the fragmentation effects of these expanding transportation corridors so as to preserve biodiversity and develop a coherent and sustainable ecological network across the country. The main questions we addressed are: (1) What sections of the rail and road networks are expected to significantly affect the viability of wildlife populations? (2) Which of these sections need to be addressed most urgently? And: (3) What measures could be taken to solve the problems? With the help of population viability analysis 283 bottleneck locations were identified in the existing road and railroad network of Bulgaria. About 30% of all bottlenecks are classified as high priority locations. Immediate action is recommended at these locations as these have been identified as locations where the impact on population viability is high and/or wildlife is frequently killed in traffic. The construction of 213 wildlife passages across the country is recommended, as well as retrofitting 331 existing road tunnels, viaducts or bridges, to allow for better use of these structures by wildlife. The implementation of this plan for road and railroad mitigation will significantly improve the population viability of most threatened wildlife species and, as such, is an indispensable first step in preserving Bulgaria’s biodiversity and developing a coherent and sustainable ecological network across the country.

Fences and animal detection systems

How effective are wildlife fences in preventing collisions with wild ungulates?
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Keywords: Wildlife fence, collision, wild ungulate, parallel road, traffic

Wildlife fences are a widely used method for preventing collisions with wild ungulates and other large mammals. In Finland it is estimated that number of ungulate-vehicle collisions in highways can decrease even 80 per cent after erecting fences. This estimate notices only collisions in fenced road sections despite that fencing can have an effect on a larger scale. We compared number of collisions with moose and deer in two cases on a highway and its parallel road in southern Finland before and after highway fencing. In the first case, a road section of 28.1 kilometer on Highway 4 was fenced in 1998. There were 39 collisions with wild ungulates on three years before fencing (1995–1997). At the same time there were 7 collisions on a 25.6 kilometer long, unfenced section on the road number 140 which runs beside fenced sections of Highway 4. After fencing, number of collisions decreased on the Highway 4: there were 17 collisions on three years (1999–2001). At the same time the number of collisions in the parallel road increased to 24. In the second case, a 35.5 kilometer long road section on Highway 3 was fenced in 1993. There were 21 collisions on two years before (1991–1992) and 9 collisions after (1994–1995) fencing. At the same time, there were 10 and 16 collisions, respectively, on a 35.8 kilometer long section on the parallel road number 130. Based on our observations, we conclude that fencing of highways can alter the distribution of vehicle-ungulate collisions. It is even possible that erecting fences don’t reduce the total amount of collisions, because animals roam more than normally across minor roads when trying to find routes through fenced highways. To avoid this, we think that it is essential to build wildlife passageways always when using fences.
The barrier effect of twin tracked, non fenced railroads in Sweden
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Keywords: Barrier effect, railroads, ungulates, Sweden

Fenced infrastructure composes an almost total barrier for larger wildlife, and movements across the road or railroad are thus restricted to fauna passages, fence openings and other mitigation measures. However, the strength of the barrier caused by non fenced railroad systems is not sufficiently studied. The present Swedish railroad system is mostly single tracked and poorly mitigated for wildlife connectivity, but as new larger lines with high traffic volumes are planned, this question has to be evaluated. In theory, the barrier effect caused by a railroad may vary depending on the traffic volume, railroad width and other characteristics of the embankment, and be species specific. The aim of the study was to quantify moose and roe deer movements across and near railroad systems, and to quantify the barrier effect caused by non fenced railroads with different traffic volumes. The snow track survey was conducted at two transects parallel to the railroad. The transect near the railroad were used to control movements across the embankment and movements near the railroad, and the transect 200 meters from the railroad were used as a reference.

In total, 152 km of railroads and an equal length of reference transects were studied. Moose and roe deer crossed the railroad in average 0.065 and 0.46 times per day and km respectively during the study. No structural effects of single or twin tracked railroad systems could be found on moose and roe deer movements across the embankment. However a significant effect from train volume was found for both moose and roe deer. The results indicated that an increased traffic volume effects ungulate movements across the railroad and thus connectivity plans for wildlife should be used on present high volume lines and when planning new high volume lines.

A quantitative comparison of the reliability of animal detection systems and recommended requirements for system reliability
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Keywords: Animal detection systems, Mitigation measures, Reliability requirements, Safe crossing opportunities, Wildlife-vehicle collisions

Animal detection systems have the potential to reduce collisions with large mammals and improve human safety while not blocking or confining animal movements across the road. However, reliable warning signs are essential as the effectiveness of these systems depends on driver response. To investigate the reliability of the systems we constructed a controlled access test facility near Lewistown, Montana, USA. Nine systems were installed to detect horses and llamas that roamed in an enclosure. The llamas and horses served as a model for wild ungulates. Data loggers recorded the date and time of each detection for each system. Animal movements were also recorded by six infrared cameras with a date and time stamp. By analyzing the images and the detection data, we were able to investigate the reliability for each system. The percentage of false positives (i.e., a detection is reported by a system but there is no large animal present in the detection zone) was relatively low for all systems (≤1%). The percentage of false negatives (i.e., an animal is present in the detection zone but a system failed to detect it) was highly variable (0–31%). The percentage of intrusions (i.e., animal intrusions in the detection area) that were detected varied between 73 and 100 percent. The results suggest that some animal detection systems are quite reliable in detecting large mammals with few false positives and false negatives, whereas other systems have relatively many false negatives. In addition we investigated how the reliability of individual systems was influenced by environmental conditions. Finally we surveyed three stakeholder groups—employees of transportation agencies, employees of natural resource management agencies, and the traveling public—with regard to their expectations on the reliability of animal detection systems and compared the reliability of the nine systems to these expectations.
Restoring permeability of roads for wildlife: wildlife warning systems in practice

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Keywords: animal detection system, animal-vehicle collisions, wildlife fencing, wildlife road kills

Between 2003 and 2005, the Forest Research Institute Baden-Württemberg (FVA) played a decisive role in planning and implementing an electronic animal detecting system, a pilot project in the Federal State of Baden-Württemberg in Southern Germany. The system was intended to reduce animal vehicle collisions which doubled up to over 25 after the expansion of the national road B292.

The respective road section was fenced over a length of 3.5km with two 60m gaps allowing the animals to cross the road. At each gap an animal detection system was installed. These systems use sensors to detect large animals (e.g. deer, wild boar and fox) that approach the gaps during dawn and night and try to cross the road. Once an animal has been detected, LED-warning signs are activated for two minutes that encourage drivers to become more alert, reduce the driving speed to the mandatory 70 or 50km/h.

After two years, animal-vehicle collisions could be reduced by over 80% corresponding to a prevention of tangible damage in the amount of 110,000 €. Within two years, 5036 road-crossings (individual animals or groups) were recorded at the two gaps whereof 13 ended up in collisions. In average, this corresponds to one animal-vehicle collision per 387 road-crossings.

The lessons learned during this project as well the potential fields of application of this system to restore permeability of roads for wildlife will be emphasized.

Workshop: Fragmentation measures

Chair: Jochen Jaeger, CAN  
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There is an increasing need and interest in including indicators of landscape fragmentation in monitoring systems of sustainable landscape management. However, most monitoring systems today still lack any indicator of landscape fragmentation. One likely reason is that there is considerable debate and confusion about the exact definition of "landscape fragmentation" and how it can be measured, which impedes agreement about which of the proposed metrics should be used (Kupfer 2006). The monitoring systems for biodiversity and sustainable development in Switzerland have recently adopted an indicator of landscape fragmentation (Jaeger et al. 2008). The measure used to quantify this indicator is called "effective mesh density" (number of meshes per 1000 km²). Data on the degree of landscape fragmentation reveal an increase by 230% during the last 120 years. The German Federal Environment Agency has recently suggested to introduce region-specific limits to control landscape fragmentation, using the “effective mesh size”. We will discuss the issues involved in measuring landscape fragmentation and the requirements for metrics of landscape fragmentation (suitability criteria), and compare the strengths and weaknesses of various metrics of landscape fragmentation. We will discuss the „effective mesh size” and „effective mesh density” in more detail. We will also investigate how habitat amount and habitat fragmentation per se can be measured separately, i.e., that they are conceptually independent. We will look at many practical examples which will make the participants comfortable in using these metrics.

References:


Workshop: CEDR task 7 – Wildlife and traffic

Workshop 1: Gaps in 341 Handbook, Workshop 2: Efficient institutional systems

Habitat fragmentation has been recognised as one of the most significant factors contributing to the decline of biodiversity in Europe. Transport infrastructure is a considerable cause of fragmentation.

The CEDR (Conferences of European Directors of Roads) Wildlife and Traffic group has been established in order to discuss and share ‘best practice’ and gained experiences with different actions to reduce the impact of infrastructure on biodiversity in Europe.

CEDR arranges two workshops at the IENE conference. The topic for the proposed session falls into the below mentioned already decided major topics for the conference:

• Policy and planning
• Monitoring and follow up
• Mitigating the impact
• Landscape fragmentation
• Habitat and landscape effects

Contact information, organiser:

CEDR (Conferences of European Directors of Roads) Wildlife and traffic group (task 7), chairman Mrs. Birgitte Henriksen, Danish Road Administration, Niels Juels gade 13, Copenhagen K, bg@vd.dk.

Workshop 1: Gaps in 341 Handbook

COST 341 is a handbook with recommendations on how to deal with challenges regarding wildlife caused by transport infrastructure.

At the workshop the group will present the results of the questionnaire on usefulness of the COST 341 handbook and other national guidelines sent to the NRAs, March 2010.

The workshop will end with a discussion and common recommendations to the Road Directors concerning best practice on how to reduce the effect on wildlife from transport infrastructure.

Workshop 2: Efficient institutional systems

The workshop deals with strategies to find out fruitful advices on what approach can be taken to solve the conflict between road networks and ecological networks on a strategic, institutional level.

Initial discussion within the CEDR working group has indicated that some member states seem to have more success than others in solving these challenges. There are some hypotheses on the causes of the success but this has to be verified in a broader context. All countries are looking for this strategy but it is important to find the success factors in order to speed up the development of the road ecology strategies. The CEDR task group 7 is therefore planning a study where the approaches in different countries are compared and in addition there should be carried out an analysis of the common key factors that seem to lead to success.

At the workshop some perspectives are presented ending with a discussion on best practice on institutional aspects.

Workshop: Rail and road

This workshop aims at identifying differences and similarities in the knowledge about impacts from rail- and road infrastructure and traffic, identify needs for research, practical knowledge, organisation and policymaking.

The workshop will be divided into 4 discussion groups that discuss the same questions, but from 4 different perspectives, relating to Michael Below’s plenary talk.
Perspectives / Groups
1. Areas along the track / habitats inside infrastructure (maintenance / land use)
2. Barriers / fragmentation
3. Mortality due to infrastructure and traffic
4. Noise disturbance

Questions, session 1
1. What knowledge is urgently needed to deal with the impact related to the perspective of your group?
2. Where and to what degree can data and knowledge obtained in the road sector be transferred and used in the rail sector?
3. How can we integrate science in infrastructure construction projects - and how can practise influence science?
4. Prepare a short summary

Questions, session 2
1. Roads and railways are often situated closely together. Is this rather a problem or a possibility with respect to the environmental impact, to transport organisations and policies?
2. Rail and road infrastructure can, in some ways, have beneficial effects on biodiversity. Which are the next most important steps to develop these possibilities?
3. As high speed railway networks expand, we must learn to address environmental issues at broader scales than before. How can we best operate at regional and supra-regional scale?
4. Prepare a short summary

Wednesday poster session

Fragmentation and landscape

WE1
Habitat fragmentation due to transportation infrastructure: the state of the art in Italy
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Keyword: Road ecology, state-of-the-art, national report, Italy

Habitat fragmentation is one significant factors for the decline of biodiversity in Europe. In Italy there are 6,532 km of motorways, 17,250 km of national roads, 151,570 km of regional and provincial roads and 670,000 km of local ones, and 19,472 km of railways. 277.1 km of roads are present (2.5% of available land) every 100 sq. km. The urbanisation that accompanies infrastructure increases fragmentation. An estimate has calculated an annual loss of over 15,000 animals in every Italian province, and for the avifauna the loss is 25 birds/km of road. The costs for biodiversity and those for the human society are big: in the years 1995-2000 there were 2083 accidents with animals, and in the decade 1995-2005 human fatalities were 150 and human injuries some hundreds. The mitigation of the infrastructure impacts on biodiversity is a new chapter for conservation in Italy, although some experiences have been carried out since the 1980s. In 2008 a first report on the state of the art in Italy was published. The experiences described are: general documents, studies on road mortality, data-bank on fauna accidents, ecological studies, awareness campaign, warning signs, reflectors, fences, fauna passages, complex programmes, local ecological networks and landscape defragmentation, verge management and habitat restoration, projects for amphibian protection, actions for bird protection, fauna exits from waterways and fish passages, compensation, technical documentation, conferences, regulation and administrative measures, participation at international initiatives, projects at national level. The main problems in the Italian context are the lack of: broad acknowledgement of the topic, specific laws and technical guidelines, coordination at scientific and
technical level, systematic adoption of mitigation measures. At present, many activities and
programmes at local level have been activated, but the situation is variegated and discontinuous,
because it is based on the direct sensibility of specific technicians or administrators.

**WE2**
**Modelling the effect of roads on Moor frog metapopulations**
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Keyword: *Rana arvalis*, Connectivity, Individual-based model, Habitat fragmentation, Metapopulations

In many parts of Europe, urbanisation and intensive land use have reduced and fragmented the
natural habitats of the Moor frog (*Rana arvalis*). Thus, the Moor frog is one of the many species
listed in the Annex IV of the EU Habitat Directive. Combining population-based and individual-based
approaches, we are developing a spatially explicit model that can be used to quantify and
evaluate the impact of new road projects on a metapopulation of Moor Frogs. The model considers
the seasonal migration and dispersal patterns in a mosaic of breeding habitat, summer habitat and
non-inhabitable land. It uses raster-based GIS-maps with information on habitat type, quality and
altitude as input. An additional information layer contains data on observed frog populations in the
survey area. Furthermore, important life history parameters of the Moor frog are used for the
population-based simulation and information about movement patterns of the Moor frog is used in
the individual-based simulation. The model computes a landscape specific index of connectivity
(Hanski’s metapopulation capacity) and simulates population dynamics over time as well as the
pattern of colonisation, extinction and recolonisation of breeding ponds. In addition, the model
simulates the movement paths of the frogs. This approach will make it possible to assess the effect
of road projects on landscape connectivity and population dynamics. It will also be possible to
evaluate the effect of conservation measures such as establishment of movement corridors, buffer
zones, road passages and new habitat areas, enhancing the utility of the model as a management
tool in Environmental Impact Assessments on Annex IV species.

**WE3**
**Ecological impacts of transportation network on wildlife, key biodiversity areas and
protected areas of Turkey**
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Keywords: Turkey, Key Biodiversity Areas, fragmentation, mammals, transportation network

Transportation infrastructure affects wildlife populations and may result in habitat fragmentation,
loss of critical wildlife habitats and populations. Road network may act as a barrier for wildlife
populations but also act as a vector to spread different kinds of pollution (chemical, light, noise
etc.) as well as wildlife diseases, invasive and alien species. Turkey is unique in Europe by being
located between Europe and Asia and being at the junction of 3 global biodiversity hotspots:
Mediterranean, Caucasus and Irano-Anatolian. In addition, there are 305 Key Biodiversity Areas
(KBAs), out of which 95 have global importance for mammals. KBAs are selected by using
standard, globally applicable criteria considering the distribution and population of species for
species groups: Mammals, amphibians, reptiles, birds, freshwater fish, butterflies, dragonflies and
plants. Key Biodiversity Areas also consider the susceptibility of habitats to fragmentation in
species context therefore KBA concept is relevant to transportation infrastructure. The
transportation in Turkey heavily depends on road network which currently includes 62.023 km of
roads and 10.991 km of railway. The road network and traffic intensity is increasing since Turkey is
a developing country with a young and increasing population relative to the countries in Europe.
The effect of current road network on habitats and wildlife populations is unknown due to lack of
research and national policy for transportation focuses on mainly improving the current roads and
establishing new ones. Therefore, there is a need to assess the current road network in relation to
its role in fragmentation of wildlife populations and habitats. From this point of view, we present an
overview of the major ecological impacts of transportation infrastructure upon wildlife and their
habitats, with a particular focus on the distribution of key species groups and Key Biodiversity Areas and protected areas of Turkey.

**WE4**  
**Roads and fragmentation of wild reindeer habitat in Norway: Consequences of the development of infrastructures for conservation**  
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**Keywords:** road, reindeer, movements, trajectory, habitat connectivity

Movement may be the most salient feature of the ecology of reindeer, as these group-living mammals are able to perform among the longest overland migrations in the world between summer and winter grazing areas. Before the industrial development Norwegian wild reindeer, *Rangifer tarandus tarandus*, were grouped into two-three large population units which performed extensive annual migrations over longer distances between adjacent mountain systems. Due to the development of roads, infrastructures and human disturbance, Norwegian reindeer are now divided into 23 more or less isolated populations. We studied the effect of a road dividing in two the annual range of one of these sub-populations on migration and movement patterns of reindeer. We used radio-tracking data of 10 individual female reindeer equipped with GPS collars between 2002 and 2010; one location/3 hours was recorded. We calculated trajectory parameters such as the Step Length SL, Turning Angles TA, and the Net Square Displacement NSD, and investigated variation in these parameters when reindeer approached and crossed the road. Reindeer did cross the road twice a year to migrate between the summer and the winter range, but trajectory analyses showed that the movement patterns were clearly affected by the presence of the road and of the human disturbance associated to it. In particular, when crossing the road the SL increased to reach the highest values recorded during the 45 days preceding or following the road cross. Similarly, the analysis of TA indicates that movements were significantly more directed during the crossing than in the preceding or following 45-day period. Finally, the analysis of NSD indicates that reindeer spatial behavior changed while the animals approached the road, and suggests that this obstacle delay the arrival to the traditional calving ground. Potential implications for conservation are discussed.

**WE5**  
**Effects of the Transylvanian motorway on droving of livestock**  
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**Keywords:** Barrier effect, Grassland, Livestock, Motorway, Viaduct

The network of motorways are presently in a dramatic increase in east Europe, to the benefit of transportation and traffic safety, but with potential negative effects on landscape connectivity. Romania are internationally recognized for its large areas of high nature value grasslands, where the biodiversity is to a large extent depending on traditional land use, including droving of livestock in various spatial and temporal scales. Mobility in the landscape is an expected prerequisite for the continuation of such droving practices, and thereby also for the conservation of the outstanding grassland biodiversity. We studied the effects of the Transylvanian Motorway on traditional droving. The study was conducted along the first operating section of the motorway (42 km), passing through an agricultural landscape in the foothills of the Western Carpathians. We mapped previous and current land use and drover routes in the vicinity of the motorway, based on official land use records, interviews with officials and animal keepers, and field observations. To a large extent, the motorway line coincided with previous borders between land use administrative units, over which few livestock movements occurred even before the motorway was constructed. In other parts, livestock (sheep, cattle, water buffalo and horses) were regularly driven under the motorway through the many large viaducts. Some local adaptation to the motorway barrier was recorded, for example a slight re-routing of movements traversing the motorway corridor, relocation of sheep folds, or adjustment of land use administrative borders. The motorway could have caused some additional land abandonment, but the actual effect was hard to establish due to
the highly variable agricultural system with frequent shifts in land use. We conclude that the motorway will not have a dramatic effect on the traditional use of high nature value grasslands in the area, but the situation may be different in a less hilly region, where fewer viaducts are constructed.

**Eco**

**Ecological networks and corridors as tools for defragmentation**

**WE6**

**Migration corridors for large mammals in the Czech Republic and their linkages to neighbouring states**

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**Keywords:** migration corridors, large mammals, migration, international connection

Landscape fragmentation and habitat alteration due to growing anthropogenic impacts and especially by the transportation infrastructure and settlements is a serious problem at present time. One of the most affected vertebrate species are large mammals, because of their large territory area requirements and inclination to undertake long distance migration. As a target species that have been taken into account within the project are the European Lynx (*Lynx lynx*), the Brown Bear (*Ursus arctos*), the Grey Wolf (*Canis lupus*), the Eurasian Elk (*Alces alces*) and the Red Deer (*Cervus elaphus*). Migration corridors on the Czech territory have been identified on the basis of current and historical occurrence and migration data of focal species. The axes of migration corridors have been preferably delineated in concordance with known habitat preferences for forests and other wooded areas. In addition, critical places with barrier effect along each corridor were described. Main purpose of this project is to ensure migration permeability for large mammals with crucial respect for proper cross-border continuation of migration possibilities to neighbouring states.

**WE7**

**Habitat suitability models as a tool for designing wildlife corridors in the Czech Republic; synthesis of two different approaches**

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**Keywords:** habitat suitability models (HSM), wildlife corridors, large carnivores, GIS

Habitat suitability modeling based on assessment of statistical relationships between occurrence data and underlying environmental conditions is increasingly used to predict spatial patterns of potential distribution of target species. In case of large carnivores in the Czech Republic, where only „presence-data“ were available, two different method were tested. Mahalanobis Typicality, included in Land Change Modeler for ArcGIS (ESRI), expresses the likelihood that a set of environmental variables at specific location is typical to a known location of the species (Sangermano & Eastman 2007). Second algorithm Environmental Niche Factor Analysis (ENFA) integrated in BIOMAPPER software, compares in the multidimensional space of ecological variables, the distribution of the localities where the focal species were observed to a reference set describing the whole study area (Hirzel et al. 2002). Outputs of both modeling approaches are maps of habitat suitability for target species scaled from 0 to 100%. Resulted maps were compared in Geostatistical Analyst (ESRI) and used for definition of core zones, stepping stones and migration corridors forming continuous wildlife network. Core zones were defined as large areas of present or potential occurrence of focus species, reflecting the minimum size of their home ranges. Stepping stones were defined as smaller areas of suitable habitat appropriate for temporal species occurrence. All these refuges were interconnected by migration corridors according to computed habitat suitability.
From Patchwork to Network: Results peer exchange De-Fragmentation inside ECONAT

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Keywords: infrastructure, connectivity, wildlife passage, ecoducts, road ecology, international cooperation

ECONAT 2000 has been developed to promote the exchange of best practice and experience for implementing Natura 2000 and its harmonization with economic developments. The aim is to enhance trans-boundary and cross-sectoral cooperation by exploring in greater detail how the 'legal', 'ecological' and 'economic' targets in the Habitats and Birds Directives are applied in practical cases. The ECONAT 2000 network originally was an initiative of the Dutch 'Rijkswaterstaat'. They established an international exchange of experiences in the field of 'Natura 2000 and economic developments' with France (L'Atelier Technique des Espaces Naturels), UK (Natural England - Nature Conservation Agency in England) and the NLWKN in Germany. Please find more information about the network and its activities on http://econat.n2000.fr/home.

ECONAT organised in April 2010 in Utrecht (NL) a peer exchange around de-fragmentation. The results of this meeting were presented in the general conference in June in Schneverdingen (Germany). The results are combined in the poster. In summary: De-fragmentation of linear infrastructure is one of the instruments to come from patchwork of isolated nature areas to a real network of Natura 2000 sites.

Defragmentation approaches for existing transport networks

Gap analysis in road permeability - towards a mitigation action plan for wildlife

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Keywords: de-fragmentation, barrier effects, traffic mortality, mitigation action plan, transport infrastructure, ecological impact, mitigation, GIS, wildlife passage.

Existing road and rail networks can comprise significant movement barriers to wildlife which may adversely affect species management and conservation. Mitigation is possible, but it may not be self-evident where and how remedying measures should be taken. We developed a pragmatic GIS based approach to help the Swedish Road Administration identifying potential deficiencies in habitat connectivity for larger wildlife caused by the existing infrastructure network and setting up a mitigation action plan to resolve important barriers. The approach employed multiple steps: 1) We mapped potential barriers based mainly on traffic and road characteristics combined with road safety policy. 2) We evaluated existing conventional bridges and tunnels with respect to their probable use by wildlife and estimated their remedying effect on the identified road barriers. 3) We developed criteria for weighting mitigation need and feasibility of unresolved barriers in dialogue with regional and local experts, engineers and land owners. 4) The criteria included various biological, ecological, administrative as well as practical concerns and were used in a mitigation action plan by the Road administration. In our paper, we focus on the GIS work, its fundamental assumptions, important practical simplifications and implementation barriers, which, inevitably, produce rather pragmatic results. We present its application to the western administrative region of the Road Administration and along the European highway E4 in particular.
WE10
Strategic solutions for defragmentation of a very dense area
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Keywords: Defragmentation, strategic solutions, impact of recreation, ecoducts, ecological network

The Utrechtse Heuvelrug is a forested area in the Netherlands that is highly fragmented by roads, buildings, military installations and recreational areas. This area provides important habitat for different species of woodland and heathland ecosystems and harbors a refuge for some of the Netherlands rare species.

The challenge comes from the need to address multiple habitat defragmentation issues for a single area. Different strategies exist to develop solutions and different government agencies and authorities must work together to break the landscape barriers and restore permeability. In order to connect fragmented areas it is necessary to build six overpasses on highways and railroads, defragmenting the barrier effect of at least twelve regional roads, and take additional measures along multiple local/community roads. At the same time, the ecological network must be reinforced with conservation zoning for recreational and developed areas; otherwise the ecological capacity of the landscape would be insufficient and the measures taken would become inadequate. The poster presentation will illustrate strategies for just a few of the defragmentation solutions in the Utrechtse Heuvelrug region. The examples contain:

- A case study concerning the zoning of recreation in the proximity of an ecoduct. Within a distance of 500 meters of an ecoduct that is going to be built in the next few years, there are two campgrounds and a dense network of recreational paths. In this study the impact of recreation is studied and boundary conditions of the land use are identified;
- An exchange of urban and nature areas and the development of air base Soesterberg. This airbase is recently abandoned and turned over to the regional government. Redeveloping this area means a great opportunity to develop ecological corridors and restore the ecological network;

Several mitigation measures. In the years to come six large ecoducts and several small over- and underpasses are going to be built. The poster presentation shows some examples and the connections between all of the measures. It also shows some of the first results.

Transport corridors as habitat

WE11
Roadside vegetation in Mediterranean wetlands: defragmentating or increasing mortality of birds? Management implications
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Keywords: wetlands, bird mortality, road management, verge vegetation.

One of the challenges for the managers of protected areas is to know the effects of roads on wildlife, especially the mortality produced by traffic. This is an important issue in farmlands that represent the feeding areas for a high percentage of species whose presence led to protection of the area. So far this has been studied little in areas with a high density of roads. Determination of which factors influence the presence of high density of roadkills at local scale, and how they interact with the fauna represent the main basis for optimum management of the issue.

The role of verge vegetation in bird mortality was studied in a road that crosses a wetland (l’Albufera de Valencia, E Spain) catalogued as a Natural Park and belonging to the Natura 2000 net. Two sections of the road were chosen, one with reeds and associated vegetation on one verge, and another one as control, without vegetation. Bird abundance, density, richness and diversity were studied at different distances from the road once per week between March and November 2009. Bird mortality was monitored along the entire road (5.5 km) twice per week during the same time period.
460 bird roadkills were detected, belonging mostly to Passeriformes (n=262) and waterfowl (n=191). Results show the great influence of the helophytic vegetation in the bird community assemblage, with differences mainly according to phenologic periods.

Mortality of passerines and waterfowl were dependent on the presence of verge vegetation. This proved to be a decisive factor in passerine’s mortality, with greater abundance of birds next to the road, and so the frequency of movement around it.

Presence of vegetation with this structure affected waterfowl during the post breeding dispersion period.

Our results could be used to devise an interesting tool to manage bird mortality in farmland areas surrounding protected areas through the management of verge vegetation.

WE12
Study on some insect groups on Hungarian highways in relation to climate changes
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Keywords: Hemiptera, scale insects, climate change, Athen-Brussel axis.

A detailed study on arthropod communities on highways was started in Hungary to determine indicator insect species and to understand insect movement on the highways. We also made some surveys till Athens (Greece), Vienna and Bratislava, which are also important points for study of some of our indicator species. These surveys concentrated the Athens-Brussels and Rome-Kiev axis of Europe. The changes of insect communities on these axis could serve as an insect thermometer, to indicate the effect of climate change on insect species distribution. In Hungary, 53 points were studied in detail on highways, including M0, M1, M3, M5 and M7. In the present work we show some results of the studies on scale insects. Number of scale insect species found on Hungarian highways is 102 which is 53,68% of the Hungarian scale insect fauna and much more than expected. Among these insect species, there are several new for Hungarian fauna, and there is a protected species, as well. Some species occurred at too high population densities on sown grasses. It was determined that the infestation on woody plants was also extremely high in some places, too. The heavy infestation of young trees by insects (conifers, ashes, thuyas, junipers, prickwoods, etc) at newly opened highway stops indicates that the planting materials were already infested. We identified new sites in Hungary during the pheromone trapping of white peach scale (Pseudaulacaspis pentagona). The number of males on highways was much lower compared to the ones in the towns. Our data support the assumption of spreading white peach scale by vehicles (“transport vector”). The three studied in detail invasive species of Mediterranean origin (Planococcus citri, P. ficus and Pseudococcus comstocki) were not detected on highways so far. However some new Mediterranean species as Carulaspis minima or, Dimargarodes mediterraneus appeared in some places.

WE13
Fragments of steppe vegetation in roadsides and railway verges in the Great Hungarian Plain
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In agricultural landscapes of the Great Hungarian Plain the original vegetation often survived only in verges (boundaries, roadsides, field margins). Verges are few (on average 2-15, max. 50) meters wide lawn strips running along roads, railways, borderlines and ditches. Two main types of the verges can be distinguished in the landscape. The primary verges take a slice of the original vegetation with several protected or endangered plant species of Pannonian loess steppe. The secondary ones are abandoned from arable field, valuable species are only rarely found on these habitats. Our study was undertaken in the Csanádi-hát loess region (SE Hungary) (approx. 940 km²). During the 10-year long investigation in each mapping unit of the Central Europaeen Flora Mapping System (approx. 6.5×5.5 km) the average number of the protected plant species was 5.5. Among these species 1.0 (18.6%) species was found only in coherent areas (meadow, forest, arable land etc.), 0.4 species (6.6%) occurred both in coherent areas and verges and 4.2 species (74.9%) occurred only in verges. In the Csanádi-hát region 90-100% of populations of the protected plant species Adonis vernalis, Ajuga laxmannii, Anchusa barrelieri, Clematis integrifolia, Inula germanica, Oxytropis pilosa, Prunus tenella, Silene bupleuroides and Vinca herbacea were
found in the verges. At present, these fragments are in general not protected – in the study area in each mapping unit of the flora mapping system 71.0% of the protected plant species was found in unprotected verges only. These narrow grassland fragments are supposedly also of great importance in other loess lowland areas (e.g. Central and E Hungary, W Romania, N Serbia). The verges are highly endangered because of lack of treatment (mowing, grazing), shrubs, ploughing and pollution. The preservation of the steppe fragments of verges needs new nature conservation strategies in the Pannonian Biogeographical Region.

WE14
How contribute the Service Areas on Polish motorways to the diversity of flora and vegetation?
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Keywords: flora, plant communities, service areas, motorways

Motorways as linear objects form a corridor suitable for migration of different species both in the time of construction and during the exploitation. The network of motorways is in Poland still very scarce and counts ca 763 km. There are two not yet finished motorways running in the West-East direction (A2 – 253,4 km, and A4 – 420,4 km) and one in the North-South (A1 - 90 km).

The aim of this study, conducted in 2010, was to analyze the spontaneously occurring plant species and communities in the service areas along above mentioned existing motorways in order to state whether the flora and vegetation show any particular traits and if their composition reflects the specificity of geobotanical region, period of functioning of the motorway and type of the service area. The service areas, the only places along the motorway where travelers can stop, get out of the car and rest, are possible centers for spreading of new elements of the flora. Depending on the management, they also contain some elements contributing to the comfort of resting of travelers (patches of natural greenery, ponds etc.). Therefore the analysis focused on two groups of species: invasive newcomers, possibly spread along motorways and native elements still present despite transformation of habitat connected with motorway construction. The intensive management of service areas leaves only little space for development of plant communities. Their number is very low, but still shows some regularities, reflecting the habitat diversity, type of surrounding landscape and intensity of management.

Case studies: mitigation and monitoring

WE15
Ecological highway development in the area of Piacenza, Cremona and Brescia
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Keywords: Highways, environmental compensation, ecological mitigation

Autostrade Centro Padane (ACP) is the Society which manages the A21 highway, between Piacenza, Cremona and Brescia, in the north of Italy. From many years, ACP projects and builds new highways (Ospitaletto-Montichiari, Cremona-Mantova, etc.) in the largest respect of environment and ecological networks.

With this aim, a lot of innovative interventions have been applied in the ordinary and extraordinary activities.

Large farming areas have been bought and changed into woods, wetlands or natural ecosystems to restore the ecological damages induced by new highways. This process of ecological compensation usually goes through before the real highway construction (e.g. the Park of Mella River, near Brescia).

An original kind of vegetal barrier, the so-called “shaped roof” hedge, has been planted for a depth of 15 meters from the asphalt to reduce air pollution and crops contamination in the fields close to highways. Along the escarpments of new motorways, a lot of seedlings have to be placed to reduce landscape and environmental impacts (e.g. 160.000 trees for 20 km of new roads, between Azzano Mella and Montichiari).
New and specific wetlands have been created, with a large use of grasses, trees and natural soil, to prevent water contamination close to the most busy areas (parking lots and toll booths). The particular kind of pollution, generated by the vehicular traffic, induces to innovative technical solutions (e.g. the new motorway station of Brescia Sud).

At last, part of the technical buildings of the new (and first) regional motorway of Lombardy, the Cremona-Mantova, will be supplied with renewable energies. Contracts between farmers and the managing Society will ensure about huge crops of maize for the biomass energy plants.

WE16
Long time monitoring of biodiversity on D4707 motorway
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Keywords: Long time, monitoring, biodiversity, ecoduct, impact.

Expressway and motorway roads are often in a collision with migration tracks of various fauna. Monitoring of fauna behaviour is very important precaution of protection. Localization, behaviour and direction and time of migration are among investigated factors. The risk of fauna-vehicle collision should be reduced. Monitoring of fauna behavior can be performed by classical ways and by using camera system. As a part of research project were long time monitored by the first and the second monitoring method sections D4709.1, D4709.2 and D4704 of newly constructed motorway D47 and route I/11 in Czech Republic. The sections were monitored before and during construction of motorway and now they are monitored during the full operation of the motorway. Results from long time monitoring of mentioned sections will be presebted in a paper and also using this results will be discusses impact of D4707 on the environment.

WE17
Species at risk in Ontario, Canada: habitat fragmentation, a threat to survival
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Keywords: fragmentation, threats, species at risk, mitigation, Species at Risk Act

Ontario is over one million km² in area (i.e., larger in area than Spain and France combined) and has a population of over 13 million people, 80% of which are found in urban centers, most of which are located within the Great Lakes Basin. Over 220 federally-listed species at risk occur in Ontario, and the majority of these species also occur within the Great Lakes Basin. The human population continues to grow in Ontario, as does the number of federally-listed species at risk, and habitat loss and fragmentation due to development and associated road infrastructure remain key threats to the survival of wildlife species in Ontario. Declining numbers of herpetofaunal species found in urban centres and increased incidents of wildlife road mortality are documented and there is growing public concern regarding the protection of wildlife in natural habitats adjacent to road networks in southern Ontario. Stewardship programs are underway and various tools are being developed and implemented in Ontario to mitigate habitat fragmentation effects including the development of a ‘How Much Habitat is Enough?’ guidance document; habitat improvement projects (e.g., creation of nesting sites and hibernacula, use of fencing to prevent access to major highways); road ecology workshops led by key non-government groups; and the use of wildlife passages. Although awareness is increasing surrounding the effects of habitat fragmentation on wildlife species in Ontario, there is still a need to prevent further habitat loss and fragmentation in Ontario landscapes and incorporate effective protection and mitigation measures into landuse planning activities, environmental assessment reviews, and provincial and federal permitting processes. This presentation will focus on some species at risk threatened by road mortality and mitigation measures underway to protect these species and their habitats in Ontario.
**WE18**

When fencing and translocation is the right measure to prevent road-related amphibian decline: mass migration of Lissotriton and Triturus newts at Lake Kapszeg

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Keywords: *Lissotriton vulgaris*, newt, road mortality, fencing, translocation, Hungary

Solving wildlife - infrastructure conflicts requires the consideration of diverse strategies to find the best local solutions. Lake Kapszeg is an abandoned stretch of the River Danube in the southern part of Hungary. Today, it is protected as it supports a great diversity of natural values. In autumn, 2004, an intensive autumn migration of *Lissotriton* (*Triturus*) *vulgaris* from Lake Kapszeg to an area that is an arable field today separated from the reserve by two busy roads was detected. As building a permanent mitigation measure would have been an expensive and questionable solution, the translocation of the animals to safe hibernation sites was arranged. A 240 metre temporary mitigation measure was set up along the Kapszeg Nature Conservation Area at the appropriate section of the 5112. road between Szekszárd and Mózs from 2005. It consisted of plastic fences and buckets dug into the soil in approximately every 15 metres. The buckets were emptied two or three times a day depending on the intensity of the migration. Altogether nine amphibian taxa were recorded during the study period. Unlike most other amphibian migration corridors, where anurans predominate, the ratio of tailed amphibians was over 90% with *Triturus vulgaris* as the most common species. In the first year more than 42,000 amphibians were moved away from crossing two busy roads into a safe hibernation area along other parts of Lake Kapszeg. This number decreased to 12,000 in 2006, 8,100 in 2007 and even lower in 2008-2009. These changes seem to have two reasons, the lowering of the water table in Lake Kapszeg and the translocation of mainly juvenile newts.

**WE19**

Wetland creation and restoration near the Bothnia Line railroad – a pioneer project in ecological compensation for northern migrant birds

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Keywords: ecological compensation, migrant birds, Natura 2000, railroad, wetland,

The Natura 2000 site Ume River Delta and Plains (SE0810475) is a major staging site for wetland birds along the Bothnian flyway. It is regularly hosting at least 41 species of birds included in the EU Birds Directive, annex 1. To compensate for possible negative effects of the Bothnia Line railroad passage through the Natura 2000 site, large-scale restoration and construction of wetlands has been undertaken in adjacent areas. The aim is to create new habitats for resting wetland birds during spring migration, mostly Whooper Swan (*Cygnus cygnus*), Common Crane (*Grus grus*) and various geese and duck species. The compensation measures include pumping of freshwater onto arable fields to create temporary spring floods, restoration of moist estuarine meadows, creation of shallow freshwater wetlands and growing of crops favoured by the birds. In all, the compensation areas cover an area of 500 hectares, all of which will be included in the Natura 2000 network and protected as nature reserves. An extensive, long-term monitoring programme will follow the compensation areas to control their ecological function. Although the compensation areas were not yet fully functional in spring 2009, they were already used by thousands of wetland birds.

The project is the first large-scale example in northern Sweden of wetland restoration specifically aimed at migrant wetland birds. The conclusions from the project will probably prove very useful when planning ecological compensation in future infrastructure projects.
**WE20**

**Living in the road vicinity – unique habitat of Zamenis longissimus in the Ohře River Valley, the Czech Republic**

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Keywords: Aesculapian snake, traffic, barrier, seasonal movements, Zamenis longissimus

The isolated population of Zamenis longissimus in the Ohře River Valley is restricted to only 8 km². The whole population is divided into 25 more or less isolated subpopulations. One of them is situated in a deep river valley in the road vicinity. Dry stone walls along both sides of the road serve as shelter for snakes. During three seasons 36 specimens were captured, individually marked, and released back at the locality. We uncover regular seasonal movements typical for the snake’s life cycle between posthibernation, spring (mating), summer (egg – laying) and prehibernation sites that require to cross the road. Using mark-recapture method 24 adults were recaptured and in 13 cases we detected road crossing. Concerning road mortality we found 18 road-kills during the three-year study. However, 16 of the snakes (89 %) were juveniles or sub-adults. Repeated road crossings and relatively low road mortality of adult animals indicated their safe passing through tunnels. This was later confirmed by a special study. These tunnels with stone walls are remnants of a historical path. They were built to overbridge small periodical streams at a distance of 200m.

The obvious difference between juvenile and adult road mortality might be caused by experience acquired throughout the life. Adult snakes in contrast to juveniles know the tunnels and can use them. High juvenile mortality has lead us to construction of a special barrier at the most risky transect of the road. The barrier directs juveniles and sub-adults into the same tunnels that are used by adults. Since the barrier started working in 2007 the juvenile loss has been significantly reduced. These underpasses are of a high importance for snakes because of their location and stone structure. It is necessary to protect the underpasses from improper repairing or other activities which could negatively influence their function.

**WE21**

**Effects of installing amphibian tunnels and amphibian fence on roads in Poland and Denmark**

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The monitoring of the use of amphibian tunnels and fences in Poland and Denmark is presented on discussed on two lane roads as well as on motorways. The ecological effects as well as the maintainance of different tunnelshape in concrete and and fence systems in concrete, polymeebeton, metal and plastic are presented

The first Polish amphibian tunnels were installed in 2000 in the table Mountains National Park in order to guide tens of thousands of common Rana temporaria and Bufo bufo from the hills to the breeding pond in the valley. The second Polish amphibian tunnels were build on Via Baltica express road near Lithuania-Polish border to in 2002 in order to secure connection an ecological connection between breeding pond and terrestrial habitats for 9 species of amphibians among them 5 listed on the EU habitat directive annex IV (Bombina bombina, Pelobates fuscus, Triturus cristatus, Rana arvalis and Rana lessonae).

In Denmark the first amphibian tunnels-fence system was build in 1998 targeted 5 species among them Pelobates fuscus and Rana arvalis. In 2008 the Danish motorway build a demonstration project with 4 types of amphibian fence for the test of the ecological effects, test of longetivity of materials as well as the test in maintaincecost of the material and maintaincecost of the vegetation along the the fence types. The system was build were large populations of Rana arvalis, Rana temporaria, Bufo bufo, Triturus cristatus and Triturus vulgaris occur.
Fences and Animal detection system

WE22
Monitoring the effect of a screen installed to mitigate the impact of a high speed railway on bats
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Keywords: Bats, High Speed Railways, Monitoring, Mitigation measure

A new 160-km stretch of high speed railway (HSR) between Córdoba and Málaga (Andalucía, southern Spain) began operation at the end of 2007. As established during the Environmental Impact Assessment (EIA), the public company ADIF that is responsible for the construction and maintenance of the infrastructure undertake a monitoring project to analyse the effectiveness of the measures taken to mitigate the impact of the railway on birds and mammals. The project is being carried out by a team of experts in bats and wildlife management and will be extended until the end of 2011.

Close to the infrastructure is a horizontal well that houses a colony of cave-dwelling bats. One measure that is being monitored is the screen that has been installed to prevent bat mortality. This screen is a 5-meter high wire fence that runs for 110 m along the tracks on an embankment built between two tunnels and with an underpass (8x6.4 m).

In May 2009, data from the colony were recorded using infrared video cameras and bat detectors. The effects of the fence on bat flight were investigated by measuring bat flight activity in seven sampling stations. Two infrared video cameras were used to study bat behaviour close to the fence.

During the study, 1,861 bats from 6 species of the genera Rhinolophus, Miniopterus and Myotis were recorded leaving the roost. 544 individuals were registered crossing the HSR by passing either above a tunnel located close to the roost (60.7%) or through the underpass below the embankment (39.3%). With respect to the effect of the fence, from 70 images analysed most bats crossed over the fences or flew parallel to them. Less than 5% of the bats flew into the area between the fences on each side of the tracks, and were thus at risk of collisions with trains.

According to our data, the bat colony has increased to 1,127 individuals in comparison with data recorded in 2004 during the construction of the infrastructure. Hence, the population that existed before the railway was built has probably been recovered. In addition, it seems that the fence has helped to prevent collisions with bats. The research that will be carried out in the next two years will provide more conclusive results, and will focus on juveniles’ behaviour in particular.

WE23
Highway fencing and moose migrations in northern Sweden
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Keywords: Barrier, Moose migrations, Road fencing

We studied the effects of road fencing and snow depth on moose migration in northern Sweden. A coastal highway, perpendicular to the expected migration direction for moose, was fenced. Snow tracking before and after fencing showed that the barrier effect of fencing was about 80 %. In the first years after fencing, large numbers of moose accumulated along the road, particularly during early winter, causing severe local damage to pine plantations. The fenced road prevented moose in the dense population found along the coastal strip of land to transpose to inland locations. But also
after fencing, moose occasionally passed the road at available openings at road crossings and
lakes, and the number of such successful crossings increased slightly with time. In addition, the
road manager responded to a major moose winter accumulation by temporarily opening the fence,
to let the animals pass. Observations of marked moose showed that individuals “trapped” on the
coastal side moved frequently along the coast and between islands in the archipelago, thereby
forming an elongated but continuous population. A meta-analysis of moose migration studies
showed that the migration distance, and probably also the proportion of migrants in the
population, was higher in areas with deeper average snow layer. The results suggest that
landscape fragmentation by roads can be a problem to moose demography and management. The
study suggests that snow depth can be used as an indicator for barrier effects by roads on the
moose population. Our study highlights the importance of maintaining landscape connectivity for
large animals, particularly in times of environmental change, when dispersal and migration
mechanisms are expected to be of vital importance for population stability.

WE24
Efficiency of odour repellents on free ranging red deer (Cervus elaphus) and roe deer (Capreolus capreolus): a field test
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Wildlife-vehicle collisions pose an increasing problem for species conservation and traffic safety as
road and railway density and traffic intensity increase. Odour repellents may reduce ungulate
browsing damages and has also been suggested as a method to reduce collisions between
ungulates and vehicles. Scent-markings applied over short distances have been reported to reduce
collisions between moose (Alces alces) and trains. Repellents are presumed to make ungulates
more alert and vigilant. However, animals tend to habituate to remedies aimed at affecting animal
behaviour near roads and railways, e.g. wildlife reflectors and sound scares, and few products have
been thoroughly tested. We examined the effect of two odour repellents (Wolf Urine Deer Repellents, Trident, USA and Mota FL, Bayer, DK) on free ranging red deer (Cervus elaphus) and
roe deer (Capreolus capreolus) experimentally. The effectiveness of the odour repellents was asses
by comparing visitation rates to sand bed arenas for a 7 day period before and after application of
repellents in small containers at nine arenas. Deer visitation rates were also counted
simultaneously at nine control arenas. Neither Wolf Urine nor Mota FL reduced deer visitation rates
at the arenas. A quick habituation to the repellents or lowered sensitivity to predator odours due to
the lack of natural predators can explain the inefficiency of the tested repellents to the ungulates.
We conclude that these repellents have limited effect as a mitigation method to reduce the number
of deer-vehicle collisions.

Trans European wildlife network

WE25
Importance of landscape connectivity for wolf and lynx in Bulgaria
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Keywords: wolf, lynx, connectivity, highways, Bulgaria

Following the social changes in Bulgaria at the end of 90ties, there was a rapid development of the
human related infrastructures. These changes were following two lines – expansion of urban zones
and the need of improvement of the road network. The poster presents the use of modelling
approach for identifying the connectivity and level of fragmentation for two large carnivores in
Bulgaria – the wolf and the newly re-established after half a century extinction lynx. The models
showed a great deal of connectivity for both of the species. Yet, the overlay with the existing road
network and newly planned highways showed critical areas where the highways can cause
significant fragmentation in the landscape in the future. Additionally, the future development of
the urban area along these highways can furthermore additional fragmentation. These and other
connectivity aspects are further shown and discussed in the poster.
WE26
Patterns of mammals mortality on main roads in the Northwestern Poland
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Keywords: ungulates, carnivores, traffic mortality, temporal patterns

We have analyzed a database of mammals killed in traffic accidents on national roads and highways in the Zachodniopomorskie Province (NW Poland). Animals were recorded by the staff of the National Roads and Highways Agency during daily inspections of 1043 km of roads. Totally 1263 road casualties were recorded from September 2005 to December 2009: 1204 mammals identified to species or genus, 52 unidentified animals and 7 large birds (sparrow hawks, owls and ducks). Amongst mammals the following 16 species were revealed: fox *Vulpes vulpes* (33.5%), domestic cat *Felis sylvestris catus* (13.4%), roe deer *Capreolus capreolus* (10.5%), wild boar *Sus scrofa* (9.7%), raccoon dog *Nyctereutes procyonoides* (7.9%), domestic dog *Canis lupus familiaris* (7.6%), badger *Meles meles* (7.6%), marten *Martes* sp. (3.1%), European hare *Lepus europaeus* (3.0%), hedgehog *Erinaceus* sp. (1.4%), red deer *Cervus elaphus* (0.8%), polecat *Mustela putorius* (0.4%), otter *Lutra lutra* (0.3%), beaver *Castor fiber* (0.2%), weasel *M. nivalis* (0.2%), red squirrel *Sciurus vulgaris* (0.2%), fallow deer *Dama dama* (0.1%) and American mink *M. vison* (0.1%). We have observed substantial changes in the species composition of mammals killed in traffic accidents among seasons, as well as different patterns of mortality of every species throughout a year. For wild boars 4.3% of cases involved groups of animals (2-6 individuals).

WE27
Migration corridors for large carnivores in the West Carpathians, Czech Republic – current threats and conservation activities
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Keyword: migration barriers, habitat fragmentation, mitigation measures, monitoring, large mammals

The Beskydy Mountains located on the Czech – Slovak border function as an important gateway for wolves, lynxes and bears. Their populations recovered in last 50 years by recolonisation mainly from the Slovak Carpathians, but they suffer from illegal hunting and migration barriers. There are three key migration corridors with national or international importance in the West Carpathians: Jablunkov region (1) located on the north part of the Beskydy Mts. is probably the only corridor ensuring direct connectivity among Czech, Slovak and Polish populations of large carnivores. South corridors in Vsetín region (2) connect Beskydy with another mountain range on Czech-Slovakian border (White Carpathians) and with hills continuing to the west. The west corridor located in Moravian gate lowlands (3) is important for migration of large mammals to the Jeseníky Mts. and possible Šumava Mts. / Bavarian forest and other regions with potential presence of large carnivores. The functionality of the key migration corridors is endangered by several factors. The most important is increasing traffic and lacking adequate mitigation measures. The tremendous example is Jablunkov region cut by road with increasing traffic between two new car factories - Nošovice (CZ) and Žilina (SK). No mitigation measures have been realised so far. Similar situation takes place in Moravian gate, where mitigation measures on D47 (D1) highway have been invested non-effectively and possibilities for migration of large mammals are very limited. Second problem comes from planned new industry and build-up areas in relatively cheap agriculture lands, which have worked as passages for animals so far. All key corridors are at least potentially endangered by this factor. FoE CZ conduct monitoring, research and lobby for better protection in decision making process, EIA/SEA procedures and spatial planning. It deals with public awareness and stakeholders' education as well. Concrete examples, achievements and failures are presented.
Friday, 1 October

Plenary session III.

Ecology and Transportation: Trends and Challenges and Opportunities
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Awareness of how transportation systems can affect the natural environment has evolved from the primary focus on animal-vehicle collisions toward more systemic thinking and more coordinated solutions aimed at promoting transportation that is not only safe, but also ecologically sound. A growing community of people, concerned with these matters, is bringing new partnerships, perspectives and resources to bear. Success in this undertaking involves factors in three broad categories: 1) Technical factors which address the effects of roads and transportation systems on organisms, ecosystems and ecological processes, as well as measures that can be implemented to minimize effects. Current trends include: increased attention to multi species approaches; integration of aquatic and terrestrial approaches; more detailed evaluation of crossing structure effectiveness; and landscape scale planning for ecological connectivity. 2) Process factors which address how ecological considerations can be integrated into the processes transportation planning, construction and operation. Current trends here include: expanded institutional frameworks for project coordination; expanded public involvement; initiatives for sustainability as well as climate change adaptation strategies. 3) Catalyzing factors which help build and maintain momentum, affect change, new thinking, and new solutions and partnerships Current trends here include: Increased public interest in road ecology issues; policy direction from government and other organizations; increased academic research focus; and coordinated research strategies.

This discussion provides an overview of the current trends, as well as challenges and opportunities for these factors of Road Ecology in North America.

Transport infrastructure planning in Europe
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We have had six decades of post-war transport development in Europe and the associated environmental dimension has grown into a complex and challenging issue for all concerned.

The growing concern across Europe to halt biodiversity loss has inevitably highlighted the impact of transport networks not least its fragmentation effects.

All three linear surface networks - rail, road and water have had to address the need for accurate and relevant environmental impact assessment and associated good environmental design to achieve acceptability if planning consents are to be forthcoming.

In countries like Belgium, England and the Netherlands the intensity of land use and development poses the greatest challenge to transport network operators. New techniques have evolved to deal with the many environmental effects ranging from air quality to water. This challenge has been reinforced by the EU Directives and increasingly stringent national policies for protecting the natural environment.

The rising awareness of the impact of climate change is driving a need to both mitigate for its future impact by reducing the production of greenhouse gases, whilst adapting to its effects by ensuring that transport infrastructure can cope with a myriad of climatic change effects. These include intense weather effects such as heavy precipitation, very high summer temperatures and periods of spring and summer drought.

The natural environment will be under ever greater pressure so it will become essential to find ways of minimising the effects of transport on habitats and species. Greater connectivity, reduced pollution and in time a reduced demand for transport will be needed.

The future will be characterised by the need for innovative solutions to transport provision accompanied by looking for opportunities to improve the environmental performance of existing railways, roads and waterways.
Trans European wildlife network

Mitigation of negative impact of transport infrastructure on large carnivores in Poland
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Keywords: wolf, lynx, brown bear, roads, ecological corridors, wildlife crossing structures

Poland is inhabited by three species of large carnivores: the lynx, the wolf and the brown bear. Studies on the impact of habitat fragmentation on movement, dispersal, genetic variability and different parameters of population ecology of large carnivores have been conducted for last ten years in Poland. There were several projects focused on creating of a national-wide network of ecological corridors. The most recent one aimed the development of an ecological network linking the most suitable habitats of large carnivores. It includes most of the legally protected forest areas as well as other habitats of great natural values. Defining of the corridors was based on reconstructions of historical dispersal pathways as well as on analyses of current dispersal routes of indicator species (mainly wolf and lynx), but also on results of genetic studies. Recently in most of Polish provinces the regional ecological corridors projects have been already developed or are under preparation. They will be integrated into new spatial management plans. In order to mitigate the disturbance of ecological corridors by transport infrastructure by mid-2009, 48 passages for big and medium sized mammals have been constructed on about 800 km of motorways and 515 km of express roads in Poland. The average width of overpasses ranges from 10 (the oldest) to 45 m (more recent), while 30 to 40 m wide are the most common. The underpasses width varies from 2 to over 500 m when the passage is located under viaducts. The wildlife crossing structures of different shapes and dimensions will be broadly implemented as mitigation measures on roads and railways in nearest future. There are plans to build about 160 large and medium sized passages on new road sections within the next few years. The new overpasses for large mammals will be mostly 50 to 60 m of width. Some other mitigation measures, such as noise screens and ponds with drinking water will be also implemented to improve the quality of habitats for big mammals on sides of new roads crossings large forests tracts.

Using the Brown bear (Ursus arctos) as an indicator species for landscape connectivity - a tool for spatial conservation prioritization
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Keywords: habitat connectivity, fragmentation, transport infrastructure, Brown bear, Romania

Romania hosts natural landscapes outstanding in Europe for their low degree of fragmentation. Alike other new member states of the European Union, Romania currently undergoes a considerable increase in transport infrastructure development. Despite of European Union conservation regulation the danger of underrating landscape conservation requirements in favour of infrastructure development is immanent with periods of industrial improvement. In order to prevent irreversible habitat destruction, a sound balancing of infrastructure planning and conservation issues is required from the outset. The requirements of adequate conceptions range from implementing mitigation measures on regional level to strategies for fragmentation mitigation on national and supra-national level. The maintenance of functional habitat networks is formulated as a demand of the European Union’s conservation regulation. To fulfil the demand means to ensure ecological connectivity for species, communities, and ecological processes. However, implementation of this mandatory demand depends on effective tools for spatial conservation prioritization and on data adequate to represent relevant landscape patterns. Ecological data gathering on a landscape level is complex and costly. Therefore, our research strives to develop operational conservation prioritization schemes based on data sets and information currently available for Romania. In order to evaluate current conservation planning, in a first step we combine data sources for Brown bear (Ursus arctos) distribution – as an indicator species for large connected areas – with existing and planned spatial distribution of nature reserves. This data, interfaced with transport infrastructure (existing and planned) data will provide a first concept of fragmentation “hotspots” on the national level. The result is a scheme that is meant to be
permanently refined by additional ecological and socio-economical data in order to provide a tool for planning and decision making, permanently based on the best available information.

**Green bridges and other structures for permeability of highways in Croatia: Case of large carnivores**

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Zagreb, Croatia

Keywords: Large carnivores, permeability, highways, green bridges, Croatia

The construction of wildlife crossings over highways is already well-established in the Croatian road planning processes and relevant legislation. Only in the mountainous part of Croatia a total of 367 km of new highways was constructed in the period 1999 – 2008. One green bridge was constructed on the Zagreb – Rijeka highway (Dedin, 100 m) and 10 other green bridges on the Zagreb – Dubrovnik highway (120-200 m each). In addition, one big tunnel (Plasina) and 5 viaducts were constructed to mitigate the highway permeability. In total, 25.2% of the Zagreb – Rijeka highway, 13.1% Zagreb – Dubrovnik highway do have structures that allow animal crossings (tunnels, viaducts, bridges and green bridges). We studied the impact of the Rijeka – Zagreb highway through Gorski kotar on large and medium sized mammal movements, and estimated the highway permeability for those animals. The conclusions were that large mammals of Gorski kotar preferred to use wide overpasses (100 m and wider) instead of narrow (10 to 50 m) underpasses. We documented that all large mammals used green bridges on regular basis, but the frequency and patterns of crossings vary during day, as well as between large mammal species and groups. There was strong negative correlation between human passage and passage of large carnivores as well as between passage of large carnivores and ungulate passage, and positive correlation between human and ungulates passage. Therefore, in order to increase usage of green bridges by large carnivores, human influence at green bridges should be eliminated or at least minimized by the enforcement of existing legislation.

**Brown bear connectivity in Bulgaria and the effect of the highways**

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Keywords: brown bear, connectivity, highways, Bulgaria

There are two bear sub-populations in Bulgaria which until recently were through to be isolated – the Central Balkan (Stara Planina) and the Rila-Rhodopean. During a project in the frame of national bear management plan preparation (2005-2008), the current distribution and important connectivity areas for bears were identified and studied in attempt to understand better the threats and other issues for the species in the country. Additionally, an assessment of bear habitat suitability was done for the whole country by the means of inductive modelling, using Mahalanobis distance approach. This theoretical approach was combined with a detailed analysis of field data for the impact of transport infrastructure on the habitat fragmentation. Highways, although currently few in Bulgaria are found to be significant barriers for the free movements of the animals. Out of the two main highways, concerning the bear distribution in the country, Trakia highway being poorly equipped with structures suitable for bear crossing and wide enough habitat corridors leading to them, proved to have the major effect on the bear habitat fragmentation and thus – the two sub-populations isolation. After the accession of Bulgaria in the European Union, there is a pressure for prolongation of the current highways and building new ones (Struma highway), which will also have impact on the bear population connectivity. These highways routes were also analyzed in attempt to propose solutions for dealing with the barrier effect of the highways.

**Workshop: IENE project: Geographic interactive database on fauna passages**

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Over the past three decades, a considerable number of fauna passages, i.e. green bridges, ecoducts, wildlife overpasses, tunnels, etc, has been built across Europe. Only some of these technical measures have been monitored for their usage by wildlife, and experiences on passage
efficacy give a diffuse picture that highlights the significance of environmental factors over the bare design. Engineers and planners rightfully question the recommendations made by ecologists, partly because of economic constraints that require more cost-efficient solutions, but partly also because they are not yet familiar with these kinds of measures. Here, the exchange of knowledge and experience would not only be inspiring and promoting, it is far more a key necessity in the adaptive development in fauna provisions and should be an imperative for expensive investments such as ecoducts. At present, however, there is no concerted and easy way to access international knowledge about fauna passages.

IENE intends to change this by developing an interactive, Wikipedia-like, geo-referenced database on fauna passages that combines the ease of well established and ready-to-use web tools such as Google maps with detailed and validated technical information, including pictures and references. This database and its web-interface shall be maintained by the IENE secretariat in collaboration with a network of editors who help to upload and validate information.

During this workshop, we will present the database application in its present state of development, discuss details and kind of data that can be made available, and begin to establish the editorial network of national experts.

**Workshop: Ecological connectivity - towards a framework for understanding network nature**

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**Invitation to a thought experiment**

During the last centuries European nature has been fragmented by human settlements and infrastructure, but is recently being reconnected by corridors and fauna passages. This is not a return to a former situation, even supposing such a return would be possible in nature, but it is the creation of unprecedented network of “planned” or “designed” nature across Europe. Empirical data and a sound theoretical understanding of this process are required, if only to provide a robust scientific basis to the relevant policy discussions. Furthermore, large amounts of money are involved and the measures taken will influence the European nature for a long time to come. On such a scale, we can assume that European nature will be subject to evolutionary forces and we should face questions like:

- Which species will prosper and which ones will decay?
- Will the ecosystems become more or become less dynamic?
- Will food chains become longer or shorter?
- Will there be more or less migration?
- Will local biodiversity be higher or lower?

Finding an answer to these theoretical questions is no easy matter and therefore we propose to start with an ecological thought experiment. During the workshop we will, together with the participants, build a few ecological scenarios. The organizers will pose a hypothetical situation, after which the participants will be asked to draw from their experience and sketch possible ecological developments. It should be noted that building scenarios is not about predicting the future, but about thought experiments and consistency, regardless of likelihood.

As a result of the workshop, we hope to have a clearer view on the range of possibilities for the future development of European nature. The workshop will draw conclusions relevant for defragmentation policies and, if possible, for a research agenda.
Index of authors

Page numbers: 17-29: in the Programme
30-96: in the Abstracts

A
Abbott, Isobel ..................................19, 42
Abderhalden, Angelika ......................24, 72
Acerbi, Francesco .............................26, 86
Affolter, Dominik .............................24, 72
Akriotis, Triantafylllos .......................21, 22, 58, 62
Allen, Tiffany D.H. ............................24, 76
Alonso, Juan C. ................................51, 56
Alvarez, Georgina .............................20, 49
Anděl, P. ....................................23, 25, 64, 82
Andersen, Poul N..............................27, 91
Andersen, Roy ..................................25, 81
Andreas, Michal.....................23, 25, 64, 82
Arroyo, Natalia ................................20, 52
Ascensão, Fernando..........................17, 31
Augustsson, Evelina.........................24, 76
Avia, Miguel Lizana .........................19, 20, 40, 41, 51

B
Baader, Phil .......................................... 23
Bager, Alex................................ 21, 53, 54
Balfors, Berit...................................18, 38
Banti, Paolo .....................................19, 46
Barbaud, Christophe ..............................17, 31
Beecham, John.................................22, 62
Bekker, Hans ............ 18, 23, 25, 33, 83, 96
Below, Michael .................................23, 63
Benedito, V........20, 24, 26, 52, 53, 73, 84
Bernardo, João...................................17, 31
Bianchin, Sylvi .....................................24, 70
Biserkov, Valko..................................24, 75
Bláhová, A.................................23, 25, 64, 82
Blank, Matt.......................................24, 76
Blaskovits, Zoltán.............................26, 88
Bobek, Boguslaw ...............................19, 42
Bocek, Radomír.................................26, 87
Bojda, Michal ..................................27, 92
Bousbouras, D. .......................23, 25, 69
Brehme, Cheryl S. ..............................19, 45
Briggs, Lars............................26, 89
Bufka, Luděk.....................................25, 82
Butler, Fidelma..................................19, 42

C
Çağlayan, Eray.................................25, 80
Çağlayan, Semiha Demirbaş..............25, 80
Can, Özgün Emre ..................................25, 80
Carol, J. ........................................20, 24, 52, 73
Carvalho, Filipê.................................20, 46
Chouvardas, D. .................................23, 69
Christensen, Jens T.........................27, 91
Chuman, Tomas.................................25, 82
Clevenger, Anthony P. .......................18, 38
Colino Rabanal, Víctor Javier........ 19, 20, 40, 41, 51
Collinder, Per .....................................18, 35
Colomer, Jaume Hidalgo i .................20, 48
Colomer, MGS..................................21, 56
Corpade, Ciprian.............................25, 81
Costa, Mónica .....................................17, 31
Csáthó, András István........21, 26, 55, 85
Csáthó, András János..........................21, 55
Cunnington, Glenn............................18, 36
Da Rosa, Clarissa Alves....................21, 53, 54
Dahlström, Anna...............................23, 67
Dalamagas, Vasilios ..............................21, 58
Dauber, J. .......................................21, 57
de Brito, Gustavo Ferreira ....................21, 53
de Haan, Martijn ..............................18, 33
de Haes, Helias A. Udo.............................96
de Jong, Adriaan ..................................18, 35
de Resende Cardoso, Thálita .................21, 53
de Tejada, S. Romero .........................20, 24, 52, 73
del Real, Javier .................................95
Delgado, Juan D.................................20, 52
Dinetti, Marco.................................20, 25, 48, 79
Dirksen, Jolanda..............................18, 37
Dolan, L.M.J..............18, 21, 23, 35, 57, 69
Domokos, Csaba ..............................28, 94
Dorsey, Benjamin ..............................20, 51
dos Santos, André Luis Pracucci Gomes ..21, 53
Durán, Jorge.....................................20, 52
Dutsoev, Alexander............................27, 28, 91, 95

E
Elmeros, Morten .............................27, 91
Emmerson, M. .........................18, 21, 23, 35, 57, 69
Enetjärn, Anders..............................26, 88
Esswein, Heide.................................23, 64
Evangelou, C...................................23, 69
Everaert, Joris.................................21, 59

F
Fahrig, Lenore.................................17, 18, 29, 36
Falldorf, Tobias ...............................25, 81
Fernández-Bou, M. ..................20, 24, 26, 52, 73, 90
Findlay, Scott.................................18, 36
Finnerty, E.J. ...................................23, 69
Fisher, Robert N..............................19, 45
**Index of authors**

<table>
<thead>
<tr>
<th>Index of authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jullien, A.</td>
</tr>
<tr>
<td>Juárez, Esther</td>
</tr>
<tr>
<td>Jooss, Rüdiger</td>
</tr>
<tr>
<td>Jones, Darryl</td>
</tr>
<tr>
<td>Jávor, Benedek</td>
</tr>
<tr>
<td>Freitas, Simone R.</td>
</tr>
<tr>
<td>Gélbrink, Owe</td>
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<tr>
<td>Gémesi, Dorottya</td>
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<td>Georgiadis, L.</td>
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<tr>
<td>Giannakopoulos, Alexios</td>
</tr>
<tr>
<td>Gielen, E.</td>
</tr>
<tr>
<td>Ginot, A.</td>
</tr>
<tr>
<td>Godes, Konstantinos</td>
</tr>
<tr>
<td>Gorčičová, I.</td>
</tr>
<tr>
<td>Greenwood, Mark C.</td>
</tr>
<tr>
<td>Grilo, Clara</td>
</tr>
<tr>
<td>Guinard, Eric</td>
</tr>
<tr>
<td>Gunson, Kari E.</td>
</tr>
<tr>
<td>Gylje, Sofia</td>
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<tr>
<td>Freitas, Simone R.</td>
</tr>
<tr>
<td>François, D.</td>
</tr>
<tr>
<td>Foral, Mojmír</td>
</tr>
<tr>
<td>Foglar, Marek</td>
</tr>
<tr>
<td>Folkesson, Lennart</td>
</tr>
<tr>
<td>Foral, Mojmír</td>
</tr>
<tr>
<td>François, D.</td>
</tr>
<tr>
<td>Freitas, Simone R.</td>
</tr>
<tr>
<td>García, Francisco J.</td>
</tr>
<tr>
<td>García-Ráfols, Ruth</td>
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<tr>
<td>García-Suikkanen, C.</td>
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<td>Gebrink, Owe</td>
</tr>
<tr>
<td>Gémesi, Dorottya</td>
</tr>
<tr>
<td>Georgiadis, L.</td>
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<td>Giannakopoulos, Alexios</td>
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<td>Gielen, E.</td>
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<td>Ginot, A.</td>
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<td>Godes, Konstantinos</td>
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<td>Gorčičová, I.</td>
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<tr>
<td>Greenwood, Mark C.</td>
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<td>Grilo, Clara</td>
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<td>Guinard, Eric</td>
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<tr>
<td>Gunson, Kari E.</td>
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<tr>
<td>Gylje, Sofia</td>
</tr>
<tr>
<td>Hagiwara, Toru</td>
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<td>Haller, Ruedi</td>
</tr>
<tr>
<td>Hara, Fumihiro</td>
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<td>Harrison, Simon</td>
</tr>
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<td>Helldin, J-O.</td>
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<td>Heltai, Miklós</td>
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<td>Hernández, C.</td>
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<td>Hlaváč, V.</td>
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<td>Houlaian, Jeff</td>
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<td>Huber, Djuro</td>
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<td>Huele, Ruben</td>
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<td>Huijser, Marcel P.</td>
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<td>Hagiwara, Toru</td>
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<td>Haller, Ruedi</td>
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<tr>
<td>Huele, Ruben</td>
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<tr>
<td>Huijser, Marcel P.</td>
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</tbody>
</table>

**Index of authors**

<table>
<thead>
<tr>
<th>I</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iliopoulos, Yorgos</td>
</tr>
<tr>
<td>Ireland, Dave</td>
</tr>
</tbody>
</table>

**Index of authors**

<table>
<thead>
<tr>
<th>J</th>
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<tbody>
<tr>
<td>Jaeger, Jochen</td>
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<td>Janča, Martin</td>
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<td>Janoušek, Karel</td>
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<td>Jávor, Benedek</td>
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<td>Jędzzejewski, Włodzimierz</td>
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<td>Jones, Darryl</td>
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<td>Juárez, Esther</td>
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<td>Julliard, Romain</td>
</tr>
<tr>
<td>Jullien, A.</td>
</tr>
</tbody>
</table>

**Index of authors**

<table>
<thead>
<tr>
<th>K</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kaczmarczyk, Eva</td>
</tr>
<tr>
<td>Kaphegyi, Thomas A.M.</td>
</tr>
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<td>Karadeniz, Nilgün</td>
</tr>
<tr>
<td>Karamanlidis, A.A.</td>
</tr>
<tr>
<td>Karameros, Nikolaos</td>
</tr>
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<td>Karlberg, Åsa</td>
</tr>
<tr>
<td>Kienast, Felix</td>
</tr>
<tr>
<td>Kiss, Balázs</td>
</tr>
<tr>
<td>Klar, Nina</td>
</tr>
<tr>
<td>Klenke, Reinhard</td>
</tr>
<tr>
<td>Kohler, Yann</td>
</tr>
<tr>
<td>Konczné Benedicty, Zsusanna</td>
</tr>
<tr>
<td>Kostas, Theodorou</td>
</tr>
<tr>
<td>Kovács, Tibor</td>
</tr>
<tr>
<td>Kozár, Ferenc</td>
</tr>
<tr>
<td>Krajča, Tomáš</td>
</tr>
<tr>
<td>Krambokoukis, L.</td>
</tr>
<tr>
<td>Kristek, Vladimir</td>
</tr>
<tr>
<td>Kruidering, Anne Martine</td>
</tr>
<tr>
<td>Kusak, Josip</td>
</tr>
<tr>
<td>Kutil, Miroslav</td>
</tr>
</tbody>
</table>

**Index of authors**

<table>
<thead>
<tr>
<th>L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lambrechts, Jorg</td>
</tr>
<tr>
<td>Lammerant, Johan</td>
</tr>
<tr>
<td>Lampou, E.</td>
</tr>
<tr>
<td>Lang, Stefan</td>
</tr>
<tr>
<td>Langton, T.E.S.</td>
</tr>
<tr>
<td>Larsson, Magnus</td>
</tr>
<tr>
<td>Larsson, Sofia</td>
</tr>
<tr>
<td>Lehoczki, Róbert</td>
</tr>
<tr>
<td>Leitão, Inês</td>
</tr>
<tr>
<td>Lennartsson, Tommy</td>
</tr>
<tr>
<td>Lasbarrères, David</td>
</tr>
<tr>
<td>Lindberg, Gunnar</td>
</tr>
<tr>
<td>Lindberg, Niklas</td>
</tr>
<tr>
<td>Lindqvist, Mats</td>
</tr>
<tr>
<td>Loscialo, John</td>
</tr>
</tbody>
</table>

**Index of authors**

<table>
<thead>
<tr>
<th>M</th>
</tr>
</thead>
<tbody>
<tr>
<td>Madrigan, Francis</td>
</tr>
<tr>
<td>Madrignant, Luis F.</td>
</tr>
<tr>
<td>Madsen, Aksel Bo</td>
</tr>
<tr>
<td>Maia, Ana Carolina</td>
</tr>
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<td>Markolt, Ferenc</td>
</tr>
<tr>
<td>Marques, Helena</td>
</tr>
<tr>
<td>Marques, J. Tiago</td>
</tr>
<tr>
<td>Martin, Anne</td>
</tr>
<tr>
<td>Mata, Rosa María</td>
</tr>
<tr>
<td>Matos, Hugo</td>
</tr>
<tr>
<td>Mayer, Jan</td>
</tr>
<tr>
<td>Mechura, Timea</td>
</tr>
<tr>
<td>Medinas, Denis</td>
</tr>
<tr>
<td>Melin, Anna</td>
</tr>
<tr>
<td>Mertzanis, Yorgos</td>
</tr>
<tr>
<td>Metzger, Jean Paul</td>
</tr>
<tr>
<td>Mináríková, T.</td>
</tr>
<tr>
<td>Mira, António</td>
</tr>
</tbody>
</table>
Moelants, Marleen ................................28, 33
Mőlich, Thomas ................................23, 65
Mörtberg, Ulla ..................................18, 38
Mountrakis, Giorgos ..........................17, 30
Musilová, Radka ................................26, 89
Mykitchak, Taras ..............................21, 55
Myśliak, Robert .................................27, 28, 92, 94

N
Nachman, Gösta ................................25, 80
Nagy, Barnabás ..................................23, 68
Navás, Ferran ...............................20, 24, 49, 52, 73
Neubert, Marco ................................24, 70
Niemi, Milla .....................................24, 75
Nilsson, Lars .....................................18, 28, 34
Noros, Misako ...................................20, 47
Nowak, Sabina ..................................27, 28, 92, 94
Nummi, Petri ....................................24, 75
Nuti, Sabrina ....................................19, 46

O
O’Rourke, E. ......................................18, 35
Olsson, Mattias .................................24, 25, 27, 76, 83, 90
Otthurg, Fabrice .................................18, 22, 37, 61

P
Palacín, Carlos .....................................21, 56
Palmenguela, Valle ................................20, 52
Panagiotis, Dimitrakopoulos ...............22, 62
Panzacchi, Manuela .............................25, 81
Péncik, Jan .......................................19, 21, 26, 43, 60, 87
Peris Álvarez, Salvador José ..................19, 20, 40, 41, 51
Pernkopf, Lena ....................................19, 44
Pilla, Marcello ...................................26, 86
Pinheiro, Paula ...................................17, 31
Poirazides, Kosmas ..............................22, 62
Pontoppidan, Maj-Britt .........................25, 80
Ponzetta, Maria Paola .........................19, 46
Puig, Jordi .......................................20, 50
Puky, Miklós ....................................19, 22, 26, 28, 43, 62, 88

R
Ratyńska, Halina ..................................26, 86
Remolar, A. ......................................20, 26, 53, 84
Reshetyo, Ostap ..................................21, 55
Reoto, Dyana ....................................17, 31
Riegler, Susan ...................................22, 62
Rodríguez, Alexandra .........................20, 52
Romportl, Dušan .................................23, 25, 64, 82
Rosal, Antonio ...................................20, 52
Rosell, Carme ....................................20, 24, 26, 49, 52, 73, 90

S
Saga, Ayami ......................................20, 47
Sánchez, Jesús R. ...............................20, 52
Sangwine, Tony ..................................28, 93
Santos-Reis, Margarida ..........................17, 31
Sá-Sousa, Paulo ..................................17, 32
Schmid, Christian ...............................24, 72
Schueler, Frederick W .........................24, 74
Schultz, Björn ....................................24, 71
Schwarz-von Raumer, Hans-Georg .......19, 23, 44, 64
Schwick, Christian ..............................19, 44
Seiler, Andreas .................................24, 25, 27, 28, 76, 83, 90, 95
Seoane, Javier ...................................21, 56
Siller, José Miguel ...............................26, 90
Silva, Carmo .....................................19, 41
Silva, Filipe .....................................17, 31
Simeonova, Vanya ..............................24, 75
Simões, M. Paula ................................19, 41
Sjölund, Anders .................................23, 25, 70, 83
Slezak, Barbara ..................................26, 87
Snep, Robbert ....................................22, 61
Soanes, Kylie ....................................21, 59
Sorbetti-Guerri, Francesco ..................19, 46
Soukop, Tomas ..................................19, 44
Sousa, Cláudia O. M. ...........................18, 34
Sousa, Joana .....................................17, 31
Spangenberg, Annette .........................28
Spooner, Peter G. ..............................23, 66
Stegehuis, Bert ..................................18, 33
Stout, J. ..........................................21, 57
Strand, Olav .....................................25, 81
Strein, Martin .................................24, 77
Strnad, Martin .................................23, 25, 64, 82
Suárez, Francisco ...............................21, 56
Szemethy, László ...............................20, 47
Szita, Áva ......................................23, 68
Szővényi, Gergely ...............................22, 62

T
Tanskanen, Ari ....................................24, 75
Thompson, R. ...................................18, 21, 35, 57
Török, János ....................................18, 37
Torres, Aurora .................................21, 56
Tragos, Athanassios .........................21, 58
Trocmé, Marguerite ............................24, 72
Tsaknakis, Ioannis ..............................22, 62

V
Vági, Balázs ......................................18, 37
Valchev, Kostadin ..............................27, 28, 91, 95
van der Grift, Edgar A .........................18, 22, 24, 36, 37, 61, 75
van der Ree, Rodney .........................18, 21, 36, 59
Van Moerter, Bram ...........................25, 81
Vávrová, Eva ...................................25, 82
Vera, P ...........................................20, 24, 26, 52, 53, 73, 84
Villarroya, Ana ..................................20, 50
Vogel, Jochen ...................................23, 65
Index of authors

W

Wagner, Matthias .........................20, 50
Wagner, Paul J............................28, 93
Walter, Martina ...........................18, 38
Wang, Shaowei ............................24, 76
Whelan, P.M. ..........................18, 21, 23, 35, 57, 69
Widén, Per ...............................24, 27, 76, 90
Winbladh, Jens K..........................27, 91

Wojciuch-Płoskonka, Marta...........19, 42
Wojterska, Maria .........................26, 86

Z

Žák, Jaroslav ...............................26, 87
Zavadil, Vít.................................26, 89
Zlatanova, Diana......................27, 28, 91, 95
„On dangerous roads”
Selected drawings of the IENE 2010 children's competition